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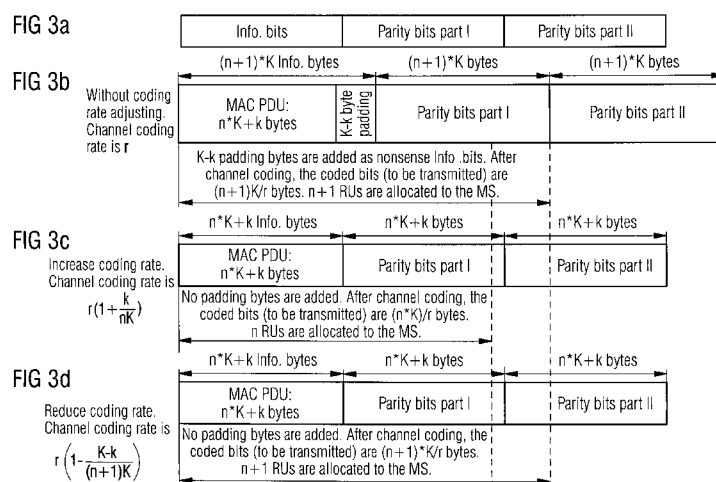
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(54) Title: METHOD, COMMUNICATION DEVICE AND COMMUNICATION SYSTEM FOR DETERMINING A CHANNEL CODING RATE FOR REMOVING PADDING OVERHEAD IN A DATA TRANSMISSION



(57) Abstract: Method (12) of determining a channel coding rate for removing padding overhead in a data transmission, comprising determining (1) a modulation coding scheme level having a first channel coding rate; determining (2) an amount of data to be transmitted; determining (3) a number of resource units required for accommodating the amount of data to be transmitted; wherein each resource unit has a defined data capacity; and wherein the first channel coding rate is indicative for the data capacity; determining (4) a remaining amount of data; wherein the remaining amount of data is the modulus of the amount of data to be transmitted and the data capacity of a resource unit; and determining (5) a second channel coding rate such that the amount of data to be transmitted is a whole-number multiple of the data capacity of one resource unit when employing the second channel coding rate.

Method, communication device and communication system for de-
termining a channel coding rate for removing padding overhead
5 in a data transmission

Technical field of the invention

10 The present invention relates to wireless communication in general. More particularly, it relates to a method, a network node, a mobile communication device, a communication system, a computer-readable medium and a program element for increasing the efficiency or robustness of a data transmission. In particular,
15 it relates to removing padding overhead of a data transmission.

Background of the invention

20 In wireless communication, in particular in communication using the IEEE 802.16 standard, information is transmitted by using data bursts in the physical layer. For example, data may be transmitted wirelessly as electromagnetic radiation.

25 Each data burst may contain one or multiple protocol data units (PDUs) of the medium access control layer (MAC). Each MAC PDU may be considered to contain a defined number of information bytes. In the case that multiple MAC PDUs are contained in one physical layer burst or data burst the MAC PDUs may be directly
30 concatenated.

In case one communication entity is about to establish a communication link to another communication entity, special parameters for the communication link may have to be determined for
35 establishing and defining said communication link.

For example, when a network node tries to communicate with a mobile communication device, a physical layer burst (PHY burst) may be allocated to the mobile communication device for receiving and/or transmitting upload/download MAC PDU data.

To initiate an according communication connection, the network node may start by determining a suitable modulation coding scheme level, including a modulation coding scheme, a modulation order, a channel coding rate and a multiple input multiple output (MIMO) rank.

The aforementioned parameters may be determined based upon channel state information of the communication channel and a (target) block error rate of the transmission.

The network node may subsequently decide upon or determine the size of a physical layer burst based on the size of the MAC PDU(s) to be transmitted, the determined modulation coding scheme (MCS) level and the number of data subcarriers in a resource unit (RU).

The size (in bits/bytes) of the information transmitted in the MAC PDUs in a PHY burst may be indicated to a mobile communication device by the network node indicating the size of the PHY burst (e.g. in the number of resource units allocated to the mobile communication device) and the modulation coding scheme level.

The mobile communication device may then decode the PHY burst and subsequently the MAC PDUs. Information embedded in the header of the MAC PDU may be indicative of the size of the PDU.

Following, the mobile communication device may determine the size of the PDU by using the embedded information, may subsequently determine the information bytes of the MAC PDU and may remove padding information or padding bits.

5

A mobile communication device may also be a mobile station (MS).

Padding information or padding bits may be inserted into a MAC PDU in case that there are not sufficient information bits/bytes to fully occupy a MAC PDU.

This may be because a MAC PDU is of standardized size, whereas information to be transmitted may have an arbitrary value and the size of the information may be in particular be uncorrelated to the size of the MAC PDU.

The granularity, i.e. the increments between individual values between feasible PHY bursts, may be considered to be large, e.g. in an IEEE 802.16 communication environment.

For example, in download mode with two transmission antennas, there may be 96 subcarriers per resource unit. In case the modulation coding scheme is 16 QAM with 1/2 coding rate and a single spatial data stream, one resource unit may transmit 24 MAC information bytes.

A PHY burst may be able to contain the MAC PDU to be transmitted. Following, the size of the information that the whole PHY burst may contain may be larger than the size of the information to be transmitted.

Consequently, unused transmission capacity, i.e. unused capacity of the PHY burst or a single MAC PDU, may have to be padded with nonsense information bytes.

- 5 Continuing the example indicated above (24 information bytes per resource unit) 125 bytes are assumed to be transmitted.

Thus, six resource units may be allocated to the transmission, with each resource unit providing 24 bytes of information capacity. Consequently 19 bytes (6 RU x 24 bytes - 125 info
10 bytes) nonsense padding bytes may have to be added as overhead.

Padding may be considered to constitute a large overhead in a communication.

15

In document IEEE 802.16Ref2/D6, "IEEE draft standard for local and metropolitan area networks - part 16: Air interface for fixed broadband wireless access systems", June 2008 a communication system according to IEEE 802.16 standard and modulation
20 coding schemes are described.

In document IEEE 802.16m-08/003r4, "Draft IEEE 802.16m Requirements," 2008-7-29, data subcarriers and resource units are described.

25

In document IEEE C802.16m-08/660, "Rate matching in 802.16m", Motorola, July 2008 rate matching in a communication system according to IEEE 802.16m is described.

- 30 There may be a need to provide communication capability with reduced susceptibility to padding overhead, thus increased communication efficiency.

Summary of the invention

Thus, a method of determining a channel coding rate for removing padding overhead of a data transmission, a method for employing a new channel coding rate for removing padding overhead of a data transmission, a network node, a mobile communication device, a communication system, a computer-readable medium and a program element according to the independent claims are provided.

- 10 According to an exemplary embodiment of the present invention, a method of determining a channel coding rate for removing padding overhead in a data transmission is provided, comprising determining a modulation coding scheme level having a first channel coding rate and determining an amount of data to be
- 15 transmitted. The method further comprises determining a number of resource units required for accommodating the amount of data to be transmitted, wherein each resource unit has a defined data capacity and wherein the first channel coding rate is indicative for the data capacity. Furthermore, a remaining amount
- 20 of data is determined, wherein the remaining amount of data is the modulus of the amount of data to be transmitted and the data capacity of a resource unit. A second channel coding rate is then determined such that the amount of data to be transmitted is a whole-number multiple of the data capacity of one resource unit when employing the second channel coding rate.
- 25

- According to a further exemplary embodiment of the present invention, a method for employing a channel coding rate for removing padding overhead in a data transmission is provided,
- 30 comprising receiving an indication of a modulation coding scheme level having a first channel coding rate, a number of resource units, an adjustment of the first channel coding rate and a remaining amount of data. The method further comprises determining a second channel coding rate in accordance with the

first channel coding rate, the number of resource units, the indication of an adjustment of the first channel coding rate and the remaining amount of data and employing the second channel coding rate for data transmission with a communication entity.

According to a further exemplary embodiment of the present invention a network node is provided, comprising a determination unit for determining a modulation coding scheme level having a first channel coding rate, a determination unit for determining an amount of data to be transmitted, a determination unit for determining a number of resource units required for accommodating the amount of data to be transmitted, a determination unit for determining a remaining amount of data and a determination unit for determining a second channel coding rate, wherein the network node is adapted to carry out the method according to the present invention.

According to a further exemplary embodiment of the present invention a mobile communication device is provided, comprising a sending and receiving unit for receiving an indication of a modulation coding scheme level, a first channel coding rate, a number of resource units, an adjustment of the first channel coding rate and a remaining amount of data. The communication device further comprises a determination unit for determining a second channel coding rate and a unit for employing the second channel coding rate. Furthermore, the communication device is adapted to carry out the method according to the present invention.

According to a further exemplary embodiment of the present invention a communication system is provided, comprising a network node according to the present invention and a mobile communication device according to the present invention.

According to a further exemplary embodiment a computer-readable medium is provided in which a computer program is stored, which, when being executed by a processor is adapted to carry out one of the methods according to the present invention.

According to a further exemplary embodiment of the present invention a program element is provided, which, when being executed by a processor, is adapted to carry out one of the methods according to the present invention.

In the following, further embodiments of the present invention are described referring in particular to a method of determining a channel coding rate for removing padding overhead of a data transmission, a method for employing a new channel coding rate for removing padding overhead of a data transmission, a network node, a mobile communication device, a communication system, a computer-readable medium and a program element.

However, arbitrary variations and interchanges of single and multiple features between the claimed entities is conceivable and within the scope and disclosure of the present patent application.

It is also noted, that embodiments and aspects of the present invention have been described with respect to different subject-matters.

In particular, some embodiments have been described with reference to apparatus type claims, whereas other embodiments have been described with reference to method type claims.

However, a person skilled in the art will gather from the above and the following description that, unless notified, in addi-

tion to any combination features belonging to one type of subject-matter also any combination between features relating to different subject-matters, in particular between features of apparatus claims and features of method claims is considered to
5 be disclosed with this application.

These and other aspects of the present invention will become apparent from and elucidated with reference to the embodiments described hereinafter.

10

The present invention proposes a method of adjusting the information data capacity of a resource unit so that a single or multiple resource units substantially or precisely match the length, i.e. the amount of bits/bytes, of data to be transmitted.
15 ted. The information data capacity, or data capacity, thus may match the amount of the data to be transmitted, or the data to be transmitted may be an integral plurality, thus a whole-number plurality, of data capacity of a resource unit.

20 Consequently, as the data capacity closely or precisely matches the data to be transmitted, padding overhead of the data transmission may be minimized or completely removed.

This matching of the data capacity to the data to be transmitted may be achieved by adjusting at least one of the communication, connection, coding and/or modulation parameters defining a communication connection.
25

At least one of the aforementioned parameters may be considered to directly influence and definely set the data capacity of a
30 resource unit to match the amount of data to be transmitted.

For example, $n+1$ resource units may be allocated to a PHY burst with a certain number of padding bits being added to the last,

the (n+1)th resource unit. Following, two possibilities for removing the overhead from padding are conceivable.

The information data capacity of a resource unit may be increased by increasing the channel coding rate to a certain value, so that the information to be transmitted, the MAC PDU(s) may fit in n resource units. By increasing the channel coding rate, the overhead of padding bits may be removed and one resource unit may be saved, thus improving bandwidth efficiency.

It may also be conceivable that information data capacity of the resource units may be reduced by reducing the coding rate to a certain value so that the data to be transmitted, the MAC PDUs, may fit precisely in n+1 resource units. By reducing the channel coding rate, the overhead of padding bits may be removed, however consequently, the transmission robustness may be improved in this scenario without consuming additional bandwidth.

To arrive at an adjustable coding rate as required for the present invention, the coding rate may need to be very flexible, i.e. the coding rate may need to be of contiguous, continuous value.

A modulation order for determining a proper modulation coding scheme level may for example be QPSK, 16-QAM and 64-QAM.

According to a further exemplary embodiment of the present invention, the second channel coding rate may be determined in accordance with at least one element out of the group consisting of the modulation coding scheme level having a first channel coding rate, the first channel coding rate, a channel state, a target block error rate, the data capacity, the amount of data to be transmitted and the remaining amount of data.

When employing at least one element of this group, the second channel coding rate may be adapted especially well to an existing channel condition, i.e. a channel quality or channel robustness. In particular, a channel state and/or a (target) block error rate may be used to determine whether the second channel coding rate may be higher or lower than the first channel coding rate.

- 10 For example, the channel coding rate may be increased until a certain maximum target block error rate is arrived at. On the other hand, the second channel coding rate may be reduced over the first channel coding rate.
- 15 If it is determined, after increasing the channel coding rate, that the obtained block error rate is still better than the target block error rate, the channel coding rate may be increased. If it is determined, that the block error rate is higher than the target block error rate, the channel coding
- 20 rate may be reduced.

Thus, a specific tailoring of the second channel coding rate to existing communication/channel conditions may influence the determination of the second channel coding rate.

25

According to a further exemplary embodiment of the present invention, the modulation scheme level, the first channel coding rate, the number of resource units, the adjustment of the first channel coding rate and the remaining amount of data may be indicated to a communication entity.

30

Thus, the determination of a second channel coding rate may be performed by the communication entity being signaled without the need to determine the respective parameters itself.

Minor variations in the parameters when determining the parameters may be avoided, which would result in a (slightly) different channel coding rate employed by different communication entities.

Furthermore, since the method of the present invention may be considered to not provide distinct, discrete values for the channel coding rate but rather a contiguous, continuous coding rate, the signaling of the individual parameters may reduce the complexity of signaling a channel coding rate with a required, high precision.

According to a further exemplary embodiment of the present invention, the second channel coding rate may be employed for data transmission with a communication entity.

By using the second channel coding rate for data transmission, the data transmission and/or the communication channel may be specifically tailored to special requirements. The requirements themselves may also have contributed to the determination of the second channel coding rate.

According to a further exemplary embodiment of the present invention, the use of the method for determining a channel coding rate for removing padding overhead in a data transmission may be indicated to a communication entity.

Thus, a backward compatibility may be achievable with a system not being adapted for the use of the method according to the present invention.

Communication entities capable of employing both a regular communication method without determining a second channel coding

rate and a method according to the present invention may determine whether the method according to the present invention is used by a communication entity and thus may be able to adapt its communication behavior, like for example omit receiving or
5 discarding received parameters only required for employing the method according to the present invention.

Furthermore, the indication may allow to implement the method according to the present invention in an easy and simple way
10 without radical design changes in known communication entities.

For example, modulation coding scheme information and the size of a PHY burst (number of resource units) may be provided to a communication entity in a known way.

15 Furthermore, a flag bit may indicate whether the method is used for this particular burst or at least some of the following bursts. For example, the flag may be determined in the UL/DL-map-IE data structure.

20 A further bit may indicate whether the coding rate is to be increased or reduced. The presence of this bit may depend on the value of the first flag bit in the UL/DL-map-IE data structure.

25 Following, several other bits may be used to indicate the amounts of bytes to be adjusted, i.e. the remaining amount of data. The presence of these bits may depend as well on the value of the first flag bit.

30 According to a further exemplary embodiment of the present invention, the adjustment of the first channel coding rate may be one of the group consisting of a reduction of the first channel coding rate and an increase of the first channel coding rate.

As also explained earlier, the first channel coding rate may be adjusted by either increasing or decreasing the channel coding rate according to channel conditions/channel quality and/or desired target block error rate.

5

By increasing the coding rates, one resource unit may be saved so that bandwidth efficiency is improved. Also, the data capacity of one resource unit may be considered to increase as well.

- 10 By reducing the coding rates, the transmission robustness may be improved without consuming more bandwidth.

According to a further exemplary embodiment of the present invention, the network node may further comprise at least one

- 15 unit out of the group consisting of a unit for setting the first channel coding rate to the second channel coding rate, a unit for employing the second channel coding rate and a sending and receiving unit for indicating a modulation coding scheme level, a first channel coding rate, a number of resource units,
20 an adjustment of the first channel coding rate and a remaining amount of data to a communication entity.

Exemplary embodiments of the present invention will be described below with reference to the following drawings.

25

The illustration in the drawings is schematic. In different drawings, similar or identical elements are provided with similar or identical reference numerals.

- 30 Figures are not drawn to scale, however may depict qualitative proportions.

Brief description of the drawings

Fig. 1a,b show exemplary embodiments of the method of determining a channel coding rate for a moving padding overhead in a data transmission and of the method for employing a channel coding rate for removing padding overhead in a data transmission according to the present invention,

Fig. 2 shows an exemplary embodiment of a communication system comprising a network node and a communication device according to the present invention,

Fig. 3a-d show an exemplary code rate adjustment for minimizing padding overhead of a data transmission according to the present invention.

Detailed description

Now referring to Fig. 1a, an exemplary embodiment of the method of determining a channel coding rate for removing padding overhead in a data transmission is depicted.

In step 1 a modulation coding scheme level is determined. A first channel coding rate may be determined separately or as part, being defined by, the modulation coding scheme level.

Following the amount of data to be transmitted is determined.

The amount, the value, the length of the data to be transmitted may preferably be expressed in bits/bytes.

Following, the number of resource units required for accommodating the amount of data to be transmitted is determined. A resource unit has a defined data capacity in bits/bytes, wherein the data capacity depends on the channel coding rate.

An increased channel coding rate is increasing the data capacity of the resource unit, whereas a decrease of the channel coding rate is decreasing the data capacity.

- 5 The determination of the number of resource units required for accommodating the amount of data to be transmitted may comprise a determination of the number of resource units required to completely transmit the data to be transmitted (wherein $n+1$ is the number of required resource units). Following, the $(n+1)$ th
10 resource unit is required for transmitting the remaining amount of data.

- As a next step 4, the remaining amount of data is determined as described earlier. The remaining amount of data is the modulus
15 (mathematical function - i.e. the remainder) of the amount of data to be transmitted and the data capacity of a resource unit.

- Thus, it may be considered to be that (extra) amount of data
20 (in bits/bytes) for which the data capacity of the $(n+1)$ th resource unit is required over the data capacity of the n resource units.

- In step 5, the second channel coding rate is determined so that
25 the amount of data to be transmitted is a whole-number multiple of the data capacity of one resource unit, with the data capacity of the resource unit being indicated by the second channel coding rate.

- 30 In other words, the second channel coding rate is adjusted so that the data capacity of an associated resource unit multiplied by a whole-number is exactly matching the amount of data to be transmitted.

When determining a second channel coding rate, further elements of the communication channel may have to be considered, for example an increase in channel coding rate may also increase a block error rate of the channel, thus decreasing the robustness.

If the channel state or the channel quality is not sufficiently high to allow such an increase of the coding rate, i.e. the so obtained block error rate is higher than the allowed, target block error rate, an increase of the channel coding rate may not be allowable. In such a case, a decrease of the channel coding rate may be considered, thus resulting in a more robust data transmission without consuming additional bandwidth.

So, the omission of padding overhead may be interpreted as utilizing that part of the data transmission allocated to the padding overhead for either increasing the bandwidth efficiency or increasing transmission robustness.

A decision whether to increase or decrease the channel coding rate may depend on at least one element out of the group consisting of the modulation coding scheme level, the first channel coding rate, a channel state, a target block error rate, a data capacity, the amount of data to be transmitted and the remaining amount of data and may also be performed in step 5.

A decision is made whether to increase or decrease the channel coding rate and subsequently in step 6 an indication of the required parameters (modulation coding scheme level, first channel coding rate, number of resource units, adjustment of the first channel coding rate (increase or decrease) and the remaining amount of data) is indicated to a communication entity.

Furthermore, the use of the method of determining a channel coding rate for removing padding overhead in a data transmission may be indicated to a communication entity in step 6 as well.

5

Following, the determined second channel coding rate may be employed for a data transmission with the communication entity.

10 This employing or setting of the second channel coding rate as the (employed) channel coding rate for the data transmission may either be performed in step 5 or step 6.

Referring now to Fig. 1b, a method for employing a channel coding rate for removing padding overhead in a data transmission
15 is depicted.

In step 7, an indication of a modulation coding scheme level having a first channel coding rate, a number of resource units, an adjustment of the first channel coding rate and a remaining
20 amount of data may be received by a communication entity.

Step 7 may be considered to be the counterpart of step 6 on the receiving side when negotiating the parameters of a data transmission, whereas step 6 may be considered to be on the sending,
25 initiating side.

In step 8, a second channel coding rate is determined by using the first channel coding rate, the number of resource units, the indication of an adjustment of the first channel coding rate (increased or decreased channel coding rate) and the remaining
30 amount of data.

The determination in step 8 may be considered to be a mere calculation to obtain the second channel coding rate without the

need for specifically determining (i.e. measuring or decoding) individual parameters. An identical determination procedure is performed similar to step 5, so to arrive at an identical channel coding rate with high precision.

5

In step 9 the calculated second channel coding rate is employed for the data transmission with a communication entity.

Now referring to Fig. 2, an exemplary embodiment of a communication system comprising a network node and a communication device according to the present invention is depicted.

10

The communication system 20 comprises a network node 10 and a mobile communication device 11.

15

Both the network node 10 and the communication device 11 feature a microprocessor 21a,b, a memory unit 23a,b and a sending and receiving unit 27a,b.

20 The network node 10 and the communication device 11 are connectable for data transmission using the sending and receiving units 27a,b and may establish a communication link using the sending and receiving units 27a,b.

25 The sending and receiving units 27a,b are depicted as a single antenna, however multiple antennas or an antenna array are conceivable as well.

The network node 10 is connected by a communication link 31 to
30 a communication network 30 of a communication provider.

The communication device may further comprise a display unit 22, an input unit 26 as well as a microphone 24 and a speaker unit 25.

The microprocessor 21b and the memory unit 23b of network node 10 may comprise the functionality of a determination unit for determining a modulation coding scheme level having a first
5 channel coding rate, a determination unit for determining an amount of data to be transmitted, a determination unit for determining a number of resource units required for accommodating the amount of data to be transmitted, a determination unit for determining a remaining amount of data and a determination unit
10 for determining a second channel coding rate. Furthermore, the method according to the present invention may be carried out by a microprocessor 21b and memory unit 23b.

Microprocessor 21b and memory unit 23b may also comprise the
15 functionality of a unit for setting the first channel coding rate to the second channel coding rate and of a unit for employing the second channel coding rate.

However, it is also conceivable that these units are imple-
20 mented separately in independent units within the network node 10, e.g. as dedicated electronic circuits.

The microprocessor 21a and the memory unit 23a of communication device 11 may be adapted to comprise the functionality of a de-
25 termination unit or determining a second channel coding rate and a unit for employing the second coding rate. Furthermore, microprocessor 21a and memory unit 23a may be adapted to carry out the method according to the present invention.

30 However, it is also conceivable that these units are implemented as separate, independent units within the mobile communication device 11, e.g. as dedicated electronic circuits.

Now referring to Fig. 3a to d, an exemplary code rate adjustment for minimizing padding overhead of a data transmission according to the present invention is depicted.

- 5 Fig. 3a shows data to be transmitted consisting of information bits and parity bits part 1 and 2.

For the further explanations it may be assumed that modulation coding scheme is selected from a set of discontinuous values
10 e.g. like 8 different types of modulation coding schemes.

A network node may select the modulation coding scheme based on a channel state and a block error rate. The associated channel coding rate may be denoted as r .

15

One resource unit may be able to transmit a maximum of K information bytes, depending on the modulation coding scheme.

The size of the MAC PDU (or concatenated MAC PDUs - i.e. the
20 size of the data transmission, the amount of the data to be transmitted is $K \cdot n + k$ bytes with $0 < k \leq K$.

Depending on the MAC PDU size and the modulation coding scheme, $(n+1)$ resource units may be allocated to a communication entity
25 for transmitting the PHY burst.

In a system according to Fig. 3b, no coding rate adjustments may be performed. Following, $K-k$ nonsense bytes are padded as information bytes after the MAC PDU. Thus, an entirety of
30 $(n+1) \cdot K$ bytes (i.e. $K \cdot n + k$ bytes from the MAC PDU and $K-k$ padding bytes) are to be encoded. The coded bits after channel coding result in $(n+1) \cdot K/r$ bytes. The PHY channel coding rate is r .

As can be taken from Fig. 3b, the inability to adjust the coding rate results in additional data, i.e. the padding data to be transmitted in addition to the information bits (compare to Fig. 3a). This results in lengthening the data transmission as
 5 can be taken from Fig. 3b.

In Fig. 3c, an increase in the channel coding rate is depicted. For example, the network node may increase the coding rate by transmitting the $K \cdot n + k$ info bytes (without padding bytes) in n
 10 resource units. The coded bits after channel coding thus result in $n \cdot K / r$ bytes.

The increased channel coding rate r_{inc} is

$$15 \quad r_{inc} = \frac{n \cdot K + k}{\frac{n \cdot K}{r}} = r \cdot \left(1 + \frac{k}{n \cdot K} \right)$$

Consequently, each resource unit when using an increased coding rate is able to transmit slightly more data as opposed to a data transmission without channel coding rate adjustment (increase)
 20 according to Fig. 3b.

In Fig. 3d, a reduction of the coding rate is depicted. The coding rate is reduced to transmit the $(K \cdot n + k)$ information bytes (without padding bytes) in $(n+1)$ resource units. The
 25 coded bits after channel coding are $(n+1) \cdot K / r$ bytes.

The reduced channel coding rate r_{red} is

$$r_{red} = \frac{n \bullet K + k}{(n+1) \bullet K} = r \bullet \left(1 - \frac{K - k}{(n+1) \bullet K} \right)$$

The determination or selection whether to increase or reduce the coding rate may be performed by the network node. The network node may utilize channel state information and a target block error rate for the determination.

To provide information about the coding rate adjustment the network node may indicate to another communication entity the following information by explicit signaling:

The modulation coding scheme level including the channel coding rate r , the number of resource units, the value of k and the mode (increasing or reducing coding rate).

It may also be conceivable, that the channel coding rate is adjusted in a way so that not an adjacent value for the resource units is obtained but rather a value further away from n , like for example $n+5$ or $n-7$. For an according adjustment, the target block error rate, the channel state, the desired channel bandwidth and or the desired robustness of the transmission may provide limiting boundaries.

Parity bits part I and II displayed in Fig. 3a-d may be produced by the convolutional turbo code according to e.g. IEEE 802.16e. Depicted is an example, wherein a mother code is a rate 1/3 code.

It should be noted that the term "comprising" does not exclude other elements or steps and that "a" or "an" does not exclude a

plurality. Also, elements described in association with different embodiments may be combined.

It should also be noted, that reference signs in the claims
5 shall not be construed as limiting the scope of the claims.

A computer-readable medium may be a floppy disk, a CDROM, a DVD, a harddisk, a USB (Universal Serial Bus) storage device, a RAM (Read Access Memory), a ROM (Read Only Memory) and an EPROM
10 (Erasable Programmable Read Only Memory).

A computer-readable medium may also be a data communication network, e.g. the Internet, which allows downloading a program code.

Reference Numerals

	1	Step: Determining a modulation coding scheme level
	2	Step: Determining an amount of data to be transmitted
5	3	Step: Determining a number of resource units
	4	Step: Determining a remaining amount of data
	5	Step: Determining a second channel coding rate
	6	Step: Indicating parameters to a communication entity
	7	Step: Receiving an indication of parameters of a communication entity
10		
	8	Step: Determining a second channel coding rate
	9	Step: Employing the second channel coding rate
	10	Network node
	11	Wireless communication device
15	12	Method of determining a channel coding rate for removing padding overhead in a data transmission
	13	Method for employing a channel coding rate for removing padding overhead in a data transmission
	20	Communication system
20	21a,b	Microprocessor
	22	Display unit
	23a,b	Memory unit
	24	Microphone
	25	Speaker unit
25	26	Input unit
	27a,b	Sending and receiving unit
	30	Communication network
	31	Communication link

Patent claims

- 5 1. Method (12) of determining a channel coding rate for removing padding overhead in a data transmission, comprising
determining (1) a modulation coding scheme level having a first channel coding rate;
determining (2) an amount of data to be transmitted;
10 determining (3) a number of resource units required for accommodating the amount of data to be transmitted;
wherein each resource unit has a defined data capacity; and
wherein the first channel coding rate is indicative for the data capacity;
15 determining (4) a remaining amount of data;
wherein the remaining amount of data is the modulus of the amount of data to be transmitted and the data capacity of a resource unit; and
20 determining (5) a second channel coding rate such that the amount of data to be transmitted is a whole-number multiple of the data capacity of one resource unit when employing the second channel coding rate.
- 25 2. Method of claim 1, wherein
the second channel coding rate is determined in accordance with at least one element out of the group consisting of the modulation coding scheme level, the first channel coding rate, a channel state, a target block error
30 rate, the data capacity, the amount of data to be transmitted and the remaining amount of data.
3. Method of claim 1 or 2, further comprising
35 indicating (6) the modulation coding scheme level having the first channel coding rate, the number of resource units, the indication for the adjustment of the first channel coding rate and the remaining amount of data to a communication entity.

4. Method of one of the claims 1 to 3, further comprising
employing (5) the second channel coding rate for data
transmission with a communication entity.
- 5
5. Method of one of the claims 1 to 4, further comprising
indicating (6) the use of the method of determining a
channel coding rate for removing padding overhead in a da-
ta transmission to a communication entity.
- 10
6. Method (13) for employing a channel coding rate for remov-
ing padding overhead in a data transmission, comprising
receiving (7) an indication of a modulation coding
scheme level having a first channel coding rate, a number
of resource units, an adjustment of the first channel cod-
ing rate and a remaining amount of data;
- 15
- determining (8) a second channel coding rate in ac-
cordance with the first channel coding rate, the number of
resource units, the indication of an adjustment of the
first channel coding rate and the remaining amount of da-
ta; and
- 20
- employing (9) the second channel coding rate for data
transmission with a communication entity.
- 25
7. Method according to one of claims 2 to 6, wherein
the adjustment of the first channel coding rate is
one of the group consisting of a reduction of the first
channel coding rate and an increase of the first channel
coding rate.
- 30
8. Network node (10), comprising
a determination unit (21b,23b) for determining a mod-
ulation coding scheme level having a first channel coding
rate;
- 35
- a determination unit (21b,23b) for determining an
amount of data to be transmitted;

a determination unit (21b,23b) for determining a number of resource units required for accommodating the amount of data to be transmitted;

a determination unit (21b,23b) for determining a remaining amount of data; and

a determination unit (21b,23b) for determining a second channel coding rate;

the network node (10) being adapted to carry out the method according to one of claims 1 to 5 and 7.

9. Network node of claim 8, further comprising at least one unit out of the group consisting of

a unit (21b,23b) for setting the first channel coding rate to the second channel coding rate;

a unit (21b,23b) for employing the second channel coding rate; and

a sending and receiving unit (27b) for indicating a modulation coding scheme level having a first channel coding rate, a number of resource units, an adjustment of the first channel coding rate and a remaining amount of data to a communication entity.

10. Mobile communication device (11), comprising

a sending and receiving unit (27a) for receiving an indication of a modulation coding scheme level having a first channel coding rate, a number of resource units, an adjustment of the first channel coding rate and a remaining amount of data;

a determination unit (21a,23a) for determining a second channel coding rate; and

a unit (21a,23a) for employing the second channel coding rate;

the communication device being adapted to carry out the method according to one of claims 6 or 7.

11. Communication system (20), comprising

a network node (10) according to claim 8 or 9; and

a mobile communication device (11) according to claim 10.

12. A computer-readable medium, in which a computer program is
stored, which, when being executed by a processor, is
5 adapted to carry out one of the methods according to at
least one of claims 1 to 7.
13. A program element, which, when being executed by a proces-
sor, is adapted to carry out one of the methods according
10 to at least one of claims 1 to 7.

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FIG 1A

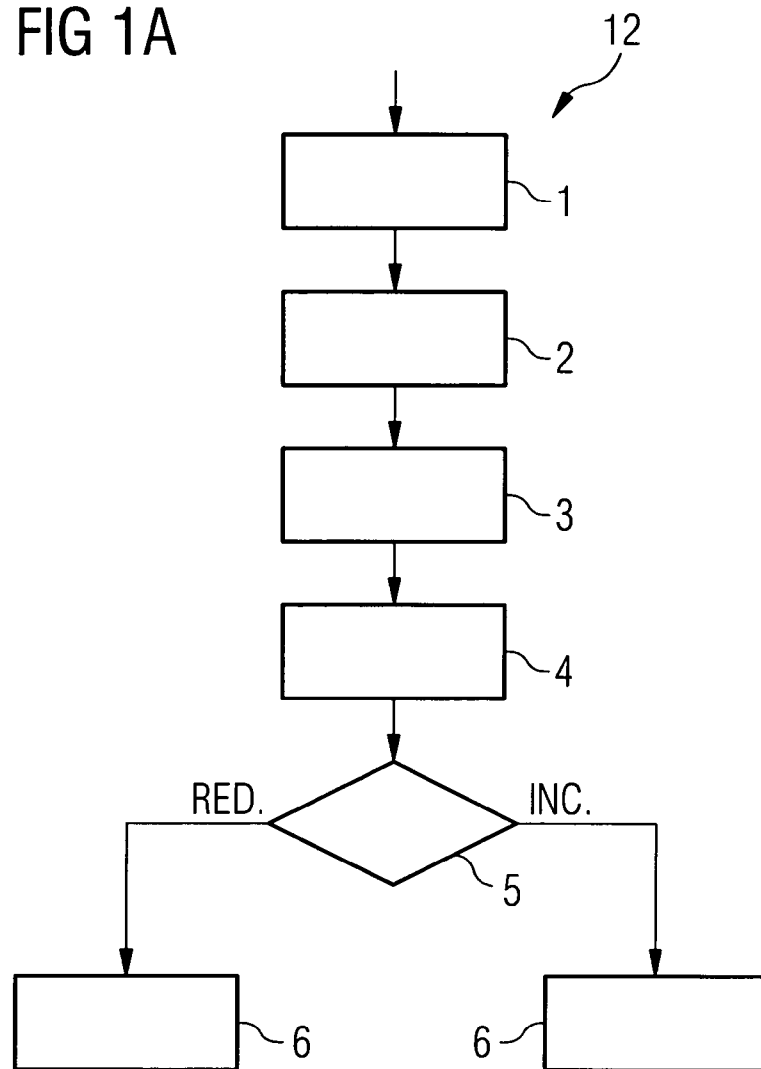


FIG 1B

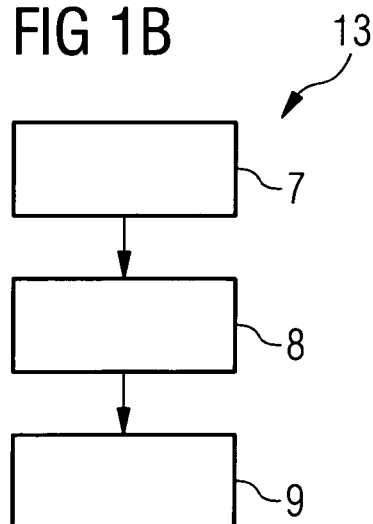


FIG 2

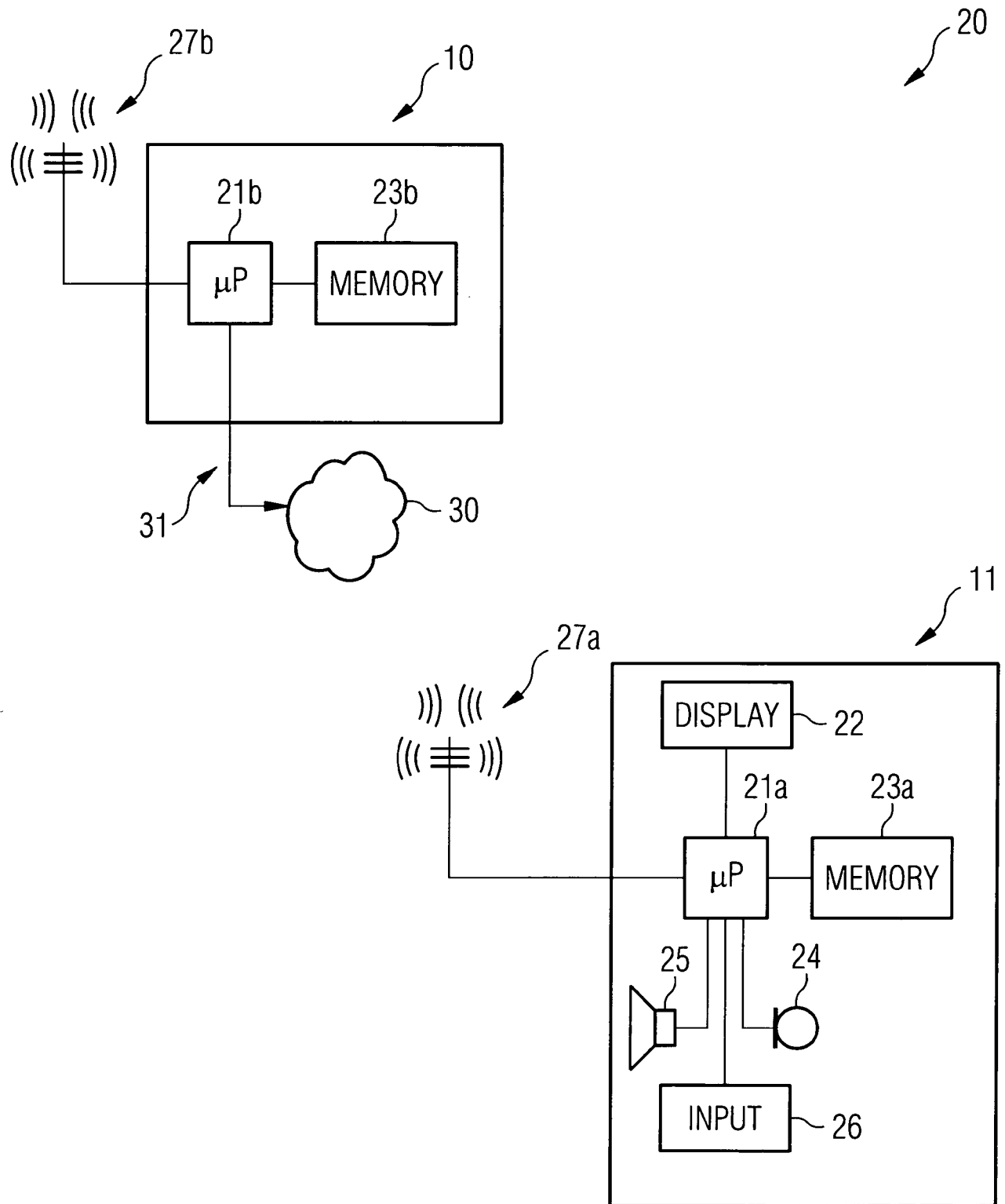
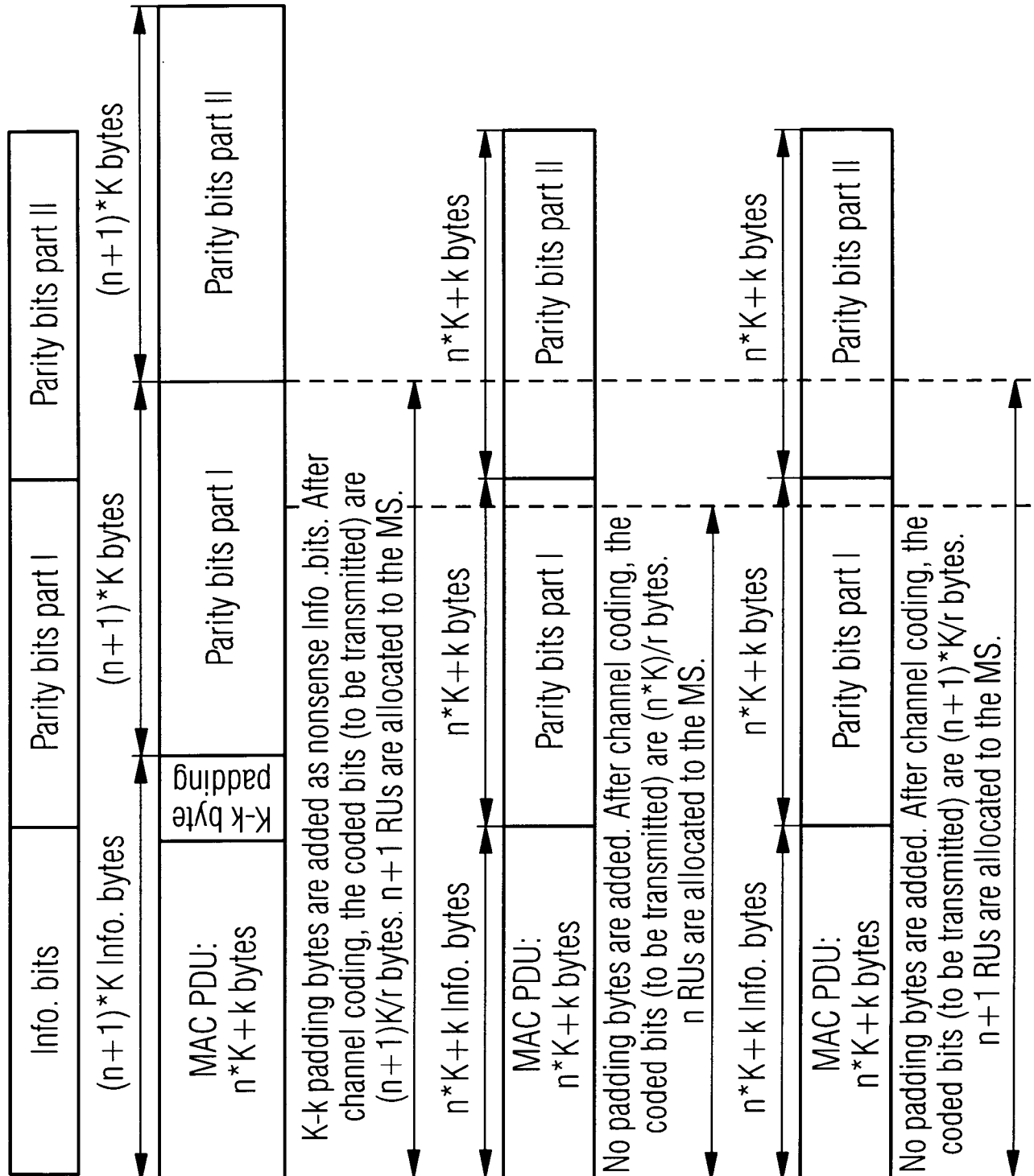
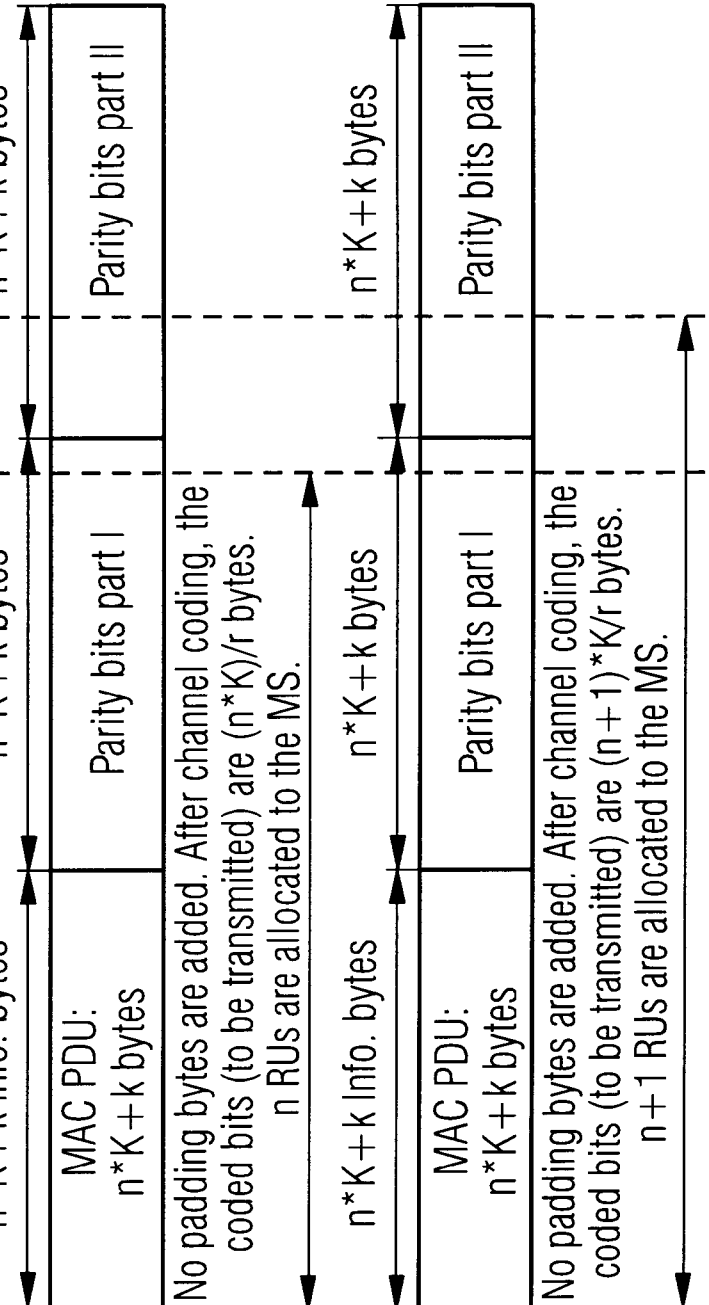


FIG 3a



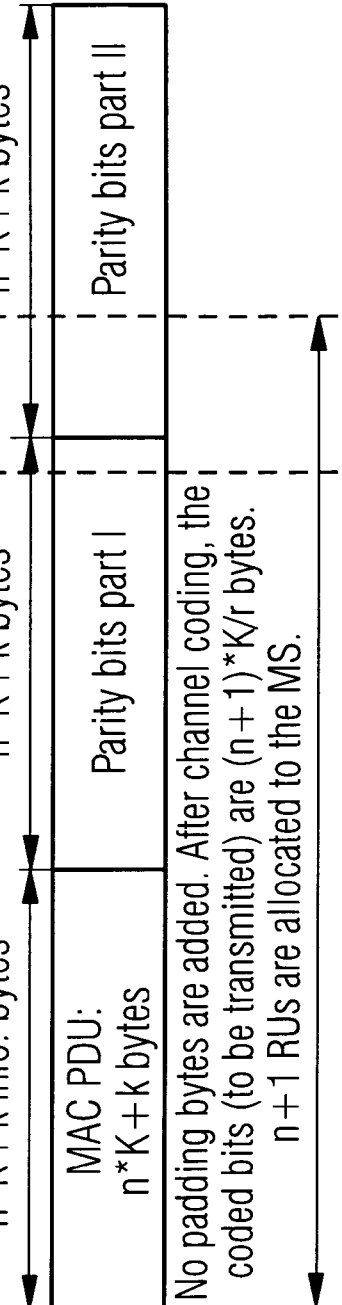
Without coding
rate adjusting.
Channel coding
rate is r

FIG 3c



Increase coding rate.
Channel coding rate is
 $r(1 + \frac{k}{nK})$

FIG 3d



Reduce coding rate.
Channel coding rate is
 $r(1 - \frac{K-k}{(n+1)K})$

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/061376

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04L1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2007/041458 A1 (HOCEVAR DALE E [US] ET AL) 22 February 2007 (2007-02-22) paragraph [0066] - paragraph [0068] -----	1-13
A	WO 2005/022814 A (QUALCOMM INC [US]; VAYANOS ALKINOOS HECTOR [US]; GRILLI FRANCESCO [US]) 10 March 2005 (2005-03-10) paragraph [0147] - paragraph [0149] paragraph [0165] - paragraph [0171] paragraph [0180] - paragraph [0184] ----- -/--	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

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& document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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