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The Procedures at Transmitter and at Receiver defined for LTE

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A B S T R A C T

In this paper, we have explained how the Long Term Evolution LTE transmission is done at the eNode B in downlink DL, we have shown the procedures at the transmitter defined for LTE such as: segmentation, turbo encoding, rate matching, code block (CB) concatenation, modulation, resource mapping and antenna mapping, we saw the two types of rate matching which are: the unbalanced rate matching and the balanced rate matching. In the first type (the unbalanced rate matching), the code blocks CBs at the output of the rate matcher have the same size. In the second type (the balanced rate matching), some code blocks CBs at the output of the rate matcher have the same size. The CB concatenation in both types of rate matching will give a coded transport block (TB) of size G which will be modulated (Q is the modulation order) to obtain (G⁄Q) signals. After the modulation there will be a generation of a subframe which contains Resource Elements (G⁄Q (REs)) of Physical Downlink Shared Channel (PDSCH) which carry (G⁄Q) signals resulting from the modulation. After the resource mapping procedure there will be an antenna identification. The antenna of the eNode B (assuming that the eNode B is equipped with a single antenna) transmits a band of width 20 MHz to the active user equipments (UEs) positioned in the cell covered by this eNode B. We have also spoken about the procedures at the receiver defined for LTE and explained precisely the role of turbo decoder for 4G.

Keywords: Broadband Channel; eNode B; Reception; Transmission; UE.

1. Main text

In LTE, Adaptive Modulation and Coding AMC is implemented as a combination of a fixed $1/3$ turbo encoder and a rate matching process. The technology used in LTE is called Orthogonal Frequency Division Multiple Access OFDMA (Active users do not share the same sub-band). The eNode B allocates to each active user a some number of Physical Resource Block PRB pairs (this number of PRB pairs is great for the active user who dedicates it the highest sub-bandwidth). The PRB pair duration is 1 ms which is equal to the subframe duration. 4G arrives in 2010 to meet the needs of users, it offers a Transport Block Size TBS (it contains: a Medium Access Control MAC header, Radio Link Control RLC headers, Packet Data Convergence Protocol PDCP headers, headers added at the Radio Resource Control RRC layer, data (Internet Protocol (IP)) and control (RRC)) that can reach the maximum value of 75 Mb/s in DL [2]. In this article entitled LTE Rate Matching Performance with Code Block Balancing [1], they showed some procedures at the transmitter defined for LTE, they compared between the two types of rate matching (standard rate matching and the balanced rate matching). In our article, we have given the overall scheme that explains the procedures at the receiver defined for LTE, we have accurately described the role of the turbo decoder, the interferences between users have been cancelled in the IP / RRC layer of each active UE (removal of MAC header in the MAC layer of each active UE, removal of RLC headers in the RLC layer of each active UE, removal of PDCP headers in the PDCP layer of each active UE, removal of RRC headers in the RRC / IP layer of each active UE, removal of control (RRC) in the RRC / IP layer of each active UE, use of the IP data known by each active UE in the IP/RRC layer (by extraction of this IP data from users data (IP) by each active UE)). The problem to be solved concerns how to calculate the number of resulting code blocks CBs after segmentation, concerns how a turbo encoder works, concerns how a turbo decoder works, concerns the knowledge of mysterious procedures for us taken at the receiver defined for LTE. To find the number of resulting CBs after segmentation simply divide the (TBS plus the 24 bits of the Cyclic Redundancy Check CRC added to the TBS) on (6144 minus 24). The whole part by excess of the result of the division obtained will give the exact number of the resulting CBs after the segmentation procedure (this equation was known after research). The role of the turbo encoder (knowledgeable after research) of fixed encoding rate which equals to $1/3$ is to encode for example a code block CB of size k_- into a CB of size $3.(k_- + 4)$. The role of the turbo decoder (knowledgeable after research) is to decode for example a CB of size $3.(k_- + 4)$ into a CB of size k_- . Filtering, resource demapping, equalization, demodulation procedure, CB deconcatenation, de-rate matching, turbo decoding (channel decoding), filler bits removal, CB CRC decoding, CB Desegmentation and TB CRC decoding are the procedures at the receiver defined for LTE (knowledgeable after research). The rest of our article consists of: a section entitled Methodology which presents the theoretical part of my work concerning transmission and reception in LTE. A section entitled results and discussion which presents the results and discussion of the results of the practical part for LTE transmission and reception. A short conclusion.

2. Methodology

The transmission system of our study consists of a single eNode B that covers a geographical area called a cell and user equipments (UEs) that are positioned in this area. In the LTE physical layer occurring: adding filler bits at the beginning of the Transport Block, adding CRC bits at the end of the transport block, segmentation (if TBS is greater than or equal to 6144), adding CRC bits at the end of each resulting code block CB after the segmentation procedure, channel coding, rate matching, CB concatenation, modulation, resource mapping and antenna identification. Filler bits (zero bits) of size F are added to TBS [1]. The TBS value is represented by N_{TB} . The binary sequence of size $F + N_{TB}$ will pass in the CRC encoder if N_{TB} is greater than or equal to 40 in order to obtain at the output of the encoder a CB of size $+N_{TB} + 24$. In case the size of TBS is less than 40, it's stuffed until reaching this size.

If $40 \leq N_{TB} < 6144$, the CB of size $F + N_{TB} + 24$ isn't segmented. If the Transport Bloc Size $N_{TB} \geq 6144$, the code block CB of size $F + N_{TB} + 24$ is segmented into N_{CBs} code blocks CBs [2]. The number of code blocks after segmentation is calculated as follows [2]:

$$N_{CBs} = \left\lceil \frac{N_{TB}+24}{6144-24} \right\rceil \quad (1)$$

$$N_{CBs} = N_{k_-} + N_{k_+} \quad (2)$$

$$N_{CBs} = C \quad (3)$$

N_{CBs} is composed of N_{k_-}code blocks CBs and N_{k_+} code Blocks CBs. Each code block CB among N_{k_-}CBs has a size of k_-, the 24 CRC bits are included in k_- . Each code block CB among N_{k_+} has a size of k_+ , the 24 CRC bits are included in k_+ . The filler bits of size F are included in the first code block CB obtained after the segmentation process. The maximum size of resulting code block CB after the segmentation is equal to 6144.

Now, assuming we have these values: N_{CBs} is equal to 3, N_{k_-} is equal to 1 and N_{k_+} is equal to 2. The first code block CB of size k_- is encoded by the turbo encoder in order to get in its output a code block CB of size $3.(k_- + 4)$. The second CB of size k_+ is encoded by the turbo encoder in order to get in its output a code block CB of size $3.(k_+ + 4)$. The third code block CB of size k_+ is encoded by the turbo encoder in order to get in its output a code block CB of size $3.(k_+ + 4)$. Where T which is equal to 4 represents the termination bits of recursive systematic coder RSC. The coding rate is calculated like that [1]:

$$R_1 = \frac{k_-}{3\ .\ (k_-+4)} \quad (4)$$

$$R_2 = \frac{k_+}{3\ .\ (k_++4)} \quad (5)$$

$$R_3 = \frac{k_+}{3\ .\ (k_+ + 4)} \quad (6)$$

The turbo encoder consists of two RSC encoders and a random interleaver. The figure 1 shows the turbo encoder for LTE.

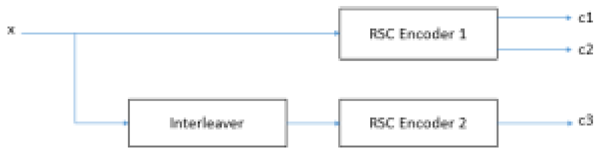

Fig. 1. Turbo Encoder.

The RSC (Recursive Systematic Convolutional) encoder 1 encode the code block CB of size k_- into two codes which are the following: c1 of size $k_- + 4$ and c2 of size $k_- + 4$. The systematic sequence is c1. The recursive convolutive sequence is c2. The same sequence of size k_- is mixed by a random interleaver and will pass to the second RSC encoder which will encode it into recursive convolutive sequence (c3) of size $k_- + 4$. Then, the RSC encoder 1 encode the code block CB of size k_+ into two codes which are the following: c1 of size $k_+ + 4$ and c2 of size $k_+ + 4$. The systematic sequence is c1. The recursive convolutive sequence is c2. The same sequence of size k_+ is mixed by a random interleaver and will pass to the second RSC encoder which will encode it into recursive convolutive sequence (c3) of size $k_+ + 4$ [3]. Next, the RSC encoder 1 encode the last code block CB of size k_+ into two codes which are the following: c1 of size $k_+ + 4$ and c2 of size $k_+ + 4$. The systematic sequence is c1. The recursive convolutive sequence is c2. The same sequence of size k_+ is mixed by a random interleaver and will pass to the second (2) RSC encoder which will encode it into recursive convolutive sequence (c3) of size $k_+ + 4$. The c2 code is a low weight code. The c3 code is a high weight code because the random interleaver increases the code weight. In the unbalanced rate matching, the first code block CB of size $3.(k_- + 4)$ will pass to the rate matcher which will give in its output a code block CB of size G/C , the second code block CB of size $3.(k_+ + 4)$ will pass to the rate matcher which will give in its output a code block CB of size G/C , the third code block CB of size $3.(k_+ + 4)$ will pass to the rate matcher which will give in its output a code block CB of size G/C . In the balanced rate matching, the first code block CB of size $3.(k_- + 4)$ will pass to the rate matcher which will give in its output a code block CB of size $G.\frac{k_-}{k_-+k_++k_+}$, the second code block CB of size $3.(k_+ + 4)$ will pass to the rate matcher which will give in its output a code block CB of size $G.\frac{k_+}{k_-+k_++k_+}$, the third code block CB of size $3.(k_+ + 4)$ will pass to the rate matcher which will give in its output a code block CB of size $G.\frac{k_+}{k_-+k_++k_+}$. In the both types of rate matching, the concatenation of code block CB will give a coded TB of size G. The formula for calculating the effective code rate ECR is given as follows [1]:

$$ECR = \frac{N_{TB}}{G} \quad (7)$$

The figure 2 shows some procedures at the transmitter defined for LTE transmission (Assuming we have these values: N_{CBs} is equal to 3, N_{k_-} is equal to 1 and N_{k_+} is equal to 2).

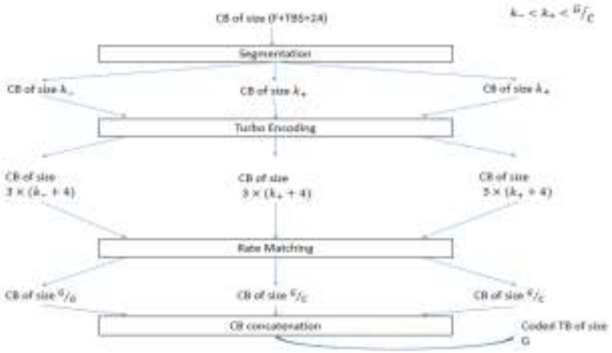

Fig. 2. Some Procedures at the Transmitter defined for 4G Transmission in the case where C is equal to 3, N_{k_-} is equal to 1 and $N_{k_+}$is equal to 2.

The binary sequence of size G will pass to the modulator (For example: Quadrature Phase Shift Keying (QPSK) Modulator). After the modulation process there will be a generation of a subframe which contains Resource Elements ($G/2$(REs)) of PDSCH (the Resource Element (RE) of PDSCH has a duration of 0,07135 ms and a bandwidth of 15 KHz) which carry ($G/2$) signals resulting from the modulation. After the resource mapping procedure there will be an antenna identification. The antenna of the eNode B (assuming that the eNode B is equipped with a single antenna) transmits a band of width 20 MHz (a band of width 18 MHz of the subframe which has a duration of less than 1 ms and which contains Resource Elements ($G/2$(REs)) of Physical Downlink Shared Channel (PDSCH) which carry ($G/2$) signals resulting from the modulation, a lower guard band of width 1 MHz of the subframe which has a duration of less than 1 ms (the same minimum time as the minimum time of the subframe which has a bandwidth of 18 MHz and the same maximum time as the maximum time of the subframe which has a bandwidth of 18 MHz) and which does not contain data and an upper guard band of width 1 MHz of the subframe which has a duration of less than 1 ms (the same minimum time as the minimum time of the subframe which has a bandwidth of 18 MHz and the same maximum time as the maximum time of the subframe which has a bandwidth of 18 MHz) and which does not contain data) in the wireless channel (Broadband Channel) to the active user equipments (UEs) positioned in the cell covered by this eNode B. Assuming that each active UE has only one antenna. The procedures at UE1 are: the filtering of two guard bands by the band-pass filter of UE1 which lets the 18 MHz bandwidth pass (the minimum cut-off frequency of the filter is equal to the minimum frequency of the band of width 18 MHz and the maximum cut-off frequency of the filter is equal to the maximum frequency of the band of width 18 MHz). The resource demapping and equalization (to extract and equalize what is inside of each Resource Element of PDSCH). Assuming that UE1 is positioned in an area covered by this single eNode B equipped with a single antenna (no overshooting). The signals extracted from Resource elements ($G/2$) of PDSCH are: $y1(t)$, y2(t), …, $yr(t)$ [4]:

$$ym(t) = pt\ .a_m\ .e^{-j\varphi_m}\ .xm(t-\tau_1) + nm(t) \quad (8)$$

$$y1(t) = pt\ .a_1\ .e^{-j\varphi_1}\ .x1(t-\tau_1) + n1(t) \quad (9)$$

$$y2(t) = pt\ .a_2\ .e^{-j\varphi_2}\ .x2(t-\tau_1) + n2(t) \quad (10)$$

$$r = \frac{G}{2} \quad (11)$$

$$yr(t) = pt\ .a_r\ .e^{-j\varphi_r}\ .xr(t-\tau_1) + nr(t) \quad (12)$$

$$\left\{ x1(t-\tau_1) = \sqrt{\frac{2\ .\ E_S}{T_S}}\ .\cos\left((2\ .i-1).\frac{\pi}{4}\right).\cos(2\ .pi\ .f_c\ .(t-\tau_1)) - \sqrt{\frac{2\ .\ E_S}{T_S}}\ .\sin\left((2\ .i-1).\frac{\pi}{4}\right).\sin(2\ .pi\ .f_c\ .(t-\tau_1)) \right\} \quad (13)$$

$$\varphi_m = 2\ .pi\ .f_c\ .\tau_m \quad (14)$$

$$\varphi_1 = 2\ .pi\ .f_c\ .\tau_1 \quad (15)$$

$$\varphi_2 = 2\ .pi\ .f_c\ .\tau_1 \quad (16)$$

The transmitted power pt is equal to 39.8107170554 W. In dBm, the transmitted power is 46 dBm . E_s represents the symbol energy (J/symbol). T_s represents the symbol duration (s). The index i is equal to 1 or to 2 or to 3 or to 4. The index m is equal to 1,2 up to $G/2$, a_m represents the attenuation of the path m, φ_m represents the phase of the path m, f_c is the carrier frequency, τ_1 is the delay of the path m, $nm(t)$ is the noise signal of the channel m. The demodulation of each equalized signal will give *2 bits*. After the demodulation process, the CB deconcatenation procedure will result in 3 CBs of the same size G/C (assuming that the type of rate matching at the transmitter is the unbalanced rate matching). The de-rate matching process will give 3 CBs (1 CB among 3 has a size of $3.(k_- + 4)$ and the remaining 2 CBs have the same size of $3.(k_+ + 4)$). The passage of these 3 CBs in the turbo decoder will give 3 CBs (1 CB among 3 has a size of k_- and 2 remaining CBs have the same size of k_+). The remaining procedures at UE1 defined for LTE are: filler bits removal, CB CRC decoding, CB desegmentation and TB CRC decoding. The size of the resulting binary sequence of TB CRC decoding procedure is equal to N_{TB}. The active user equipment 1 (UE1) knows the number (n°) of each PRB allocated to it by the eNode B in order to extract its data from N_{TB} bits (removal of MAC header in the MAC layer of active UE1, removal of RLC headers in the RLC layer of active UE1, removal of PDCP headers in the PDCP layer, removal of RRC headers in the RRC / IP layer of active UE1, removal of control RRC in the RRC / IP layer of the active UE1, extraction of its IP data from users data (IP)).

3. Results and discussion

The values of CQI, N_{TB}, C, k_+, k_- and ECR are demonstrated in table 1 [1]:

Table 1. Simulation Parameters.

CQI	ECR	C	k_+	k_-	N_{TB} (b/ms)
14	0,8525390625	3	4160	4096	12256
15	0,92578125	3	5248	5184	15552

Now, we calculate the number of filler bits for the case where the Channel Quality Indicator CQI value is 15 [1]:

$$F = 2 \,.\, (k_+ - 24) + (k_- - 24) - (N_{TB} + 24) \quad (17)$$

$$F = 32 \quad (18)$$

Next, we will determine for the case of CQI 15 the number of the existing Physical Downlink Shared Channel PDSCH bits in the subframe [2]:

$$N_{CRC} = 24 + 3 \,.\, 24 \quad (19)$$

$$N_{CRC} = 96 \quad (20)$$

$$N_{TB} + N_{CRC} = ECR \,.\, Q \,.\, N_{RE\_PDSCH} \quad (21)$$

Q represents the number of bits in a PDSCH resource element. In our case, the modulation type is 64 QAM (Quadrature Amplitude Modulation). So, Q is equal to 6. For CQI 15, the number of the existing Physical Downlink Shared Channel PDSCH bits in the subframe [1]:

$$N_{TB} + N_{CRC} = ECR \,.\, PDSCH_{bits} \quad (22)$$

$$\boldsymbol{PDSCH_{bits} = \frac{N_{TB} + N_{CRC}}{ECR}} \quad (\mathbf{23})$$

$$\boldsymbol{PDSCH_{bits} = 1{,}0801687764 \,.\, (N_{TB} + N_{CRC})} \quad (\mathbf{24})$$

$$\boldsymbol{ECR = \frac{N_{TB}+N_{CRC}}{PDSCH_{bits}}} \quad (\mathbf{25})$$

$$\boldsymbol{PDSCH_{bits} = G + \frac{N_{CRC}}{N_{TB}} . G} \quad (\mathbf{26})$$

$$PDSCH_{bits} = G + 0{,}0061728395 \,.\, G \quad (27)$$

$$PDSCH_{bits} = 16902 \quad (28)$$

We calculate the value of G (the size of TB coded), we obtain [1]:

$$\boldsymbol{G = \frac{N_{TB}}{ECR}} \quad (\mathbf{29})$$

$$\boldsymbol{G = 16798{,}784810127} \quad (\mathbf{30})$$

For CQI 15, for the unbalanced rate matching (standard rate matching) case, we have these values [1]:

$$Size = \frac{G}{C} \quad (31)$$

$$Size = 5599{,}594936709 \quad (32)$$

The resulting code blocks CBS of the rate matching process have the same size (The real size of resulting CB of the rate matching procedure is 5599 bits because in digital there is the bit 0 and the bit 1, there is no 0,594936709 bit).

For CQI 15, for the balanced rate matching case, we have these values [1]:

$$G_{CB1} = G \,.\, \frac{k_-}{k_- + k_+ + k_+} \quad (33)$$

$$G_{CB1} = 5553{,}8839576681 \quad (34)$$

$$G_{CB2} = G \,.\, \frac{k_+}{k_- + k_+ + k_+} \quad (35)$$

$$G_{CB2} = 5622{,}4504270694 \quad (36)$$

$$G_{CB3} = G \,.\, \frac{k_+}{k_- + k_+ + k_+} \quad (37)$$

$$G_{CB3} = 5622{,}4504270694 \tag{38}$$

The results show that some code blocks CBS at the output of the rate matcher have the same size. The binary sequence of size 16798,784810127 resulting from the CB concatenation will pass to the modulator (64 QAM Modulator). After the modulation process there will be a generation of a subframe that contains Resource Elements ($G/_6$ (REs)) of PDSCH that carry signals ($G/_6$) resulting from the modulation. After the resource mapping procedure there will be an antenna identification. The antenna of the eNode B (assuming that the eNode B is equipped with a single antenna) transmits a band of width 20 MHz (a band of width 18 MHz of the subframe which has a duration of less than 1 ms and which contains Resource Elements ($G/_6$(REs)) of PDSCH which carry ($G/_6$) signals resulting from the modulation, a lower guard band of width 1 MHz of the subframe which has a duration of less than 1 ms (the same minimum time as the minimum time of the subframe which has a bandwidth of 18 MHz and the same maximum time as the maximum time of the subframe which has a bandwidth of 18 MHz) and which does not contain data and an upper guard band of width 1 MHz of the subframe which has a duration of less than 1 ms (the same minimum time as the minimum time of the subframe which has a bandwidth of 18 MHz and the same maximum time as the maximum time of the subframe which has a bandwidth of 18 MHz) and which does not contain data) in the wireless channel (Broadband Channel) to the active user equipments (UEs) positioned in the cell covered by this eNode B. Assuming that each active UE has only one antenna. The procedures at UE1 are: the filtering of two guard bands by the band-pass filter of UE1 which lets the 18 MHz bandwidth pass (the minimum cut-off frequency of the filter is equal to the minimum frequency of the band of width 18 MHz and the maximum cut-off frequency of the filter is equal to the maximum frequency of the band of width 18 MHz). The resource demapping and equalization (to extract and equalize what is inside of each Resource Element of PDSCH). Assuming that UE1 is positioned in an area covered by this single eNode B equipped with a single antenna (no overshooting). The demodulation of each equalized signal will give 6 bits. After the demodulation process, the CB deconcatenation procedure will result in 3 CBs of the same size (this size is equal to 5599,594936709 if the type of rate matching at the transmitter is the standard rate matching). The transition of these 3 CBs on the de-rate matcher will give in its output 3 CBs (1 CB of size 15564 and 2 CBs which have a size of 15756). The figure 3 shows the turbo decoder for LTE. The code block CB of size 15564 is composed of three sequences which are: $c1$' of size 5188, c2' of size 5188 and c3' of size 5188. His passage (the code block CB of size 15564) to the turbo decoder will give a binary sequence of size 5184. The RSC decoder 1 will receive c1' and c2' and will decode (after the detection and the correction of errors) only the c2' convolutive code into a binary sequence of size 5184 [5]. The RSC decoder 2 will receive $c3$' and c1'' (c1' mixed) and will decode (after the detection and the correction of errors) only the c3' convolutive code into a binary sequence of size 5184 [5], this binary sequence of size 5184 will pass to the deinterleaver before going to the RSC decoder 1. The second binary sequence of size 5184 that comes from RSC decoder 1 will pass to the interleaver before going to the RSC decoder2. If the RSC decoder 1 detects all errors and cannot correct all detected errors the $c2$' code is not decoded. If the RSC decoder 1 does not detect all errors the $c2$' code is not decoded. If the RSC decoder 2 detects all errors and cannot correct all detected errors the $c3$' code is not decoded. If the RSC decoder 2 does not detect all errors the $c3$' code is not decoded. If the RSC decoder 1 detects and corrects all errors the $c2$' code is decoded into a binary sequence of size 5184 (the same binary sequence of size 5184 that was passed to the RSC encoder 1 or a binary sequence of size 5184 different from that passed to the RSC encoder 1). If the RSC decoder 2 detects and corrects all errors the $c3$' code is decoded into a binary sequence of size 5184 (the same binary sequence of size 5184 that was passed to the RSC encoder 2 or a binary sequence of size 5184 different from that passed to the RSC encoder 2). The passage of the code block CB of size 15756 on the turbo decoder will give in its output a code block CB of size 5248. The passage of the last code block CB of size 15756 on the turbo decoder will give in its output a code block CB of size 5248.

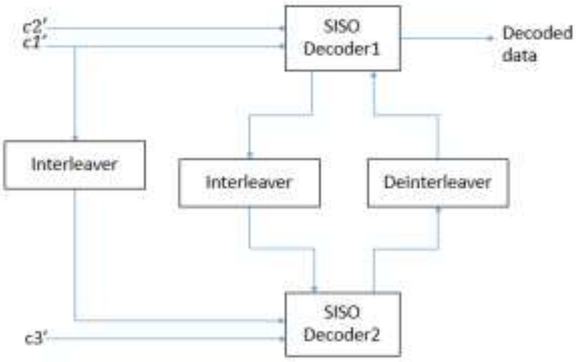

Fig. 3. Turbo Decoder.

The remaining procedures at UE1 are: filler bits removal (the removal of 32 filler bits), CB CRC decoding, CB desegmentation and TB CRC decoding. The size of the resulting binary sequence of TB CRC decoding procedure is equal to 15552 [6]. The UE1 knows the number (n°) of each PRB allocated to it by the eNode B in order to extract its data from 15552 bits (removal of MAC header in the MAC layer of active UE1, removal of RLC headers in the RLC layer of active UE1, removal of PDCP headers in the PDCP layer, removal of RRC headers in the RRC / IP layer of active UE1, removal of control RRC in the RRC / IP layer of the active UE1, extraction of its IP data from users data (IP)) [7].

4. Conclusion

Before the transmission of a band of width 20 MHz (a lower guard band of width 1 MHz of the subframe which has a duration of less than 1 ms and which does not contain data [8], an upper guard band of width 1 MHz of the subframe which has a duration of less than 1 ms and which does not contain data and a LTE band of width 18 MHz of a subframe which has a duration of less than 1 ms and which contains Resource Elements ($^G/_Q$ (REs)) of PDSCH that carry signals ($^G/_Q$)) by the antenna of the eNode B (assuming that the eNode B is equipped with a single antenna) to the active user equipments (assuming that each active user equipment is equipped with a single antenna) positioned in the cell covered by this eNode B there are message exchanges between each active user equipment positioned in the cell covered by this eNode B and this eNode B [9]. These exchanges include: sending the preamble by the active user equipment to the eNode B (64 possible preambles, randomly chosen by the active UE or assigned by eNode B) [10]. The eNode B responds by sending the Physical Downlink Control Channel (PDCCH) that carries the DCI (Downlink Control Information) to the active user equipment (UE) [11]. The eNode B also sends a RAR (Random Access Response) on the Physical Downlink Shared Channel (PDSCH) to the active user equipment [12]. RRC connection procedures are used to establish a RRC layer connection between the active user equipment (UE) and the eNode B [13]. The transmission of Reference Signals through eNode B to the active user equipment [14]. Reception of the CSI (Channel State Information) at the eNode B [15]. If the distance between the active user equipment (UE1) positioned in the cell covered by the site 0 (4G site) and the site 0 is less than the distance between the active user equipment (UE2) positioned in the cell covered by the site 0 and the site 0, the site 0 (eNode B) allocates to the active UE1 a number of PRBs greater than the one allocated to the active UE2 [16]. The subframe which has a bandwidth of 18 MHz and a duration of less than 1 ms contains several subcarriers, the width of each subcarrier is equal to 15 KHz [17], the difference between the frequency of subcarrier 1 and the frequency of subcarrier 2 is equal to 15 KHz [18], two orthogonal subcarriers means that these two subcarriers intersect and form a 90° angle [19]. Internet Protocol (IP) data is routed from the Packet Data Network (PDN) to the P-GW (Packet Gateway) and from the P-GW to the S-GW (Serving Gateway) and from the S-GW to the eNode B and from the eNode B to the active user equipments (in downlink) [20].

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