R1-00-172

Title : Proposal for Downlink Compressed mode method by puncturing

Source:Nortel Networks

Issue

- Create desired gap in each compressed frame with method A, i.e. using puncturing.
- More explicitly, reduce the number of bits for Transport Channels in each compressed frame, by eliminating supplementary bits compared to what normal Rate Matching requires for these Transport Channels.

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Process

1) Calculate number of bits to remove in each TrCh whose TTI contains compressed frame(s).

2) Find the position of the bits to be eliminated.

Requirements to find these positions and eliminate the bits:

- minimal implementation changes in the multiplexing chain
- keep optimal performance of rate matching when deleting supplementary bits

Process

- **Step 1 : Calculate number of bits to remove in each TrCh whose TTI contains compressed frame(s).**
  - > Example of calculation from Nokia (cf R1-99l33)
    - – *Calculate for each radio frame the number of bits corresponding to the transmission gap $N_{TGL}[k]$, where $N_{TGL}=0$ when the frame is not compressed.*
    - – *Evaluate the additional number of bits to be removed on each of the transport channels for each radio frame k(DN^{cm} [k]) due to compressed mode using the same formula as given in section (Formula Z)by replacing Ndata by N_{TGL}.*
    - – *For one TrCh, calculate the number of bits corresponding to the transmission gap in frame i, and DN^{cm} be the total number of bits to remove for the TTI, sum of DN^{cm} [k] for all frames k in the TTI*

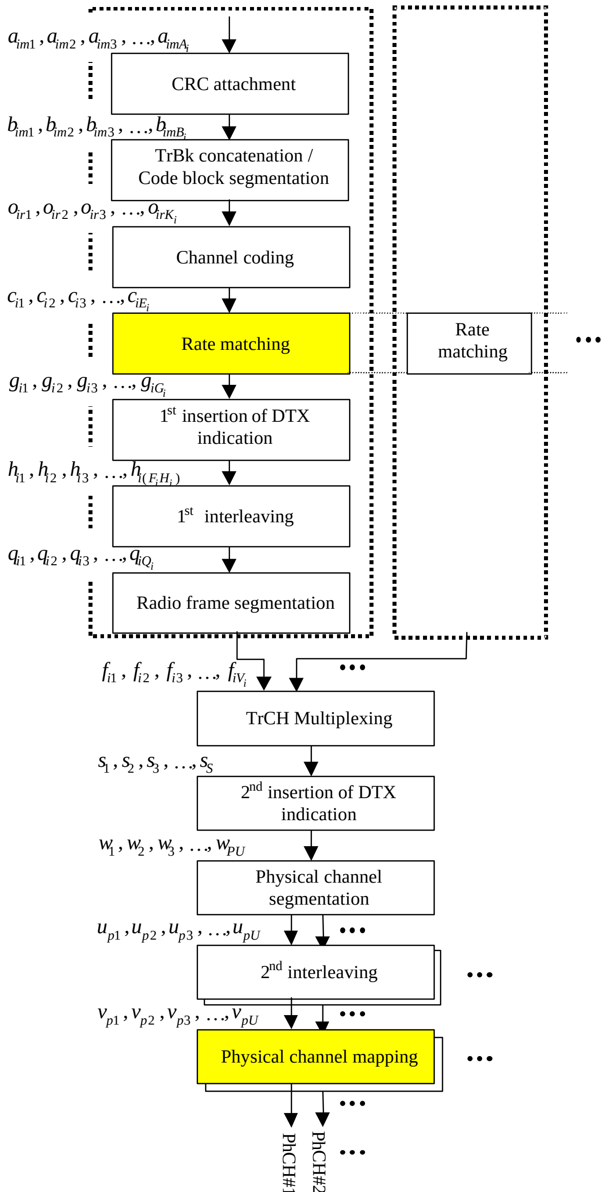
Process

- **Step 2 : Find the position of the bits to be eliminated.**
  - > Nortel proposal is a follow-up of Nokia R1-99l33 proposal
  - > Perform rate matching taking into account supplementary puncturing:

    For each TrCh, calculate $DN = DN^{TTI} + DN^{cm}$, knowing DN^{TTI} and DN^{cm} and apply rate matching on the TTI with DN.
  - > Insert $|\Delta N^{cm}[FR\ k]|$ bits with value p, in positions corresponding to the first bits of the compressed frames of the TTI using information from the first interleaver.
  - > Remove bits p in Physical Channel Mapping step.

Impact on the processing chain

- **Impacts reduced to**
  - > Rate matching block
  - > Physical channel mapping (removal of the "p" bits) before transmission



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Principle

- **<u>Notation</u> : $\Delta X < 0$ => puncturing ; $\Delta X > 0$ => repetition**
- **$\Delta N^{TTI} < 0$ then $\Delta N = \Delta N^{TTI} + \Delta N^{cm} < 0$ since $\Delta N^{cm} < 0$**
- **$\Delta N^{TTI} > 0$ and $|\Delta N^{cm}| > \Delta N^{TTI}$ then ΔN ($= \Delta N^{TTI} + \Delta N^{cm}$) < 0 . Although normal rate matching required repetition, some bits actually need to be punctured. So no bit is repeated but $|\Delta N|$ bits are punctured, and $|\Delta N^{cm}|$ bits marked p are inserted.**
- **$\Delta N^{TTI} > 0$ and $|\Delta N^{cm}| < \Delta N^{TTI}$ then ΔN ($= \Delta N^{TTI} + \Delta N^{cm}$) > 0 . No need to puncture bits, reducing repetition is enough. So ΔN bits are repeated and $|\Delta N^{cm}|$ bits marked p are inserted.**
- **$\Delta N^{TTI} > 0$ and $|\Delta N^{cm}| = \Delta N^{TTI}$ then ΔN ($= \Delta N^{TTI} + \Delta N^{cm}$) $= 0$. No need to either repeat or puncture. $|\Delta N^{cm}|$ bits marked p are inserted.**

Example with puncturing (assuming no first interleaver)

- **Hypothesis:**
  - > TTI = 40ms i.e. F=4,
  - > Normal rate matching requires 1 bit puncturing : ΔNTTI=-1,
  - > Compressed mode requires to remove 3 bits in frame number 2: ΔNcm[2]= -3,
  - > So for the TTI: ΔN= - 4, assume no first interleaver.

- **Input bits flow**

  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

  Normal RM => puncture bits 1, 6, 11, 16

  Compressed Mode=> insert 3 bits p to go in column 2

- **Bit flow after rate matching block**

  2 3 p 4 5 7 p 8 9 10 p 12 13 14 15 16 17 18 19 20

- **Bits in radio frames:**

2 3 p 4		frame 0: 2 5 9 13 18
5 7 p 8		frame 1: 3 7 10 14 19
9 10 p 12	=>	frame 2: p p p 15 20
13 14 15 17		frame 3: 4 8 12 17 d
18 19 20 d		

Example with puncturing (with first interleaver) 1/2

- **Hypothesis:**
  - > TTI = 40ms i.e. F=4,
  - > Normal rate matching requires 1 bit puncturing : ΔNTTI=-1,
  - > Compressed mode requires to remove 3 bits in frame number 2: ΔNcm[2]= -3,
  - > So for the TTI: ΔN= - 4, first interleaver is bit reversal.

- **Input bits flow**

  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

  Normal RM algorithm => puncture bits 1, 6, 11, 16

  Compressed Mode=> insert 3 bits p to go in column 1 (since 1=BR[2])

- **Bit flow after rate matching block**

  2 p 3 4 5 p 7 8 9 p 10 12 13 14 15 17 18 19 20

- **Bits in first interleaver before columns permutation:**

2	p	3	4
5	p	7	8
9	p	10	12
13	14	15	17
18	19	20	d

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Example with puncturing (with first interleaver) 2/2

- **Bits in first interleaver after columns permutation:**

2	3	p	4
5	**7**	**p**	**8**
9	**10**	**p**	**12**
13	**15**	**14**	**17**
18	**20**	**19**	**d**

- **Bits in each frame after radio frame segmentation**

frame 0: 2 5 9 13 18

frame 1: 3 7 10 15 20

frame 2: p p p 14 19

frame 3: 4 8 12 17 d

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Example with repetition (assuming no first interleaver)

- **Hypothesis:**
  - > TTI = 40ms i.e. F=4,
  - > Normal rate matching requires 7 bit repetition : ΔNTTI=+7,
  - > Compressed mode requires to remove 3 bits in frame number 2: ΔNcm[2]= - 3,
  - > So for the TTI: ΔN= + 4, assume no first interleaver.

- **Input bits flow**

  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

  Normal RM => repeat once bits 1, 6, 11, 16

  Compressed Mode=> insert 3 bits p to go in column 2

- **Bit flow after rate matching block**

  1 1 p 2 3 4 p 5 6 6 p 7 8 9 10 11 11 12 13 14 15 16 16 17 18 19 20

- **Bits in frames:**

1	1	p	2
3	4	p	5
6	6	p	7
8	9	10	11
11	12	13	14
15	16	16	17
18	19	20	d

frame 0: 1 3 6 8 11 15 18

frame 1: 1 4 6 9 12 16 19

frame 2: p p p 10 13 16 20

frame 3: 2 5 7 11 14 17 d

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Example with repetition (with first interleaver) 1/2

- **Hypothesis:**
  - > TTI = 40ms i.e. F=4,
  - > Normal rate matching requires 1 bit puncturing : ΔNTTI=+7,
  - > Compressed mode requires to remove 3 bits in frame number 2: ΔNcm[2]= -3,
  - > So for the TTI: ΔN= + 4, first interleaver is bit reversal.
- **Input bits flow**

  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

  Normal RM => repeat once bits 1, 6, 11, 16

  Compressed Mode=> insert 3 bits p to go in column 1 (since 1=BR[2])
- **Bit flow after rate matching block**

  1 p 1 2   3 p 4 5   6 p 6 7   8 9 10 11   11 12 13 14   15 16 16 17   18 19 20
- **Bits in first interleaver before columns permutation:**

1	p	1	2
3	p	4	5
6	p	6	7
8	9	10	11
11	12	13	14
15	16	16	17
18	19	20	d

Example with repetition (with first interleaver) 2/2

- **Bits in first interleaver after columns permutation:**

1	1	p	2
3	4	p	5
6	6	p	7
8	10	9	11
11	13	12	14
15	16	16	17
18	20	19	d

- **Bits in each frame after radio frame segmentation**

frame 0: 1 3 6 8 11 15 18

frame 1: 1 4 6 10 13 16 20

frame 2: p p p 9 12 16 19

frame 3: 2 5 7 11 14 17 d

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Corresponding modifications to 25.212

- **Change request contained in R1-00-121**