Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Unified FEC proposal]

Date Submitted: [March 2 2010]

Source: [Hiroshi Harada , Ryuhei Funada] Company [NICT]
[Hartman Van Wyk , Daniel Popa] Company [Itron]

Address []

Voice []

E-Mail: [harada@nict.go.jp][Hartman.VanWyk@itron.com]

Re: [ ]

Abstract: [Unified proposal of FEC schemes for 802.15.4g standard]

Unified FEC Proposal

(Doc.10-0077-01 and Doc.10-0112-01)

FEC Proposal for IEEE 802.15.4g

- Two kinds of convolutional codes

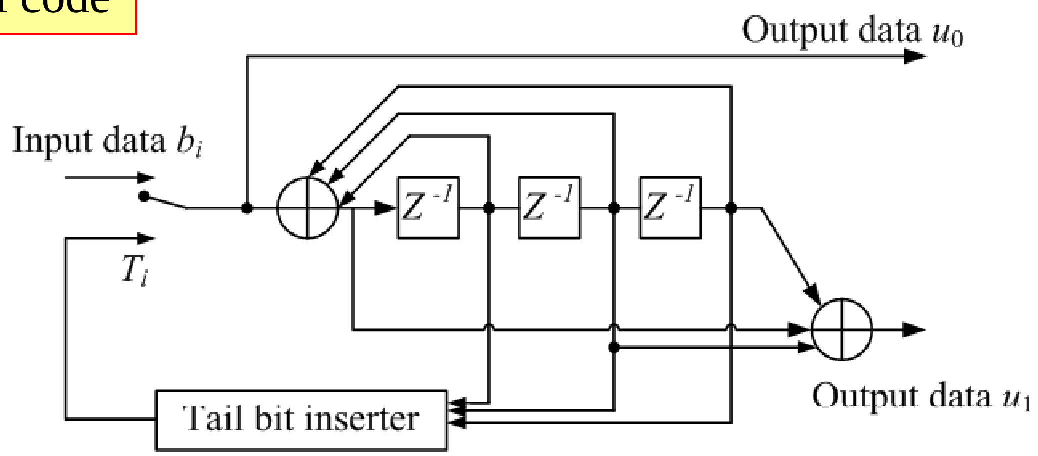
Mode	R	m	n	k	L	g0	g1
Systematic	1/2	3	2	1	4	{1 1 1 1}	{1 0 1 1}
Non Systematic	1/2	3	2	1	4	{1 1 1 1}	{1 0 1 1}

R: Coding rate
m: number of memory registers
n: number of output bits
k: input bits
L: Constraint length (n+1)
g0: Connection vector 0
g1: Connection vector 1

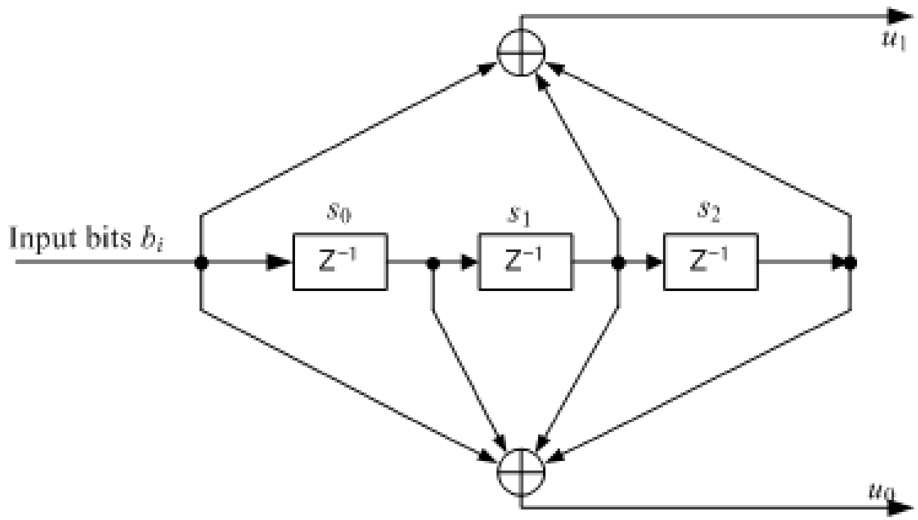
- Both will be option and implementator can choose either or both of them by taking regional environment into account

Block Diagram of encoder (see Appendix)

Systematic convolutional code

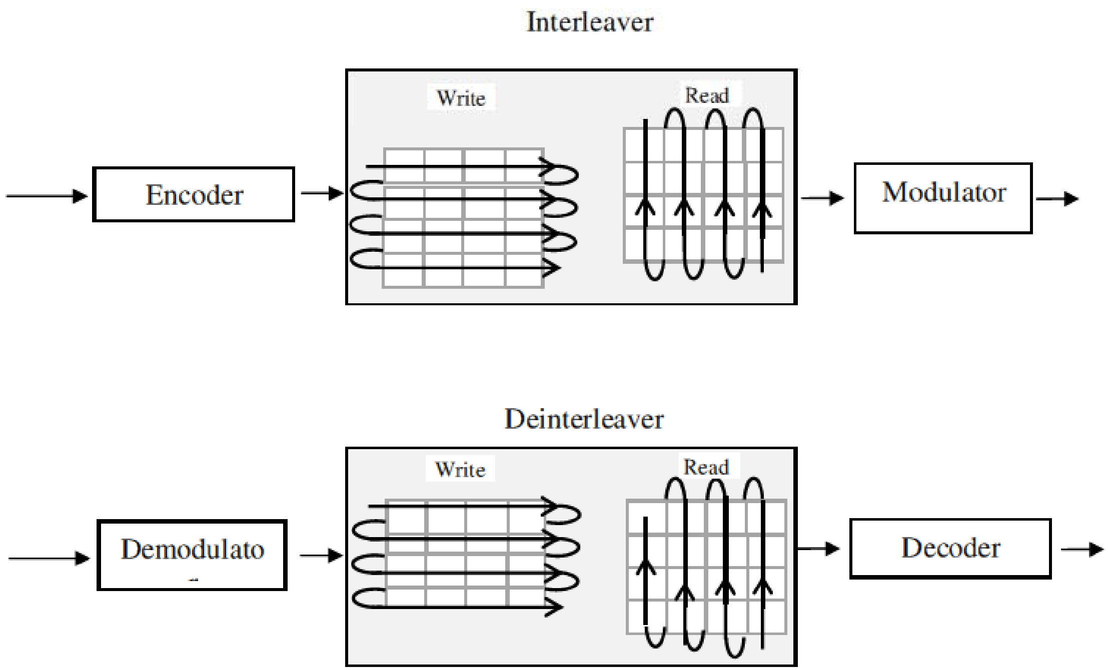


Convolutional code



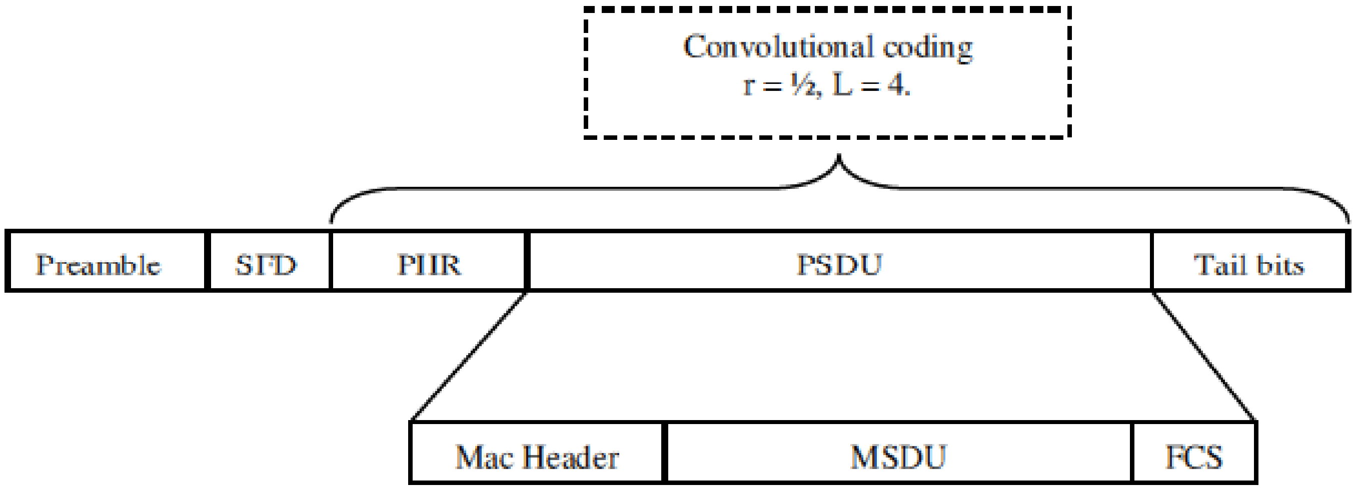
Interleaver (Doc.10-0077-01)

- Interleaving write/read buffers can be represented as 4x4 matrices, where each cell of the matrix has a size of 2 bits (i.e., one encoded output symbol)
- On or Off of interleaving will be changed by using PIB



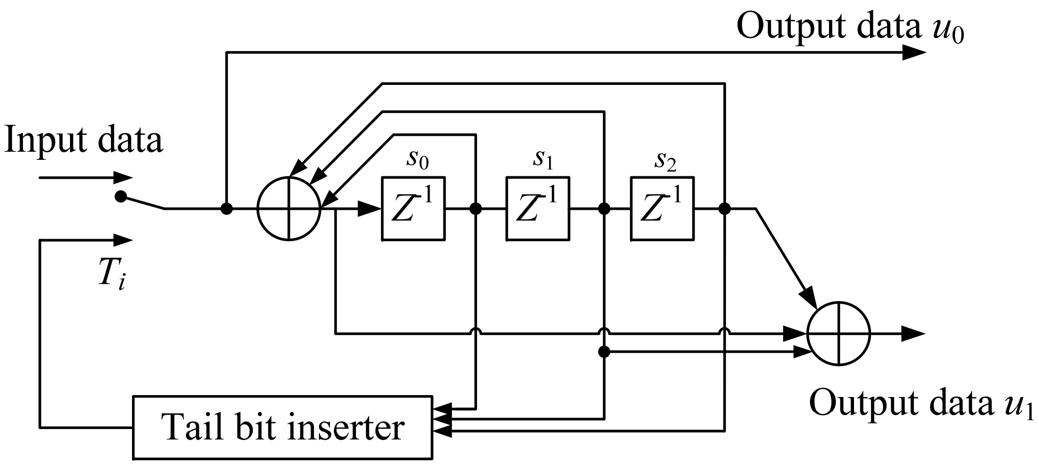
Coding Scheme

- For non-systematic type (Doc.10-0077-01)
  - The data input includes PHR, PSDU, and Tail bits.
  - A 3-bit sequence of ‘0’ is appended to the data input as Tail bits
- For systematic type
  - The data input includes PHR , PSDU, and Tail bits
  - Tail-bits are inserted according to the shift register values in order to set final state to be 0 (see tail bit section).



Tail bit

- For non-systematic type
  - A 3-bit sequence of ‘0’ is appended to the data input as Tail bits
- For systematic type
  - Tail-bits (T_0 to T_2) shall be inserted according to the shift register values (S_0 to S_2) in order to set final state to be 0 as listed in the following table.



S0	S1	S2	T0	T1	T2
0	0	0	0	0	0
1	0	0	1	0	0
0	1	0	1	1	0
1	1	0	0	1	0
0	0	1	1	1	1
1	0	1	0	1	1
0	1	1	0	0	1
1	1	1	1	0	1

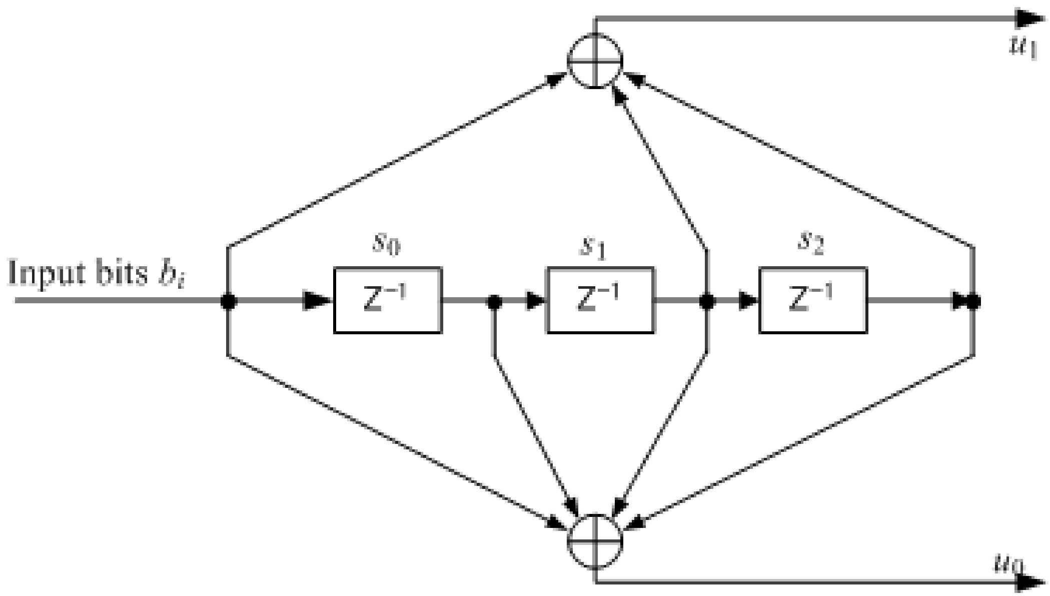
Methodology to change from non-FEC to FEC mode

- Condition
  - One of 2 SFDs (16 bits) indicates to use FEC
  - FEC bit is not used in the header
  - PIB is used to select FEC
- Methodology when FEC mode is selected (an example)
  - Exchange (or broadcast) PIB that indicates the FEC scheme between devices by using non-FEC mode
  - Once the FEC is accepted between devices, change SFD that used for FEC mode and start to communicate between devices
  - When change the FEC mode, PIB is exchanged between devices and do the same procedure
- Note
  - PIB that indicates non-systematic or systematic convolution code may be implemented in the devices in advance if the PIB is not exchange between devices

Appendix

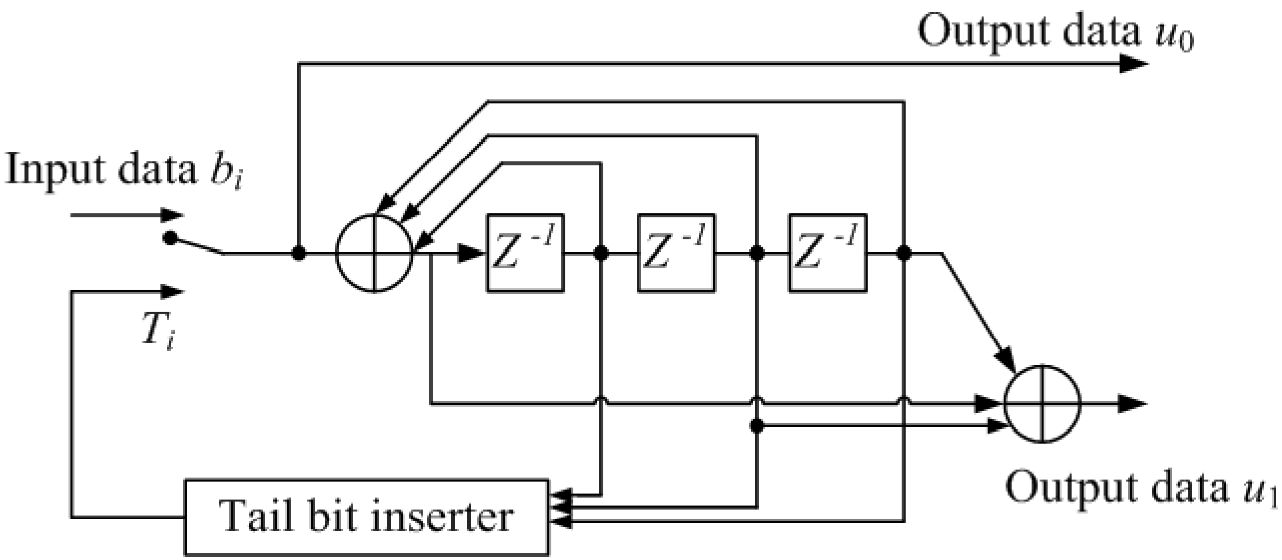
Non-systematic convolutional encoder (Doc.10-0077-01)

- Configuration: r = 1/2 , m =3, n = 2, k = 1, L = 4, g0={1 1 1 1}, g1={1 1 0 1}



Systematic convolutional encoder (Doc.10-0112-01)

- Configuration: r = 1/2 , m =3, n = 2, k = 1, L = 4, g0={1 1 1 1}, g1={1 1 0 1}; and feedback connection is set to g1 as shown in the following figure.
  - Free distance is the same as non-systematic convolutional code, which can be calculated from built-in matlab function ‘distspec’.
- Tail-bits are inserted according to the shift register values in order to set final state to be 0.

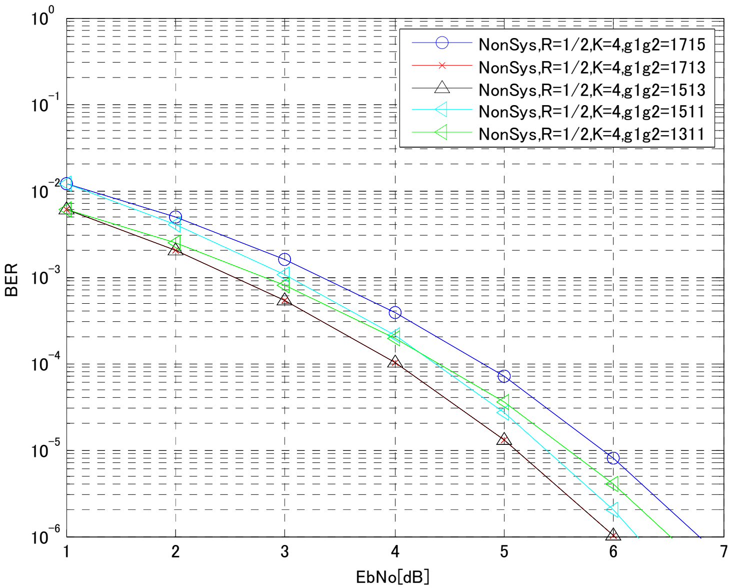


BER performance (Doc.10-0112-01)

•Same bit-error performance between sys. conv. [g0,g1]= [17 13,17] and non-sys. conv. [g0,g1]= [17 13]

•Both offers the best performance (Eb/N0=6dB at BER=10^-6) in all

Non-systematic convolutional code (R=1/2,K=4)



Systematic convolutional code (Feedback is g0) (R=1/2,K=4)