CHAPTER 7

PAIRING BASED ENCODING SCHEMES (PBES) FOR SECURE WSNs

The security services in WSNs are usually centered on cryptography. However, due to the constraints in WSNs, many already existing security algorithms like DES [56], AES [57], Blowfish [58] and IDEA [62] are not practical for use in WSNs. So we need a lightweight mechanism to provide security in WSNs.

This chapter presents a pairing based encoding scheme (PBES) which uses multiple encoding schemes to achieve security in WSNs. The use of multiple encoding schemes along with light weight encryption scheme is more economical than a heavy cryptographic algorithm. The key size used in this method is very small to activate security in WSNs. Simulation results show that this scheme is much efficient than any other heavy symmetric key cryptographic algorithms. PBES is used to achieve security in place of heavy encryption algorithm.

Rest of the chapter is organized as follows:

Section 7.1 presents a pairing based encoding scheme. Relationship between different encoding schemes has been described in Section 7.2. Results and discussions are given in Section 7.3. Finally, chapter has been summarized in Section 7.4.

7.1. PAIRING SCHEMES

The presented model is based on Pairing Scheme (PS). In this technique the digital data is organized into groups. This scheme divides the stored binary data of a packet into equal size pairs of two bit wide, i.e. 6 bit packet is divided into a group of three pairs and the size of each pair is two bit long. Two types of PS's have been used in the presented secure model.

7.1.1 Continuous Pairing Scheme (CPS)

In continuous pairing scheme, pairs are made on continuous bits. First bit is paired with second bit and third bit is paired with forth bit and so on, i.e. pair of i^{th} bit is made with

$(i+1)^{th}$ bit if i^{th} bit is an odd bit to form the (i, i+1) pair. If i^{th} bit is an even bit, then pair of i^{th} bit is made with $(i-1)^{th}$ bit to form the (i-1, i) pair. The packet bits are shown in Figure 7.1. Continuous Pairing of packet in Figure 7.1 is shown with the help of Figure 7.2 and the pairs are (1, 0), (1, 1), (0, 1), and so on.

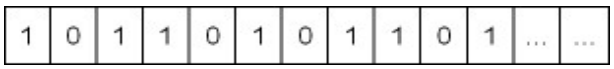

Figure 7.1: Packet Bits

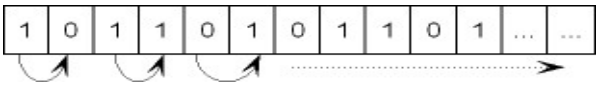

Figure 7.2: Continuous Pairing Scheme

7.1.2 Skip Pairing Scheme (SPS)

In skip pairing scheme, pairs are made by skipping one bit. First bit is paired with third bit and second bit is paired with forth bit and so on, i.e. i^{th} bit is paired with $(i+2)^{th}$ bit if (i mod 4) is one or two to form (i, i+2) pair, if (i mod 4) is zero or three then i^{th} bit is paired with $(i-2)^{th}$ bit to form (i-2, i) pair. The pairing is shown in Figure 7.3. Pairs are (1, 1), (0, 1), (0, 0), and so on.

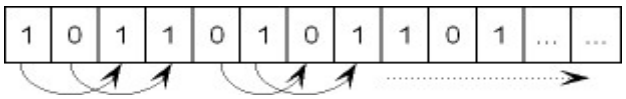

Figure 7.3: Skip Pairing Scheme

7.2. ENCODING SCHEME

Due to the resource constraints sensor nodes, traditional expensive symmetric key cryptographic algorithm is not a good option. The selected scheme must be simple and efficient. In this section we discuss a very simple encoding scheme to ensure confidentiality of sensed data without increasing transmission overhead.

Each node chooses one of the eight specified encoding schemes, i.e. Scheme A to Scheme H. The encoding scheme is based on simple transposition and substitution techniques to achieve security at the node level. The scheme works on the pairing method which is applied on the digital data to convert analog signal into digital signal. These analog signals are generated from the sensed event. The encoding process works on digital data stored in the packet. The digital data stored in the packet is divided into pairs of 2 bit long, i.e. 6 bit packet is divided into a group of three pairs and the size of each

pair is two bit long. There are eight encoding schemes, i.e. Scheme A to H. All the schemes are described below:-

i. ***Scheme A:*** First output bit is 0 if both pairing bits are same otherwise 1 and second output bit remains same as in the input pair.

Input bits	Output bits
00	00
11	01
01	11
10	10

ii. ***Scheme B:*** First output bit is 1 if both pairing bits are same otherwise 0 and second output bit remains same as in the input pair.

Input bits	Output bits
00	10
11	11
01	01
10	00

iii. ***Scheme C:*** First output bit is 0 if both pairing bits are same otherwise 1 and second output bit becomes the complement of second bit of input pair.

Input bits	Output bits
00	01
11	00
01	10
10	11

iv. ***Scheme D:*** First output bit is 1 if both pairing bits are same otherwise 0 and second output bit becomes the complement of second bit of input pair.

Input bits	Output bits
00	11

11	10
01	00
10	01

v. ***Scheme E:*** First output bit is 0 if both pairing bits are same otherwise 1 and second output bit remains same as second bit if both pairing bits are same otherwise it becomes the complement of second pairing input bit.

Input bits	Output bits
00	00
11	01
01	10
10	11

vi. ***Scheme F:*** First output bit is 1 if both pairing bits are same otherwise 0 and second output bit remains same as second pairing bit if both pairing bits are same otherwise it becomes the complement of second pairing input bit.

Input bits	Output bits
00	10
11	11
01	00
10	01

vii. ***Scheme G:*** First output bit is 0 if both pairing bits are same otherwise 1 and second output bit becomes complement of second pairing input bit if both input pairing bits are same otherwise it remains same as second input pairing bit.

Input bits	Output bits
00	01
11	00
01	11
10	10

viii. ***Scheme H:*** First output bit is 1 if both pairing bits are same otherwise 0 and second output bit becomes complement of second pairing input bit if both input pairing bits are same otherwise it remains same as second input pairing bit.

Input bits	Output bits
00	11
11	10
01	01
10	00

In the above specified eight encoding schemes, two input pairs are same as output pairs in Scheme A and B, i.e. in scheme A if the input pair is '0 0' or '1 0', the output pairing bits are same as input pair. Similarly in scheme B if the input pair is '1 1' or '0 1', the output pairing bits are same as input pair. On the other hand in scheme E, F, G and H only one output pair is same as input pair but in scheme C and D, all the output pairs are different from all the input pairs. In all the above schemes, output of every pair is independent of any other pair in any scheme. There are total 32 possible combinations for the entire encoding chart (four in each scheme out of eight schemes). Since only eight schemes have been used therefore total three bits are enough to represent the encoding scheme selected by any sensor node. All the encoding schemes are shown in Fig 4 where the digital data of the packet is '0 0 0 1 1 0 1 1' with CPS scheme.

7.2.1 Relationship between Encoding Schemes

In the given timeline, it has been shown that scheme D is complement of scheme A and scheme C is complement of scheme B. Relationship among all the schemes are given as under:-

(i). Relation between Scheme A and B: All the odd output pairing bits of Scheme B are complement of all odd output pairing bits of Scheme A and rest of the even output pairing bits in both the schemes are same.

(ii). Relation between Scheme A and C: All the even output pairing bits of Scheme C are complement of all even output pairing bits of Scheme A and rest of the odd output pairing bits in both the schemes are same.

(iii). Relation between Scheme A and D: All the output pairing bits are complement of all the output pairing bits in Scheme A, i.e. Scheme D is complement of Scheme A.

(iv). Relation between Scheme A and E: All the odd bits in both the scheme are same whereas even output pairing bits in Scheme E is complement of even output pairing bit of Scheme A if the proceeding odd output pairing bit is 0 in any of the scheme otherwise this bit is same in both the schemes.

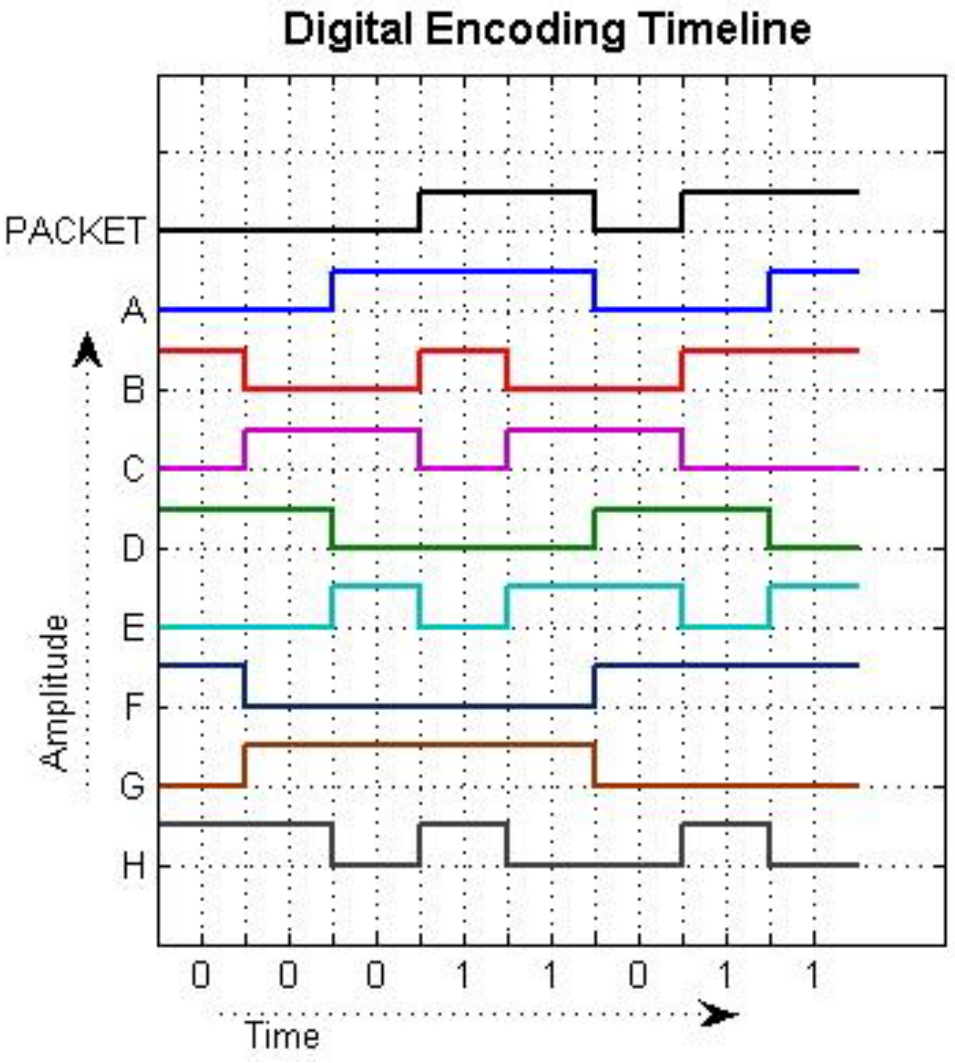

Figure 7.4: Relationship between Encoding Schemes

(v). Relation between Scheme A and F: All the odd output pairing bits in Scheme F are complement to all the odd output pairing bit of Scheme A whereas even output pairing bits in Scheme F is complement of even output pairing bit of

Scheme A if the proceeding odd output pairing bit is 0 in any of the scheme otherwise this bit is same in both the schemes.

(vi). Relation between Scheme A and G: All the odd output pairing bits in both the Schemes are same whereas the even output pairing bits in Scheme G are complement of even output pairing bits in Scheme A if the proceeding odd output pairing bit is 1 in any of the scheme otherwise this bit is same in both the schemes.

(vii). Relation between Scheme A and H: All the odd output pairing bits in Scheme H are complement to all the odd output pairing bits in Scheme A whereas even output pairing bits in Scheme H is complement of even output pairing bit of Scheme A if the proceeding odd output pairing bit is 1 in scheme A otherwise this bit is same in both the schemes.

(viii). Relation between Scheme B and C: All the output pairing bits in Scheme B, i.e. Scheme C is complement of Scheme B.

(ix). Relation between Scheme B and D: All the even output pairing bits of Scheme D are complement of all even output pairing bits of Scheme B and rest of the odd output pairing bits in both the schemes are same.

(x). Relation between Scheme B and E: All the odd output pairing bits in Scheme B whereas even output pairing bits in Scheme E is complement of even output pairing bit of Scheme B if the proceeding odd output pairing bit is 1 in scheme B otherwise this bit is same in both the schemes.

(xi). Relation between Scheme B and F: All the odd output pairing bits in both the Schemes are same whereas the even output pairing bits in Scheme F are complement of even output pairing bits in Scheme B if the proceeding odd output pairing bit is 1 in any of the scheme otherwise this bit is same in both the schemes.

(xii). Relation between Scheme B and G: All the odd output pairing bits in Scheme G are complement to all the odd output pairing bit of Scheme B whereas even output pairing bits in Scheme G is complement of even output pairing bit of Scheme B if the proceeding odd output pairing bit is 0 in any of the scheme otherwise this bit is same in both the schemes.

(xiii). Relation between Scheme B and H: All the odd bits in both the scheme are same whereas even output pairing bits in Scheme H is complement of even output pairing bit of Scheme B if the proceeding odd output pairing bit is 0 in any of the scheme otherwise this bit is same in both the schemes.

(xiv). Relation between Scheme C and D: All the odd output pairing bits of Scheme D are complement of all odd output pairing bits of Scheme C and rest of the even output pairing bits in both the schemes are same.

(xv). Relation between Scheme C and E: All the odd output pairing bits in both the Schemes are same whereas the even output pairing bits in Scheme E are complement of even output pairing bits in Scheme C if the proceeding odd output pairing bit is 1 in any of the scheme otherwise this bit is same in both the schemes.

(xvi). Relation between Scheme C and F: All the odd output pairing bits in Scheme F are complement to all the odd output pairing bits in Scheme C whereas even output pairing bits in Scheme F is complement of even output pairing bit of Scheme C if the proceeding odd output pairing bit is 1 in scheme C otherwise this bit is same in both the schemes.

(xvii). Relation between Scheme C and G: All the odd bits in both the scheme are same whereas even output pairing bits in Scheme G is complement of even output pairing bit of Scheme C if the proceeding odd output pairing bit is 0 in any of the scheme otherwise this bit is same in both the schemes.

(xviii). Relation between Scheme C and H: All the odd output pairing bits in Scheme H are complement to all the odd output pairing bit of Scheme C whereas even output pairing bits in Scheme H is complement of even output pairing bit of Scheme C if the proceeding odd output pairing bit is 0 in any of the scheme otherwise this bit is same in both the schemes.

(xix). Relation between Scheme D and E: All the odd output pairing bits in Scheme E are complement to all the odd output pairing bit of Scheme D whereas even output pairing bits in Scheme E is complement of even output pairing bit of Scheme D if the proceeding odd output pairing bit is 0 in any of the scheme otherwise this bit is same in both the schemes.

(xx). Relation between Scheme D and F: All the odd bits in both the scheme are same whereas even output pairing bits in Scheme F is complement of even output pairing bit of Scheme D if the proceeding odd output pairing bit is 0 in any of the scheme otherwise this bit is same in both the schemes.

(xxi). Relation between Scheme D and G: All the odd output pairing bits in Scheme G are complement to all the odd output pairing bits in Scheme D whereas even output pairing bits in Scheme G is complement of even output pairing bit of Scheme D if the proceeding odd output pairing bit is 1 in scheme D otherwise this bit is same in both the schemes.

(xxii). Relation between Scheme D and H: All the odd output pairing bits in both the Schemes are same whereas the even output pairing bits in Scheme H are complement of even output pairing bits in Scheme D if the proceeding odd output pairing bit is 1 in any of the scheme otherwise this bit is same in both the schemes.

(xxiii). Relation of Scheme E and F: All the odd output pairing bits of Scheme F are complement of all odd output pairing bits of Scheme E and rest of the even output pairing bits in both the schemes are same.

(xxiv). Relation between Scheme E and G: All the even output pairing bits of Scheme G are complement of all even output pairing bits of Scheme E and rest of the odd output pairing bits in both the schemes are same.

(xxv). Relation between Scheme E and H: All the output pairing bits are complement of all the output pairing bits in Scheme E, i.e. Scheme H is complement of Scheme E.

(xxvi). Relation between Scheme F and G: All the output pairing bits are complement of all the output pairing bits in Scheme F, i.e. Scheme G is complement of Scheme F.

(xxvii). Relation between Scheme F and H: All the even output pairing bits of Scheme H are complement of all even output pairing bits of Scheme A and rest of the odd output pairing bits in both the schemes are same.

(xxviii). Relation between Scheme G and H: All the odd output pairing bits of Scheme H are complement of all odd output pairing bits of Scheme G and rest of the even output pairing bits in both the schemes are same.

Example 1: Continuous Pairing Scheme

Input: 8 bit binary number

TABLE 7.1: Output Produced by Different Encoding Schemes for Continuous Pairing

INPUT DATA	PAIRS				ENCODING SCHEMES							
Binary no.	**1st**	**2nd**	**3rd**	**4th**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
00000000	00	00	00	00	00000000	10101010	01010101	11111111	00000000	10101010	01010101	11111111
00000001	00	00	00	01	00000011	10101001	01010110	11111100	00000010	10101000	01010111	11111101
00000010	00	00	00	10	00000010	10101000	01010111	11111101	00000011	10101001	01010110	11111100
00000011	00	00	00	11	00000001	10101011	01010100	11111110	00000001	10101011	01010100	11111110
00000100	00	00	01	00	00001100	10100110	01011001	11110011	00001000	10100010	01011101	11110111
00000101	00	00	01	01	00001111	10100101	01011010	11110000	00001010	10100000	01011111	11110101
00000110	00	00	01	10	00001110	10100100	01011011	11110001	00001011	10100001	01011110	11110100
00000111	00	00	01	11	00001101	10100111	01011000	11110010	00001001	10100011	01011100	11110110
00001000	00	00	10	00	00001000	10100010	01011101	11110111	00001100	10100110	01011001	11110011
00001001	00	00	10	01	00001011	10100001	01011110	11110100	00001110	10100100	01011011	11110001
00001010	00	00	10	10	00001010	10100000	01011111	11110101	00001111	10100101	01011010	11110000
00001011	00	00	10	11	00001001	10100011	01011100	11110110	00001101	10100111	01011000	11110010
00001100	00	00	11	00	00000100	10101110	01010001	11111011	00000100	10101110	01010001	11111011
00001101	00	00	11	01	00000111	10101101	01010010	11111000	00000110	10101100	01010011	11111001
00001110	00	00	11	10	00000110	10101100	01010011	11111001	00000111	10101101	01010010	11111000
00001111	00	00	11	11	00000101	10101111	01010000	11111010	00000101	10101111	01010000	11111010
00010000	00	01	00	00	00110000	10011010	01100101	11001111	00100000	10001010	01110101	11011111
00010001	00	01	00	01	00110011	10011001	01100110	11001100	00100010	10001000	01110111	11011101
00010010	00	01	00	10	00110010	10011000	01100111	11001101	00100011	10001001	01110110	11011100
00010011	00	01	00	11	00110001	10011011	01100100	11001110	00100001	10001011	01110100	11011110

00010100	00	01	01	00	00111100	10010110	01101001	11000011	00101000	10000010	01111101	11010111
00010101	00	01	01	01	00111111	10010101	01101010	11000000	00101010	10000000	01111111	11010101
00010110	00	01	01	10	00111110	10010100	01101011	11000001	00101011	10000001	01111110	11010100
00010111	00	01	01	11	00111101	10010111	01101000	11000010	00101001	10000011	01111100	11010110
00011000	00	01	10	00	00111000	10010010	01101101	11000111	00101100	10000110	01111001	11010011
00011001	00	01	10	01	00111011	10010001	01101110	11000100	00101110	10000100	01111011	11010001
00011010	00	01	10	10	00111010	10010000	01101111	11000101	00101111	10000101	01111010	11010000
00011011	00	01	10	11	00111001	10010011	01101100	11000110	00101101	10000111	01111000	11010010
00011100	00	01	11	00	00110100	10011110	01100001	11001011	00100100	10001110	01110001	11011011
00011101	00	01	11	01	00110111	10011101	01100010	11001000	00100110	10001100	01110011	11011001
00011110	00	01	11	10	00110110	10011100	01100011	11001001	00100111	10001101	01110010	11011000
00011111	00	01	11	11	00110101	10011111	01100000	11001010	00100101	10001111	01110000	11011010
00100000	00	10	00	00	00100000	10001010	01110101	11011111	00110000	10011010	01100101	11001111
00100001	00	10	00	01	00100011	10001001	01110110	11011100	00110010	10011000	01100111	11001101
00100010	00	10	00	10	00100010	10001000	01110111	11011101	00110011	10011001	01100110	11001100
00100011	00	10	00	11	00100001	10001011	01110100	11011110	00110001	10011011	01100100	11001110
00100100	00	10	01	00	00101100	10000110	01111001	11010011	00111000	10010010	01101101	11000111
00100101	00	10	01	01	00101111	10000101	01111010	11010000	00111010	10010000	01101111	11000101
00100110	00	10	01	10	00101110	10000100	01111011	11010001	00111011	10010001	01101110	11000100
00100111	00	10	01	11	00101101	10000111	01111000	11010010	00111001	10010011	01101100	11000110
00101000	00	10	10	00	00101000	10000010	01111101	11010111	00111100	10010110	01101001	11000011
00101001	00	10	10	01	00101011	10000001	01111110	11010100	00111110	10010100	01101011	11000001
00101010	00	10	10	10	00101010	10000000	01111111	11010101	00111111	10010101	01101010	11000000
00101011	00	10	10	11	00101001	10000011	01111100	11010110	00111101	10010111	01101000	11000010
00101100	00	10	11	00	00100100	10001110	01110001	11011011	00110100	10011110	01100001	11001011
00101101	00	10	11	01	00100111	10001101	01110010	11011000	00110110	10011100	01100011	11001001
00101110	00	10	11	10	00100110	10001100	01110011	11011001	00110111	10011101	01100010	11001000
00101111	00	10	11	11	00100101	10001111	01110000	11011010	00110101	10011111	01100000	11001010

00110000	00	11	00	00	00010000	10111010	01000101	11101111	00010000	10111010	01000101	11101111
00110001	00	11	00	01	00010011	10111001	01000110	11101100	00010010	10111000	01000111	11101101
00110010	00	11	00	10	00010010	10111000	01000111	11101101	00010011	10111001	01000110	11101100
00110011	00	11	00	11	00010001	10111011	01000100	11101110	00010001	10111011	01000100	11101110
00110100	00	11	01	00	00011100	10110110	01001001	11100011	00011000	10110010	01001101	11100111
00110101	00	11	01	01	00011111	10110101	01001010	11100000	00011010	10110000	01001111	11100101
00110110	00	11	01	10	00011110	10110100	01001011	11100001	00011011	10110001	01001110	11100100
00110111	00	11	01	11	00011101	10110111	01001000	11100010	00011001	10110011	01001100	11100110
00111000	00	11	10	00	00011000	10110010	01001101	11100111	00011100	10110110	01001001	11100011
00111001	00	11	10	01	00011011	10110001	01001110	11100100	00011110	10110100	01001011	11100001
00111010	00	11	10	10	00011010	10110000	01001111	11100101	00011111	10110101	01001010	11100000
00111011	00	11	10	11	00011001	10110011	01001100	11100110	00011101	10110111	01001000	11100010
00111100	00	11	11	00	00010100	10111110	01000001	11101011	00010100	10111110	01000001	11101011
00111101	00	11	11	01	00010111	10111101	01000010	11101000	00010110	10111100	01000011	11101001
00111110	00	11	11	10	00010110	10111100	01000011	11101001	00010111	10111101	01000010	11101000
00111111	00	11	11	11	00010101	10111111	01000000	11101010	00010101	10111111	01000000	11101010
01000000	01	00	00	00	11000000	01101010	10010101	00111111	10000000	00101010	11010101	01111111
01000001	01	00	00	01	11000011	01101001	10010110	00111100	10000010	00101000	11010111	01111101
01000010	01	00	00	10	11000010	01101000	10010111	00111101	10000011	00101001	11010110	01111100
01000011	01	00	00	11	11000001	01101011	10010100	00111110	10000001	00101011	11010100	01111110
01000100	01	00	01	00	11001100	01100110	10011001	00110011	10001000	00100010	11011101	01110111
01000101	01	00	01	01	11001111	01100101	10011010	00110000	10001010	00100000	11011111	01110101
01000110	01	00	01	10	11001110	01100100	10011011	00110001	10001011	00100001	11011110	01110100
01000111	01	00	01	11	11001101	01100111	10011000	00110010	10001001	00100011	11011100	01110110
01001000	01	00	10	00	11001000	01100010	10011101	00110111	10001100	00100110	11011001	01110011
01001001	01	00	10	01	11001011	01100001	10011110	00110100	10001110	00100100	11011011	01110001
01001010	01	00	10	10	11001010	01100000	10011111	00110101	10001111	00100101	11011010	01110000
01001011	01	00	10	11	11001001	01100011	10011100	00110110	10001101	00100111	11011000	01110010

01001100	01	00	11	00	11000100	01101110	10010001	00111011	10000100	00101110	11010001	01111011
01001101	01	00	11	01	11000111	01101101	10010010	00111000	10000110	00101100	11010011	01111001
01001110	01	00	11	10	11000110	01101100	10010011	00111001	10000111	00101101	11010010	01111000
01001111	01	00	11	11	11000101	01101111	10010000	00111010	10000101	00101111	11010000	01111010
01010000	01	01	00	00	11110000	01011010	10100101	00001111	10100000	00001010	11110101	01011111
01010001	01	01	00	01	11110011	01011001	10100110	00001100	10100010	00001000	11110111	01011101
01010010	01	01	00	10	11110010	01011000	10100111	00001101	10100011	00001001	11110110	01011100
01010011	01	01	00	11	11110001	01011011	10100100	00001110	10100001	00001011	11110100	01011110
01010100	01	01	01	00	11111100	01010110	10101001	00000011	10101000	00000010	11111101	01010111
01010101	01	01	01	01	11111111	01010101	10101010	00000000	10101010	00000000	11111111	01010101
01010110	01	01	01	10	11111110	01010100	10101011	00000001	10101011	00000001	11111110	01010100
01010111	01	01	01	11	11111101	01010111	10101000	00000010	10101001	00000011	11111100	01010110
01011000	01	01	10	00	11111000	01010010	10101101	00000111	10101100	00000110	11111001	01010011
01011001	01	01	10	01	11111011	01010001	10101110	00000100	10101110	00000100	11111011	01010001
01011010	01	01	10	10	11111010	01010000	10101111	00000101	10101111	00000101	11111010	01010000
01011011	01	01	10	11	11111001	01010011	10101100	00000110	10101101	00000111	11111000	01010010
01011100	01	01	11	00	11110100	01011110	10100001	00001011	10100100	00001110	11110001	01011011
01011101	01	01	11	01	11110111	01011101	10100010	00001000	10100110	00001100	11110011	01011001
01011110	01	01	11	10	11110110	01011100	10100011	00001001	10100111	00001101	11110010	01011000
01011111	01	01	11	11	11110101	01011111	10100000	00001010	10100101	00001111	11110000	01011010
01100000	01	10	00	00	11100000	01001010	10110101	00011111	10110000	00011010	11100101	01001111
01100001	01	10	00	01	11100011	01001001	10110110	00011100	10110010	00011000	11100111	01001101
01100010	01	10	00	10	11100010	01001000	10110111	00011101	10110011	00011001	11100110	01001100
01100011	01	10	00	11	11100001	01001011	10110100	00011110	10110001	00011011	11100100	01001110
01100100	01	10	01	00	11101100	01000110	10111001	00010011	10111000	00010010	11101101	01000111
01100101	01	10	01	01	11101111	01000101	10111010	00010000	10111010	00010000	11101111	01000101
01100110	01	10	01	10	11101110	01000100	10111011	00010001	10111011	00010001	11101110	01000100
01100111	01	10	01	11	11101101	01000111	10111000	00010010	10111001	00010011	11101100	01000110

01101000	01	10	10	00	11101000	01000010	10111101	00010111	10111100	00010110	11101001	01000011
01101001	01	10	10	01	11101011	01000001	10111110	00010100	10111110	00010100	11101011	01000001
01101010	01	10	10	10	11101010	01000000	10111111	00010101	10111111	00010101	11101010	01000000
01101011	01	10	10	11	11101001	01000011	10111100	00010110	10111101	00010111	11101000	01000010
01101100	01	10	11	00	11100100	01001110	10110001	00011011	10110100	00011110	11100001	01001011
01101101	01	10	11	01	11100111	01001101	10110010	00011000	10110110	00011100	11100011	01001001
01101110	01	10	11	10	11100110	01001100	10110011	00011001	10110111	00011101	11100010	01001000
01101111	01	10	11	11	11100101	01001111	10110000	00011010	10110101	00011111	11100000	01001010
01110000	01	11	00	00	11010000	01111010	10000101	00101111	10010000	00111010	11000101	01101111
01110001	01	11	00	01	11010011	01111001	10000110	00101100	10010010	00111000	11000111	01101101
01110010	01	11	00	10	11010010	01111000	10000111	00101101	10010011	00111001	11000110	01101100
01110011	01	11	00	11	11010001	01111011	10000100	00101110	10010001	00111011	11000100	01101110
01110100	01	11	01	00	11011100	01110110	10001001	00100011	10011000	00110010	11001101	01100111
01110101	01	11	01	01	11011111	01110101	10001010	00100000	10011010	00110000	11001111	01100101
01110110	01	11	01	10	11011110	01110100	10001011	00100001	10011011	00110001	11001110	01100100
01110111	01	11	01	11	11011101	01110111	10001000	00100010	10011001	00110011	11001100	01100110
01111000	01	11	10	00	11011000	01110010	10001101	00100111	10011100	00110110	11001001	01100011
01111001	01	11	10	01	11011011	01110001	10001110	00100100	10011110	00110100	11001011	01100001
01111010	01	11	10	10	11011010	01110000	10001111	00100101	10011111	00110101	11001010	01100000
01111011	01	11	10	11	11011001	01110011	10001100	00100110	10011101	00110111	11001000	01100010
01111100	01	11	11	00	11010100	01111110	10000001	00101011	10010100	00111110	11000001	01101011
01111101	01	11	11	01	11010111	01111101	10000010	00101000	10010110	00111100	11000011	01101001
01111110	01	11	11	10	11010110	01111100	10000011	00101001	10010111	00111101	11000010	01101000
01111111	01	11	11	11	11010101	01111111	10000000	00101010	10010101	00111111	11000000	01101010
10000000	10	00	00	00	10000000	00101010	11010101	01111111	11000000	01101010	10010101	00111111
10000001	10	00	00	01	10000011	00101001	11010110	01111100	11000010	01101000	10010111	00111101
10000010	10	00	00	10	10000010	00101000	11010111	01111101	11000011	01101001	10010110	00111100
10000011	10	00	00	11	10000001	00101011	11010100	01111110	11000001	01101011	10010100	00111110

10000100	10	00	01	00	10001100	00100110	11011001	01110011	11001000	01100010	10011101	00110111
10000101	10	00	01	01	10001111	00100101	11011010	01110000	11001010	01100000	10011111	00110101
10000110	10	00	01	10	10001110	00100100	11011011	01110001	11001011	01100001	10011110	00110100
10000111	10	00	01	11	10001101	00100111	11011000	01110010	11001001	01100011	10011100	00110110
10001000	10	00	10	00	10001000	00100010	11011101	01110111	11001100	01100110	10011001	00110011
10001001	10	00	10	01	10001011	00100001	11011110	01110100	11001110	01100100	10011011	00110001
10001010	10	00	10	10	10001010	00100000	11011111	01110101	11001111	01100101	10011010	00110000
10001011	10	00	10	11	10001001	00100011	11011100	01110110	11001101	01100111	10011000	00110010
10001100	10	00	11	00	10000100	00101110	11010001	01111011	11000100	01101110	10010001	00111011
10001101	10	00	11	01	10000111	00101101	11010010	01111000	11000110	01101100	10010011	00111001
10001110	10	00	11	10	10000110	00101100	11010011	01111001	11000111	01101101	10010010	00111000
10001111	10	00	11	11	10000101	00101111	11010000	01111010	11000101	01101111	10010000	00111010
10010000	10	01	00	00	10110000	00011010	11100101	01001111	11100000	01001010	10110101	00011111
10010001	10	01	00	01	10110011	00011001	11100110	01001100	11100010	01001000	10110111	00011101
10010010	10	01	00	10	10110010	00011000	11100111	01001101	11100011	01001001	10110110	00011100
10010011	10	01	00	11	10110001	00011011	11100100	01001110	11100001	01001011	10110100	00011110
10010100	10	01	01	00	10111100	00010110	11101001	01000011	11101000	01000010	10111101	00010111
10010101	10	01	01	01	10111111	00010101	11101010	01000000	11101010	01000000	10111111	00010101
10010110	10	01	01	10	10111110	00010100	11101011	01000001	11101011	01000001	10111110	00010100
10010111	10	01	01	11	10111101	00010111	11101000	01000010	11101001	01000011	10111100	00010110
10011000	10	01	10	00	10111000	00010010	11101101	01000111	11101100	01000110	10111001	00010011
10011001	10	01	10	01	10111011	00010001	11101110	01000100	11101110	01000100	10111011	00010001
10011010	10	01	10	10	10111010	00010000	11101111	01000101	11101111	01000101	10111010	00010000
10011011	10	01	10	11	10111001	00010011	11101100	01000110	11101101	01000111	10111000	00010010
10011100	10	01	11	00	10110100	00011110	11100001	01001011	11100100	01001110	10110001	00011011
10011101	10	01	11	01	10110111	00011101	11100010	01001000	11100110	01001100	10110011	00011001
10011110	10	01	11	10	10110110	00011100	11100011	01001001	11100111	01001101	10110010	00011000
10011111	10	01	11	11	10110101	00011111	11100000	01001010	11100101	01001111	10110000	00011010

10100000	10	10	00	00	10100000	00001010	11110101	01011111	11110000	01011010	10100101	00001111
10100001	10	10	00	01	10100011	00001001	11110110	01011100	11110010	01011000	10100111	00001101
10100010	10	10	00	10	10100010	00001000	11110111	01011101	11110011	01011001	10100110	00001100
10100011	10	10	00	11	10100001	00001011	11110100	01011110	11110001	01011011	10100100	00001110
10100100	10	10	01	00	10101100	00000110	11111001	01010011	11111000	01010010	10101101	00000111
10100101	10	10	01	01	10101111	00000101	11111010	01010000	11111010	01010000	10101111	00000101
10100110	10	10	01	10	10101110	00000100	11111011	01010001	11111011	01010001	10101110	00000100
10100111	10	10	01	11	10101101	00000111	11111000	01010010	11111001	01010011	10101100	00000110
10101000	10	10	10	00	10101000	00000010	11111101	01010111	11111100	01010110	10101001	00000011
10101001	10	10	10	01	10101011	00000001	11111110	01010100	11111110	01010100	10101011	00000001
10101010	10	10	10	10	10101010	00000000	11111111	01010101	11111111	01010101	10101010	00000000
10101011	10	10	10	11	10101001	00000011	11111100	01010110	11111101	01010111	10101000	00000010
10101100	10	10	11	00	10100100	00001110	11110001	01011011	11110100	01011110	10100001	00001011
10101101	10	10	11	01	10100111	00001101	11110010	01011000	11110110	01011100	10100011	00001001
10101110	10	10	11	10	10100110	00001100	11110011	01011001	11110111	01011101	10100010	00001000
10101111	10	10	11	11	10100101	00001111	11110000	01011010	11110101	01011111	10100000	00001010
10110000	10	11	00	00	10010000	00111010	11000101	01101111	11010000	01111010	10000101	00101111
10110001	10	11	00	01	10010011	00111001	11000110	01101100	11010010	01111000	10000111	00101101
10110010	10	11	00	10	10010010	00111000	11000111	01101101	11010011	01111001	10000110	00101100
10110011	10	11	00	11	10010001	00111011	11000100	01101110	11010001	01111011	10000100	00101110
10110100	10	11	01	00	10011100	00110110	11001001	01100011	11011000	01110010	10001101	00100111
10110101	10	11	01	01	10011111	00110101	11001010	01100000	11011010	01110000	10001111	00100101
10110110	10	11	01	10	10011110	00110100	11001011	01100001	11011011	01110001	10001110	00100100
10110111	10	11	01	11	10011101	00110111	11001000	01100010	11011001	01110011	10001100	00100110
10111000	10	11	10	00	10011000	00110010	11001101	01100111	11011100	01110110	10001001	00100011
10111001	10	11	10	01	10011011	00110001	11001110	01100100	11011110	01110100	10001011	00100001
10111010	10	11	10	10	10011010	00110000	11001111	01100101	11011111	01110101	10001010	00100000
10111011	10	11	10	11	10011001	00110011	11001100	01100110	11011101	01110111	10001000	00100010

10111100	10	11	11	00	10010100	00111110	11000001	01101011	11010100	01111110	10000001	00101011
10111101	10	11	11	01	10010111	00111101	11000010	01101000	11010110	01111100	10000011	00101001
10111110	10	11	11	10	10010110	00111100	11000011	01101001	11010111	01111101	10000010	00101000
10111111	10	11	11	11	10010101	00111111	11000000	01101010	11010101	01111111	10000000	00101010
11000000	11	00	00	00	01000000	11101010	00010101	10111111	01000000	11101010	00010101	10111111
11000001	11	00	00	01	01000011	11101001	00010110	10111100	01000010	11101000	00010111	10111101
11000010	11	00	00	10	01000010	11101000	00010111	10111101	01000011	11101001	00010110	10111100
11000011	11	00	00	11	01000001	11101011	00010100	10111110	01000001	11101011	00010100	10111110
11000100	11	00	01	00	01001100	11100110	00011001	10110011	01001000	11100010	00011101	10110111
11000101	11	00	01	01	01001111	11100101	00011010	10110000	01001010	11100000	00011111	10110101
11000110	11	00	01	10	01001110	11100100	00011011	10110001	01001011	11100001	00011110	10110100
11000111	11	00	01	11	01001101	11100111	00011000	10110010	01001001	11100011	00011100	10110110
11001000	11	00	10	00	01001000	11100010	00011101	10110111	01001100	11100110	00011001	10110011
11001001	11	00	10	01	01001011	11100001	00011110	10110100	01001110	11100100	00011011	10110001
11001010	11	00	10	10	01001010	11100000	00011111	10110101	01001111	11100101	00011010	10110000
11001011	11	00	10	11	01001001	11100011	00011100	10110110	01001101	11100111	00011000	10110010
11001100	11	00	11	00	01000100	11101110	00010001	10111011	01000100	11101110	00010001	10111011
11001101	11	00	11	01	01000111	11101101	00010010	10111000	01000110	11101100	00010011	10111001
11001110	11	00	11	10	01000110	11101100	00010011	10111001	01000111	11101101	00010010	10111000
11001111	11	00	11	11	01000101	11101111	00010000	10111010	01000101	11101111	00010000	10111010
11010000	11	01	00	00	01110000	11011010	00100101	10001111	01100000	11001010	00110101	10011111
11010001	11	01	00	01	01110011	11011001	00100110	10001100	01100010	11001000	00110111	10011101
11010010	11	01	00	10	01110010	11011000	00100111	10001101	01100011	11001001	00110110	10011100
11010011	11	01	00	11	01110001	11011011	00100100	10001110	01100001	11001011	00110100	10011110
11010100	11	01	01	00	01111100	11010110	00101001	10000011	01101000	11000010	00111101	10010111
11010101	11	01	01	01	01111111	11010101	00101010	10000000	01101010	11000000	00111111	10010101
11010110	11	01	01	10	01111110	11010100	00101011	10000001	01101011	11000001	00111110	10010100
11010111	11	01	01	11	01111101	11010111	00101000	10000010	01101001	11000011	00111100	10010110

11011000	11	01	10	00	01111000	11010010	00101101	10000111	01101100	11000110	00111001	10010011
11011001	11	01	10	01	01111011	11010001	00101110	10000100	01101110	11000100	00111011	10010001
11011010	11	01	10	10	01111010	11010000	00101111	10000101	01101111	11000101	00111010	10010000
11011011	11	01	10	11	01111001	11010011	00101100	10000110	01101101	11000111	00111000	10010010
11011100	11	01	11	00	01110100	11011110	00100001	10001011	01100100	11001110	00110001	10011011
11011101	11	01	11	01	01110111	11011101	00100010	10001000	01100110	11001100	00110011	10011001
11011110	11	01	11	10	01110110	11011100	00100011	10001001	01100111	11001101	00110010	10011000
11011111	11	01	11	11	01110101	11011111	00100000	10001010	01100101	11001111	00110000	10011010
11100000	11	10	00	00	01100000	11001010	00110101	10011111	01110000	11011010	00100101	10001111
11100001	11	10	00	01	01100011	11001001	00110110	10011100	01110010	11011000	00100111	10001101
11100010	11	10	00	10	01100010	11001000	00110111	10011101	01110011	11011001	00100110	10001100
11100011	11	10	00	11	01100001	11001011	00110100	10011110	01110001	11011011	00100100	10001110
11100100	11	10	01	00	01101100	11000110	00111001	10010011	01111000	11010010	00101101	10000111
11100101	11	10	01	01	01101111	11000101	00111010	10010000	01111010	11010000	00101111	10000101
11100110	11	10	01	10	01101110	11000100	00111011	10010001	01111011	11010001	00101110	10000100
11100111	11	10	01	11	01101101	11000111	00111000	10010010	01111001	11010011	00101100	10000110
11101000	11	10	10	00	01101000	11000010	00111101	10010111	01111100	11010110	00101001	10000011
11101001	11	10	10	01	01101011	11000001	00111110	10010100	01111110	11010100	00101011	10000001
11101010	11	10	10	10	01101010	11000000	00111111	10010101	01111111	11010101	00101010	10000000
11101011	11	10	10	11	01101001	11000011	00111100	10010110	01111101	11010111	00101000	10000010
11101100	11	10	11	00	01100100	11001110	00110001	10011011	01110100	11011110	00100001	10001011
11101101	11	10	11	01	01100111	11001101	00110010	10011000	01110110	11011100	00100011	10001001
11101110	11	10	11	10	01100110	11001100	00110011	10011001	01110111	11011101	00100010	10001000
11101111	11	10	11	11	01100101	11001111	00110000	10011010	01110101	11011111	00100000	10001010
11110000	11	11	00	00	01010000	11111010	00000101	10101111	01010000	11111010	00000101	10101111
11110001	11	11	00	01	01010011	11111001	00000110	10101100	01010010	11111000	00000111	10101101
11110010	11	11	00	10	01010010	11111000	00000111	10101101	01010011	11111001	00000110	10101100
11110011	11	11	00	11	01010001	11111011	00000100	10101110	01010001	11111011	00000100	10101110

11110100	11	11	01	00	01011100	11110110	00001001	10100011	01011000	11110010	00001101	10100111
11110101	11	11	01	01	01011111	11110101	00001010	10100000	01011010	11110000	00001111	10100101
11110110	11	11	01	10	01011110	11110100	00001011	10100001	01011011	11110001	00001110	10100100
11110111	11	11	01	11	01011101	11110111	00001000	10100010	01011001	11110011	00001100	10100110
11111000	11	11	10	00	01011000	11110010	00001101	10100111	01011100	11110110	00001001	10100011
11111001	11	11	10	01	01011011	11110001	00001110	10100100	01011110	11110100	00001011	10100001
11111010	11	11	10	10	01011010	11110000	00001111	10100101	01011111	11110101	00001010	10100000
11111011	11	11	10	11	01011001	11110011	00001100	10100110	01011101	11110111	00001000	10100010
11111100	11	11	11	00	01010100	11111110	00000001	10101011	01010100	11111110	00000001	10101011
11111101	11	11	11	01	01010111	11111101	00000010	10101000	01010110	11111100	00000011	10101001
11111110	11	11	11	10	01010110	11111100	00000011	10101001	01010111	11111101	00000010	10101000
11111111	11	11	11	11	01010101	11111111	00000000	10101010	01010101	11111111	00000000	10101010

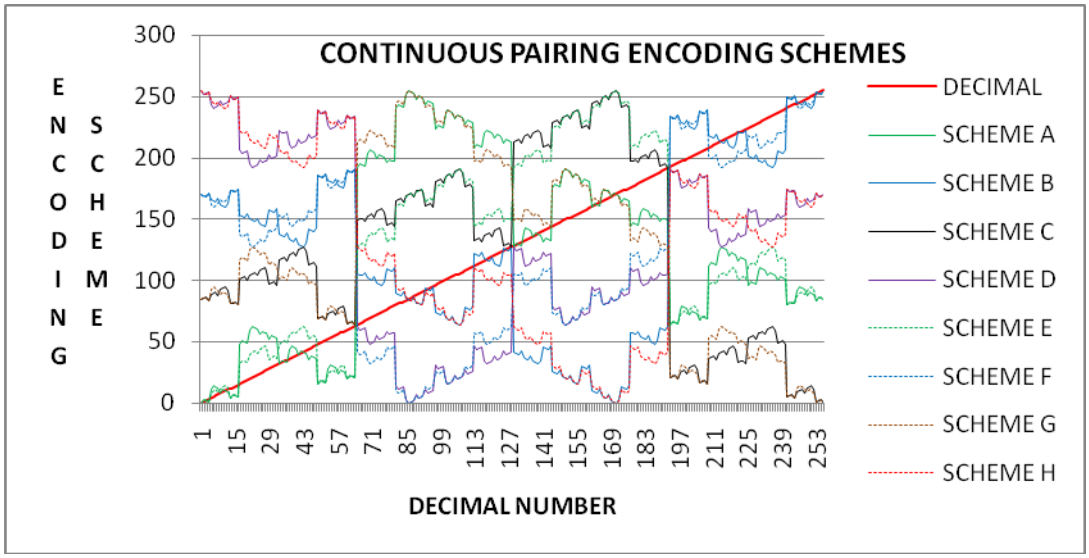

Figure 7.5: Decimal Number v/s Encoded Numbers in Continuous Pairing

Example 2: Skip Pairing

Input: 8 bit decimal number

TABLE 7.2: Output Produced by Different Encoding Scheme for Skip Pairing

INPUT DATA	SKIP PAIRS				ENCODING SCHEMES							
Binary No.	**1st**	**2nd**	**3rd**	**4th**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
00000000	00	00	00	00	00000000	10101010	01010101	11111111	00000000	10101010	01010101	11111111
00000001	00	00	00	01	00000011	10101001	01010110	11111100	00000010	10101000	01010111	11111101
00000010	00	00	01	00	00001100	10100110	01011001	11110011	00001000	10100010	01011101	11110111
00000011	00	00	01	01	00001111	10100101	01011010	11110000	00001010	10100000	01011111	11110101
00000100	00	00	00	10	00000010	10101000	01010111	11111101	00000011	10101001	01010110	11111100
00000101	00	00	00	11	00000001	10101011	01010100	11111110	00000001	10101011	01010100	11111110
00000110	00	00	01	10	00001110	10100100	01011011	11110001	00001011	10100001	01011110	11110100
00000111	00	00	01	11	00001101	10100111	01011000	11110010	00001001	10100011	01011100	11110110
00001000	00	00	10	00	00001000	10100010	01011101	11110111	00001100	10100110	01011001	11110011
00001001	00	00	10	01	00001011	10100001	01011110	11110100	00001110	10100100	01011011	11110001
00001010	00	00	11	00	00000100	10101110	01010001	11111011	00000100	10101110	01010001	11111011
00001011	00	00	11	01	00000111	10101101	01010010	11111000	00000110	10101100	01010011	11111001
00001100	00	00	10	10	00001010	10100000	01011111	11110101	00001111	10100101	01011010	11110000
00001101	00	00	10	11	00001001	10100011	01011100	11110110	00001101	10100111	01011000	11110010
00001110	00	00	11	10	00000110	10101100	01010011	11111001	00000111	10101101	01010010	11111000
00001111	00	00	11	11	00000101	10101111	01010000	11111010	00000101	10101111	01010000	11111010
00010000	00	01	00	00	00110000	10011010	01100101	11001111	00100000	10001010	01110101	11011111
00010001	00	01	00	01	00110011	10011001	01100110	11001100	00100010	10001000	01110111	11011101
00010010	00	01	01	00	00111100	10010110	01101001	11000011	00101000	10000010	01111101	11010111
00010011	00	01	01	01	00111111	10010101	01101010	11000000	00101010	10000000	01111111	11010101
00010100	00	01	00	10	00110010	10011000	01100111	11001101	00100011	10001001	01110110	11011100
00010101	00	01	00	11	00110001	10011011	01100100	11001110	00100001	10001011	01110100	11011110
00010110	00	01	01	10	00111110	10010100	01101011	11000001	00101011	10000001	01111110	11010100

00010111	00	01	01	11	00111101	10010111	01101000	11000010	00101001	10000011	01111100	11010110
00011000	00	01	10	00	00111000	10010010	01101101	11000111	00101100	10000110	01111001	11010011
00011001	00	01	10	01	00111011	10010001	01101110	11000100	00101110	10000100	01111011	11010001
00011010	00	01	11	00	00110100	10011110	01100001	11001011	00100100	10001110	01110001	11011011
00011011	00	01	11	01	00110111	10011101	01100010	11001000	00100110	10001100	01110011	11011001
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11011100	10	11	10	10	10011010	00110000	11001111	01100101	11011111	01110101	10001010	00100000
11011101	10	11	10	11	10011001	00110011	11001100	01100110	11011101	01110111	10001000	00100010
11011110	10	11	11	10	10010110	00111100	11000011	01101001	11010111	01111101	10000010	00101000
11011111	10	11	11	11	10010101	00111111	11000000	01101010	11010101	01111111	10000000	00101010
11100000	11	10	00	00	01100000	11001010	00110101	10011111	01110000	11011010	00100101	10001111
11100001	11	10	00	01	01100011	11001001	00110110	10011100	01110010	11011000	00100111	10001101
11100010	11	10	01	00	01101100	11000110	00111001	10010011	01111000	11010010	00101101	10000111
11100011	11	10	01	01	01101111	11000101	00111010	10010000	01111010	11010000	00101111	10000101
11100100	11	10	00	10	01100010	11001000	00110111	10011101	01110011	11011001	00100110	10001100
11100101	11	10	00	11	01100001	11001011	00110100	10011110	01110001	11011011	00100100	10001110
11100110	11	10	01	10	01101110	11000100	00111011	10010001	01111011	11010001	00101110	10000100
11100111	11	10	01	11	01101101	11000111	00111000	10010010	01111001	11010011	00101100	10000110
11101000	11	10	10	00	01101000	11000010	00111101	10010111	01111100	11010110	00101001	10000011
11101001	11	10	10	01	01101011	11000001	00111110	10010100	01111110	11010100	00101011	10000001
11101010	11	10	11	00	01100100	11001110	00110001	10011011	01110100	11011110	00100001	10001011
11101011	11	10	11	01	01100111	11001101	00110010	10011000	01110110	11011100	00100011	10001001
11101100	11	10	10	10	01101010	11000000	00111111	10010101	01111111	11010101	00101010	10000000
11101101	11	10	10	11	01101001	11000011	00111100	10010110	01111101	11010111	00101000	10000010
11101110	11	10	11	10	01100110	11001100	00110011	10011001	01110111	11011101	00100010	10001000

11101111	11	10	11	11	01100101	11001111	00110000	10011010	01110101	11011111	00100000	10001010
11110000	11	11	00	00	01010000	11111010	00000101	10101111	01010000	11111010	00000101	10101111
11110001	11	11	00	01	01010011	11111001	00000110	10101100	01010010	11111000	00000111	10101101
11110010	11	11	01	00	01011100	11110110	00001001	10100011	01011000	11110010	00001101	10100111
11110011	11	11	01	01	01011111	11110101	00001010	10100000	01011010	11110000	00001111	10100101
11110100	11	11	00	10	01010010	11111000	00000111	10101101	01010011	11111001	00000110	10101100
11110101	11	11	00	11	01010001	11111011	00000100	10101110	01010001	11111011	00000100	10101110
11110110	11	11	01	10	01011110	11110100	00001011	10100001	01011011	11110001	00001110	10100100
11110111	11	11	01	11	01011101	11110111	00001000	10100010	01011001	11110011	00001100	10100110
11111000	11	11	10	00	01011000	11110010	00001101	10100111	01011100	11110110	00001001	10100011
11111001	11	11	10	01	01011011	11110001	00001110	10100100	01011110	11110100	00001011	10100001
11111010	11	11	11	00	01010100	11111110	00000001	10101011	01010100	11111110	00000001	10101011
11111011	11	11	11	01	01010111	11111101	00000010	10101000	01010110	11111100	00000011	10101001
11111100	11	11	10	10	01011010	11110000	00001111	10100101	01011111	11110101	00001010	10100000
11111101	11	11	10	11	01011001	11110011	00001100	10100110	01011101	11110111	00001000	10100010
11111110	11	11	11	10	01010110	11111100	00000011	10101001	01010111	11111101	00000010	10101000
11111111	11	11	11	11	01010101	11111111	00000000	10101010	01010101	11111111	00000000	10101010

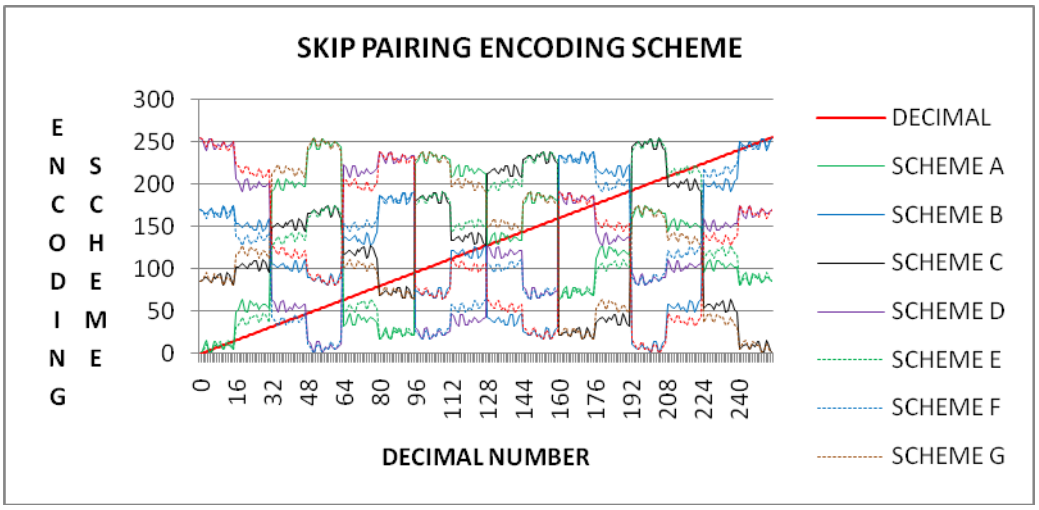

Figure 7.6: Decimal Number v/s Encoded Numbers in Skip Pairing

7.3. RESULTS AND DISCUSSIONS

To understand the behavior of the encoding scheme, we conducted an extensive study to evaluate its effect on wireless sensor networks in terms of neighbor's connectivity. In our experiments, we consider a two dimensional coverage area 'A' of 100 square meters. This network consists of a set of sensor nodes $S = \{s_1, s_2, ..., s_n\}$. Each sensor S_i, where $i = 1...n$ located at random coordinate (x_i, y_i) inside 'A'. Each sensor has a sensing range of r_i, i.e. 15 meters. Results on connectivity with a random encoding scheme for each sensor have been calculated in this work by increasing from single scheme to eight schemes.

To equip each sensor with all of the eight schemes, it is necessary to deploy sensors in such a way that each sensor in sensor network has at least eight neighbors and thereby each sensor physically be connected in the network when it has more than 8 neighbors. A sensor node is assumed to be logically connected in the network if it is physically connected in the network and all its encoding schemes are matched with its neighbors too. The number of encoding schemes in each sensor is variable from single scheme to eight schemes for measuring the behavior of neighbors in the network. Figure 7.7 shows that more than 200 sensors are required to achieve more than 90 percent physical connectivity. Figure 7.8 shows the behavior of the network for physical connectivity when more than eight neighbors are available for each sensor. Figure 7.9 shows the number of physical neighbors and Figure 7.10 shows the logical connectivity

for each encoding schemes. When only one encoding scheme is applied, the percentage of sensors with more than eight logical neighbors is approximately twenty percentage but when we apply all the eight encoding schemes then this percentage is same as in case of physical connectivity. The number of logical neighbors is shown in Figure 7.8. Table 7.1 shows the key size and block size used by different symmetric key cryptographic algorithms where the size of key is very large in comparison with presented scheme 'PBES'. The block size in all the algorithms is generally fixed and very large which need not required in case of very small packet size. In presented PBES scheme the key size is of 3 bit wide to differentiate all 8 encoding schemes. The presented system encodes any size packet by stream cipher method where no additional memory is required to store the result of intermediate step to start the next step. Presented scheme is capable to encode variable size packet became output results produced is a sequence of bits and decision taken for a portion of processed input received so far.

Table 7.3: Algorithms Settings

Algorithm	**Key Size (Bits)**	**Block Size (Bits)**
DES[56]	64	64
Triple DES[56]	192	64
AES[57]	Variable (128,192 or 256)	128
Blowfish[58]	Variable (32-448) Default (128)	64
RC2[59]	Variable (8 to 128)	64
RC4[60]	Variable (40 to 128)	Variable (32, 64, 128)
RC6[61]	Variable (128, 192 or 256	128
IDEA[62]	64	128
PBES	3	Variable

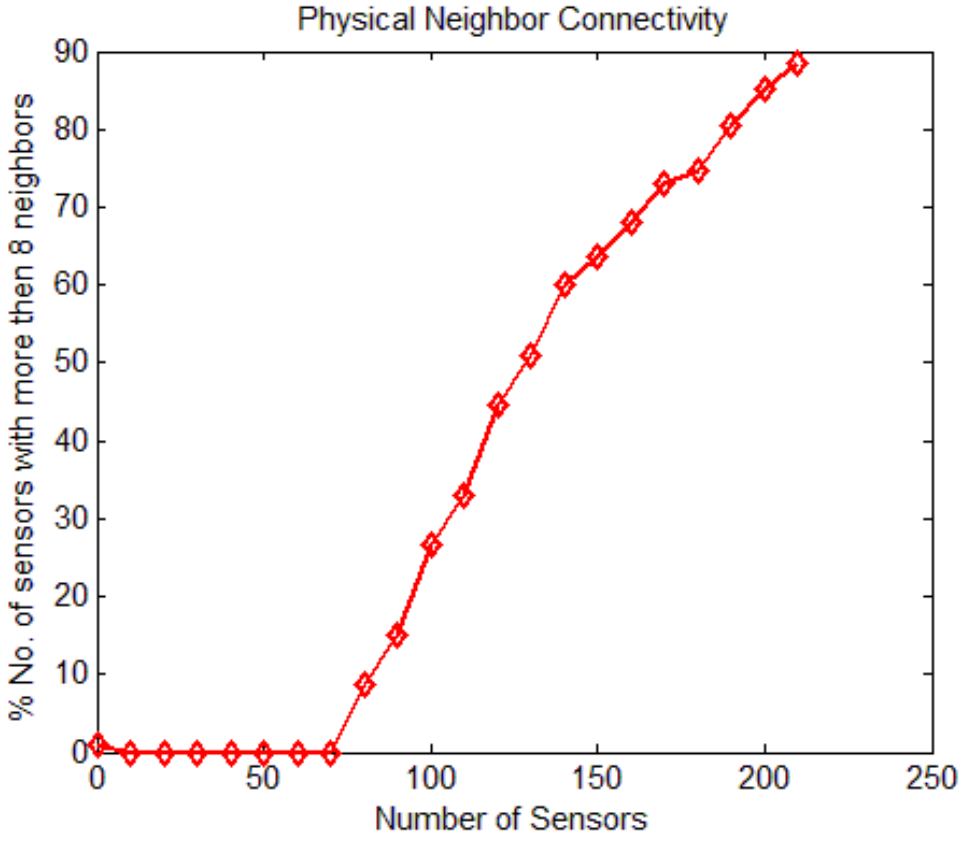

Figure 7.7: Sensors Physical Connectivity

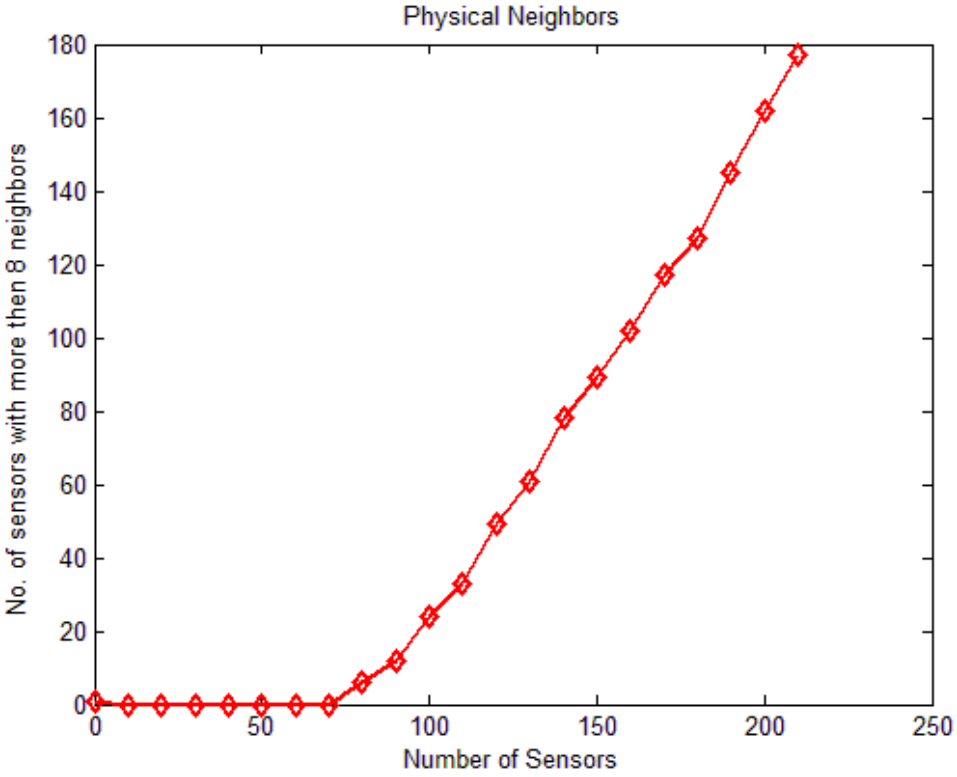

Figure 7.8: Sensors Physical Neighbors

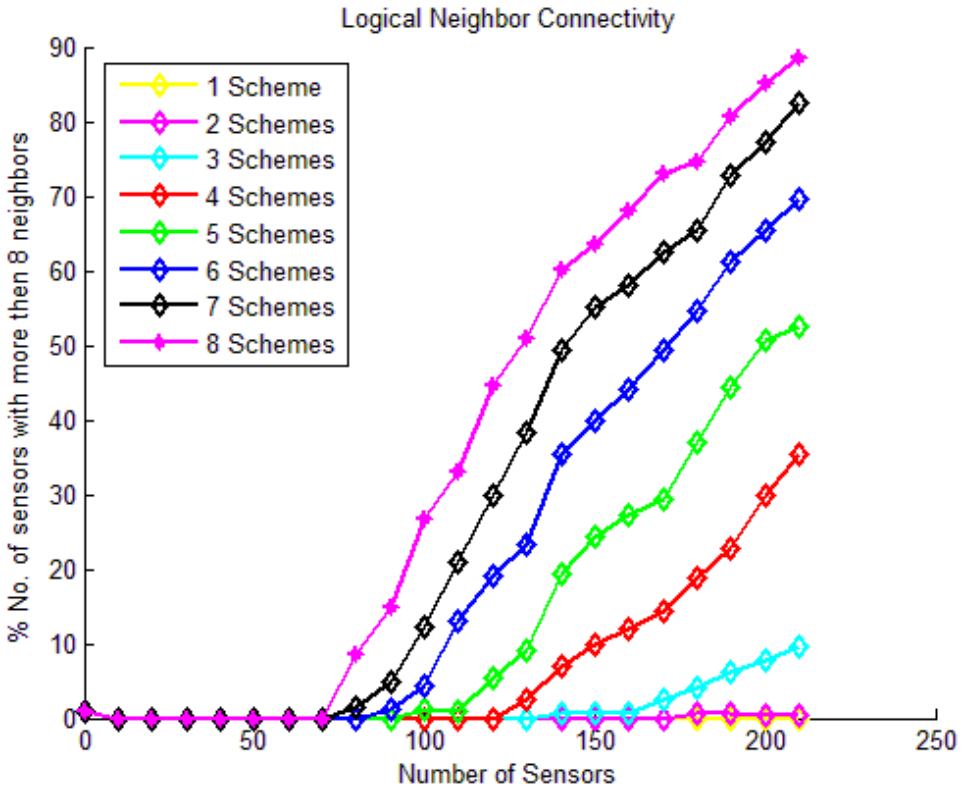

Figure 7.9: Sensors Logical connectivity

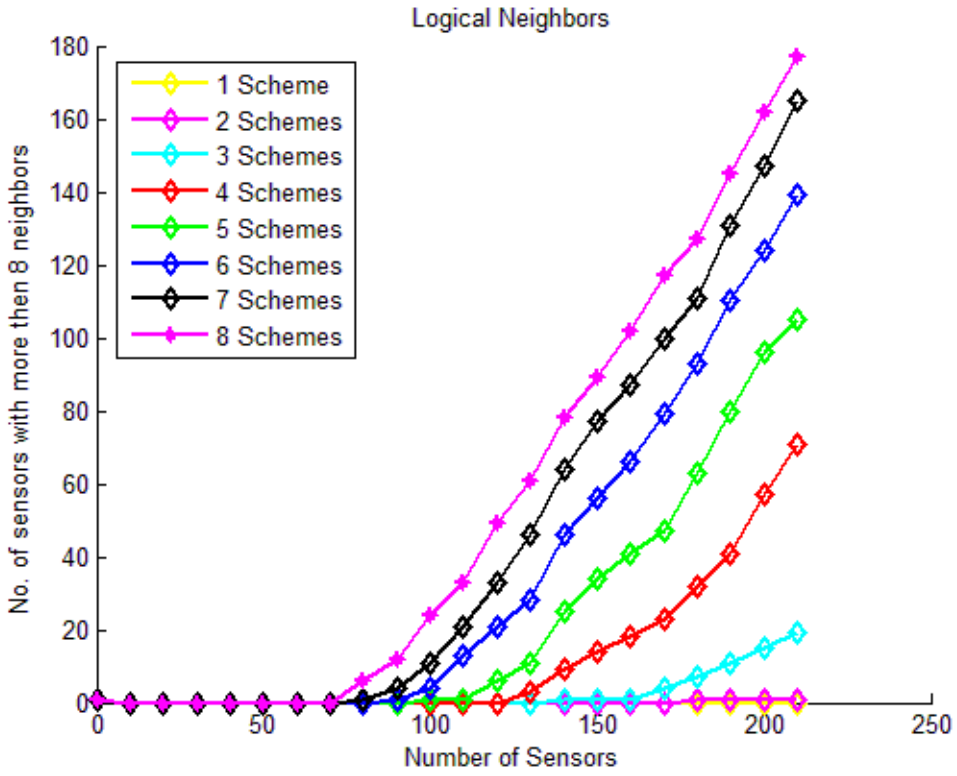

Figure 7.10: Sensor Logical Neighbors

7.4. SUMMARY

Multiple coding schemes exploring the simple logical operations have been described in detail in this chapter. Simulation results indicate that presented encoding scheme is economical than the existing heavy cryptographic algorithms such as DES, AES and IDEA or RSA in terms of reducing the resource requirements. This encoding scheme is an addition of one fold complexity to an existing encryption function. In chapter-8, conclusion and future directions has been presented in detail.