

Check Digits

These are used for Error Checking, or otherwise known as Error Detection

Check Digits

(1) Check Digits are a way of ensuring that data has been entered and read correctly.

(2) A calculation on data to create a number which is used for error checking (error detection).

**(3) After the number is input, the check digit is recalculated
And a check is made to see if it matches the number originally calculated.**

Check Digits

(2) Check Digits are Digits which are added to the ends of numbers and are calculated using the other digits in the number.

(3) Many different ways/methods/algorithms are used to generate Check Digits

Example of Simple Algorithm for Check Digits

Alice



1763

This is
the code on Alice's
product (eg a
highlighter)

Bob



17637

A Check Digit is Calculated by
summing all the numbers and then the modulus 10

$$1+7+6+3 = 17$$

$$17 \text{ MOD } 10 = 7$$

17637

The last digit is the Check Digit

Bob re-calculates the Check Digit using the
Same algorithm and also gets a value of 7

So, we can conclude that the code
has been read correctly.

Remember the MOD is the remainder when 2 numbers are divided by each other.

Examples where Check Digits are used in Real Life

(1) ISBN Numbers ISBN-13 978-1-84078-596-8 The last digit here is the Check Digit

(2) Bar/Product Codes 0 705 632 441 947 The last digit here is the Check Digit

(3) Credit Cards 6360 5495 5110 9991 The last digit here is the Check Digit

Various different algorithms produce these check digits.

Question and Answer

**What is the Check Digit of the following code,
if the check digit is generated by summing the digits of the code
and then taking MOD 11 ?**

56743

Question and Answer

**What is the Check Digit of the following code,
if the check digit is generated by summing the digits of the code
and then taking MOD 11 ?**

56743

Answer

$$5+6+7+4+3 = 25$$

$$25 \text{ MOD } 11 = 3$$

567433

Remember the MOD is the remainder when 2 numbers are divided by each other.

Parity Bits

Parity Bit

(1) A Parity Bit is a type of Check Digit .

(2) It is an extra bit added to a data message (made up of binary data) at its origin (i.e before the data is transmitted) .

And then scrutinised at the receiving end to determine whether an error has occurred in transmission,

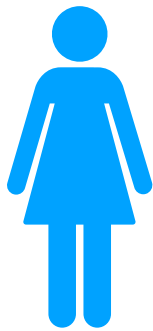
(3) We have:-

(I) Even Parity - here an extra bit is added to construct a string with an even number of 1s'.

(II) Odd Parity - here an extra bit is added to construct a string with an odd number of 1s'.

Even Parity

Alice



1010 010

1010 010

(1) Alice wants to transmit
this string.
The string has 7 bits

(2) This string has
3 1s' in it.
So the string has an odd
number of 1s'.

(3) Now, in even parity a string has to be created with an even number of 1s'

(4) So, in order to fulfil the criteria of even parity,
a '1' is added to the end of the string before transmission..
This extra bit is the parity bit.

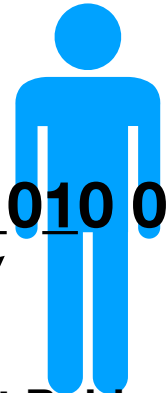
(5) 1010 010 1

(6) This results in an 8-bit string with an even number of 1s.

(7) We can see that the string has 4 1s' in it.

(8) And this 8-bit string which includes the extra parity bit is passed to Bob

Bob



(9) 1010 010 1

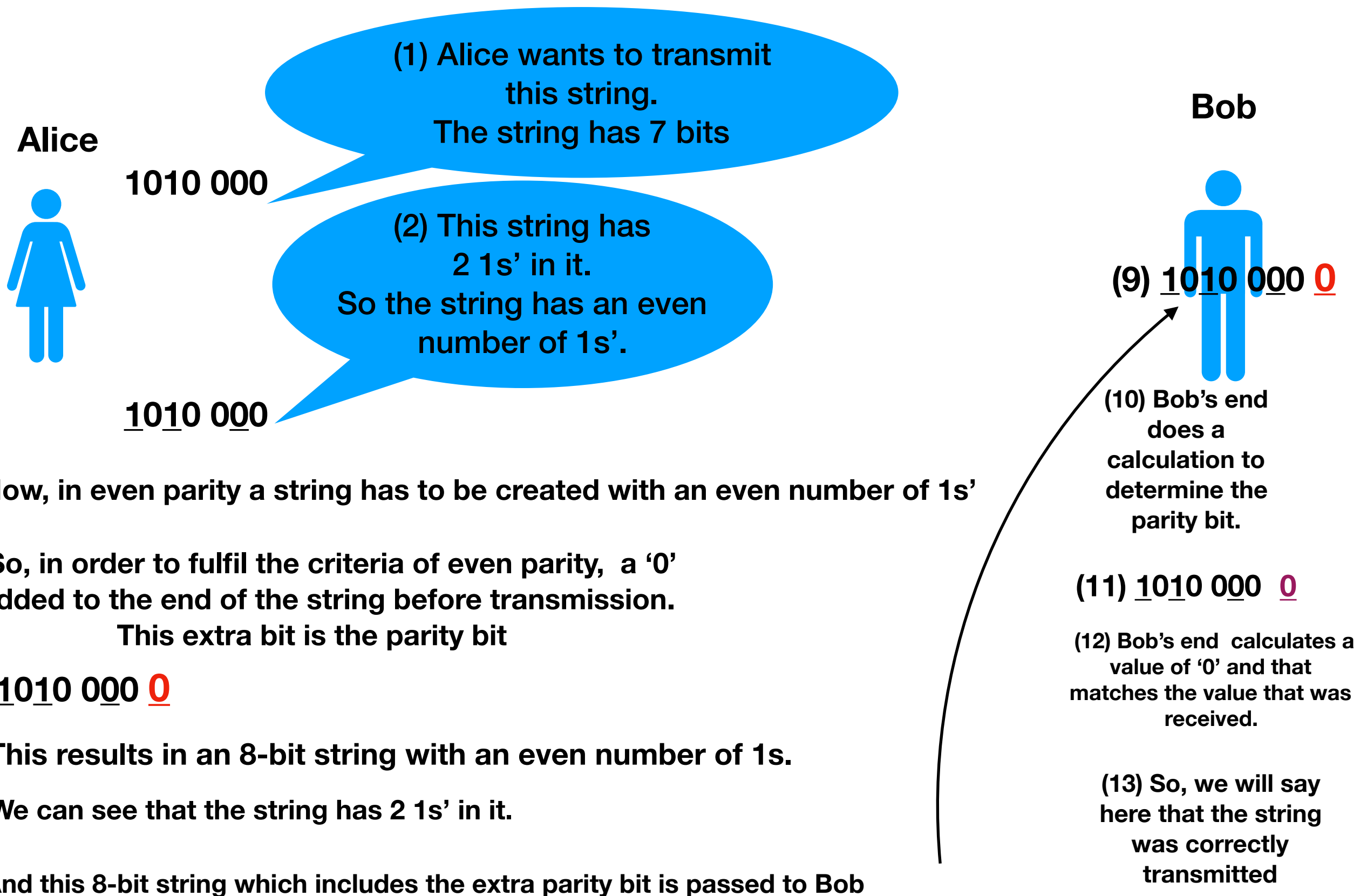
(10) At Bob's end
a calculation is
performed to
determine the
parity bit.

(11) 1010 010 1

(12) At Bob's end a value of
'1' is calculated and that
matches the value that was
received.

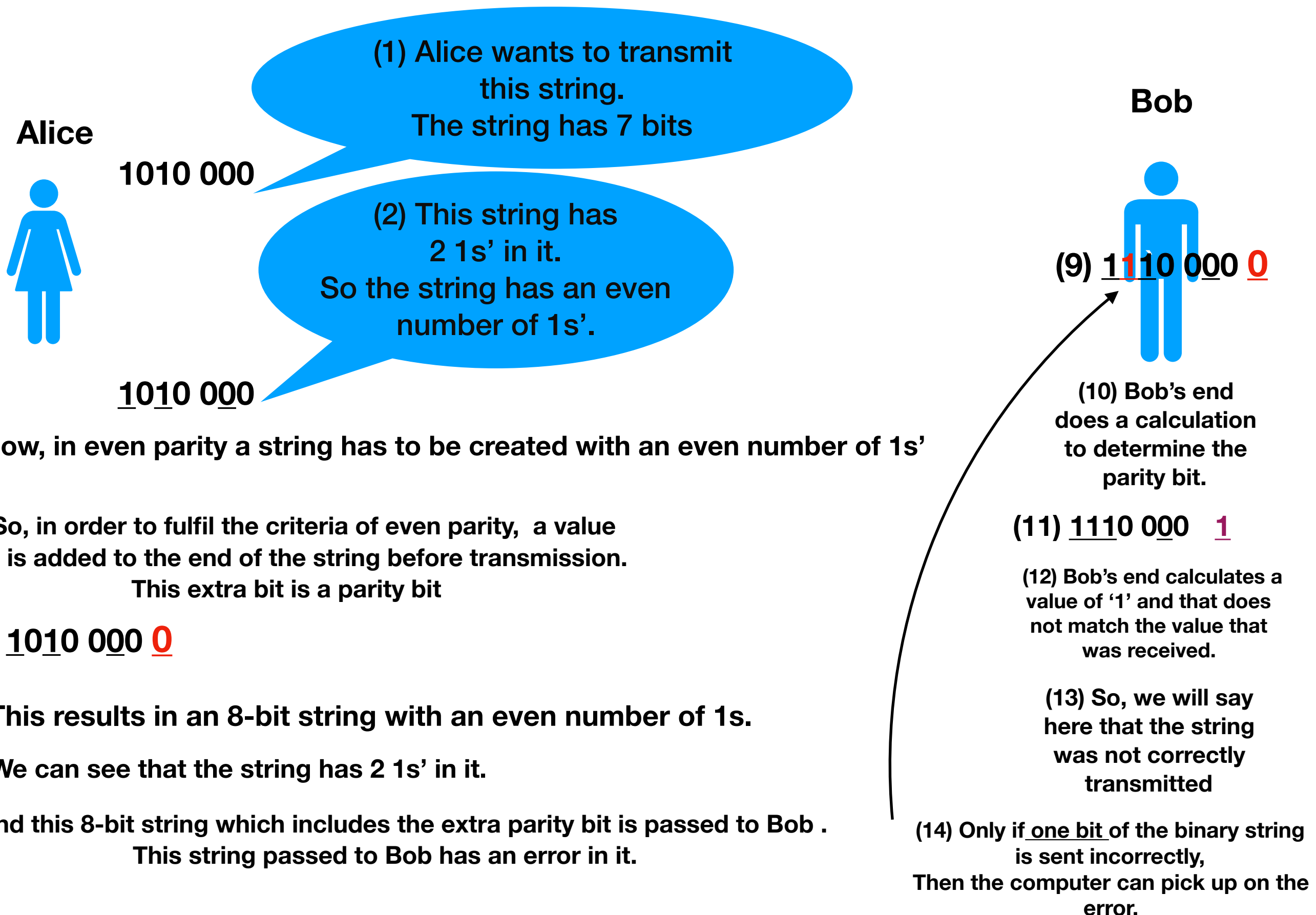
(13) So, we will say
here that the string
was correctly
transmitted

Another Example of Even Parity Detecting Correct

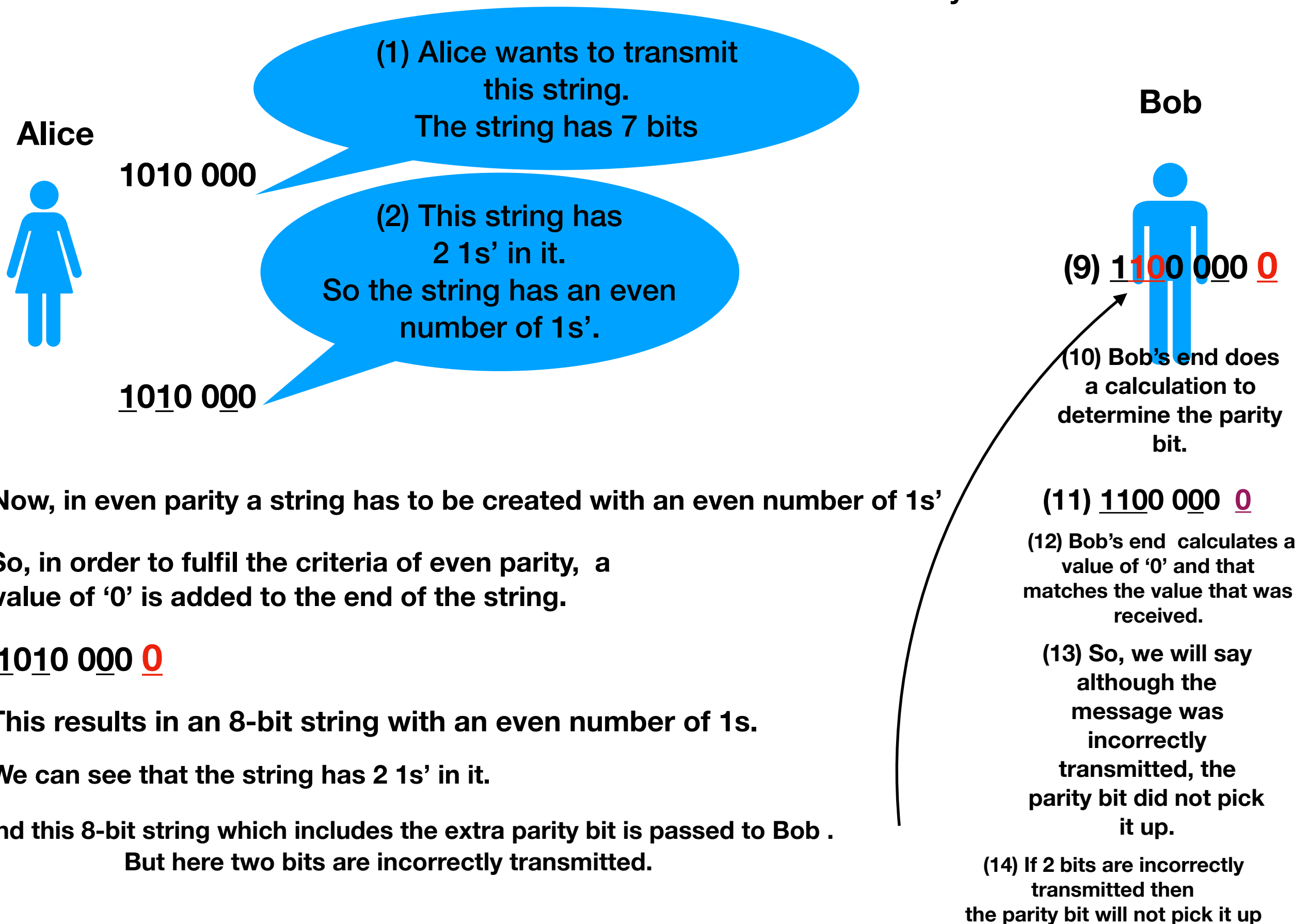


Detecting an Error in Transmission of Data with Even Parity.

This can happen only if one bit is sent/read incorrectly.



Incorrect Message sent but No Error Detected with Even Parity Bit - if 2 bits are transmitted/read/sent incorrectly



Questions & Answers

An even parity bit has been added to the end of three 7-bit binary codes to create the 8-bit binary codes below.

Identify and explain which code contains an error

Code 1

10101011

Code 2

10100101

Code 3

10010011

Questions & Answers

**An even parity bit has been added to the end of three 7-bit binary codes to create the 8-bit binary codes below.
Identify and explain which code contains an error**

Code 1

10101011

Code 2

10100101

Code 3

10010011

10101011

**The last digit is
the parity bit.**

Code 1 has 5 1s'

**But in even parity you
Need an even number of 1s'**

**So this Code 1
contains an error'**

10100101

**The last digit is
the parity bit.**

Code 2 has 4 1s'

**And in even parity you
Need an even number of 1s'**

**So this Code 2 does not
contain an error'**

10010011

**The last digit is
the parity bit.**

Code 3 has 4 1s'

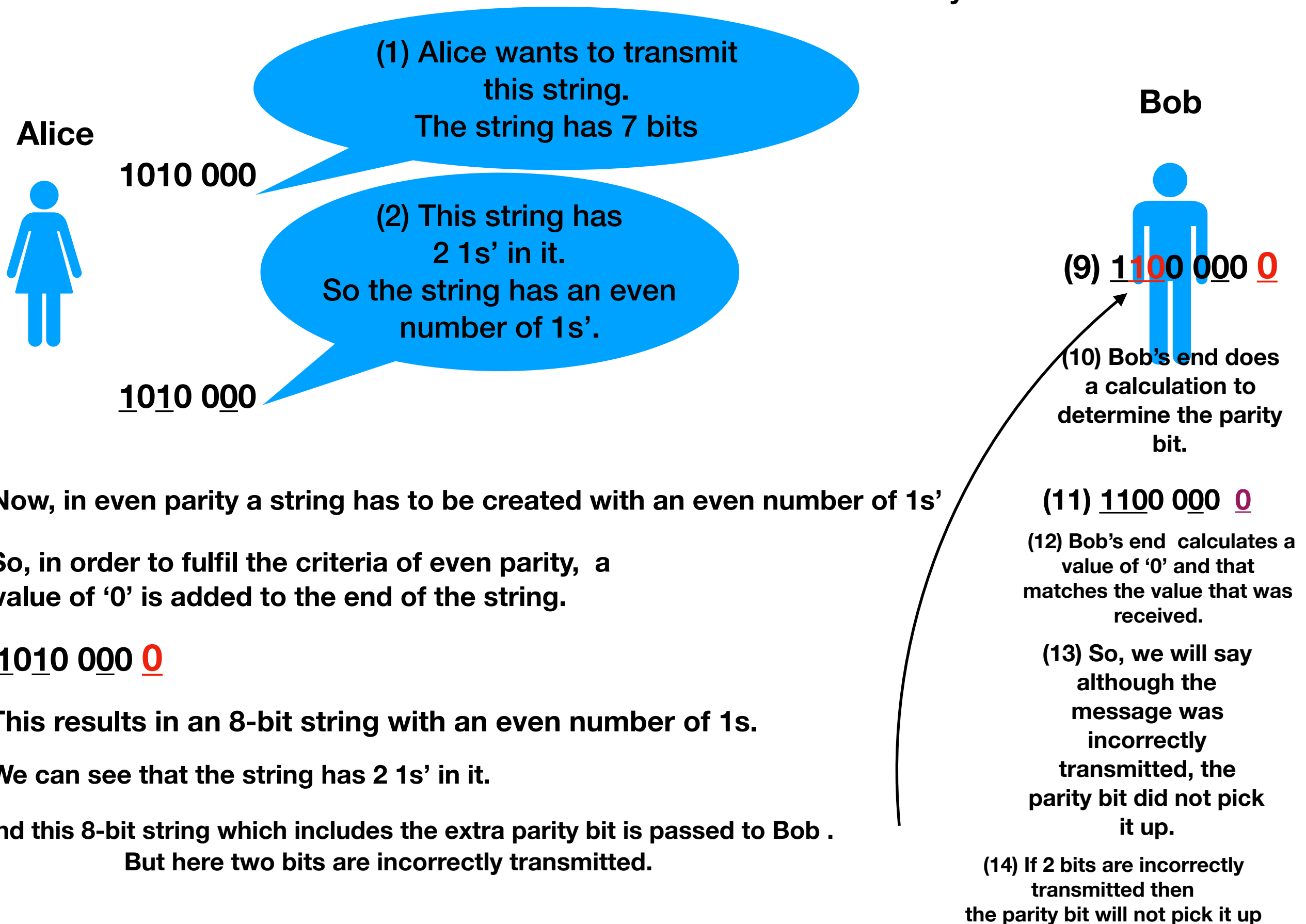
**And in even parity you
Need an even number of 1s'**

**So this Code 3 does not
contain an error'**

Question

Explain how a binary code containing a parity bit can be read incorrectly without any errors being detected

Incorrect Message sent but No Error Detected with Odd Parity Bit - if 2 bits are transmitted/read/sent incorrectly



Questions & Answers

Explain how a binary code containing a parity bit can be read incorrectly without any errors being detected

**If 2 bits are incorrectly transmitted then
the parity bit will not pick it up**

Parity Bits

Parity Bit

(1) A Parity Bit is a type of Check Digit .

(2) It is an extra bit added to a data message (made up of binary data) at its origin (i.e before the data is transmitted) .

And then scrutinised at the receiving end to determine whether an error has occurred in transmission,

(3) We have:-

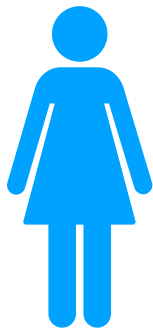
(I) Even Parity - here an extra bit is added to construct a string with an even number of 1s'.

(II) Odd Parity - here an extra bit is added to construct a string with an odd number of 1s'.

Odd Parity

Example of Odd Parity Detecting Correct Transmission of Data

Alice



1010 010

1010 010

(1) Alice wants to transmit this string.
The string has 7 bits

(2) This string has 3 1s' in it.
So the string has an odd number of 1s'.

(3) Now, in odd parity a string has to be created with an odd number of 1s'

(4) So, in order to fulfil the criteria of odd parity, a '0' is added to the end of the string before transmission..

This extra bit is the parity bit.

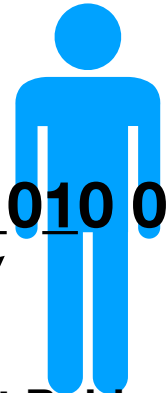
(5) 1010 010 0

(6) This results in an 8-bit string with an odd number of 1s.

(7) We can see that the string has 3 1s' in it.

(8) And this 8-bit string which includes the extra parity bit is passed to Bob

Bob



(9) 1010 010 0

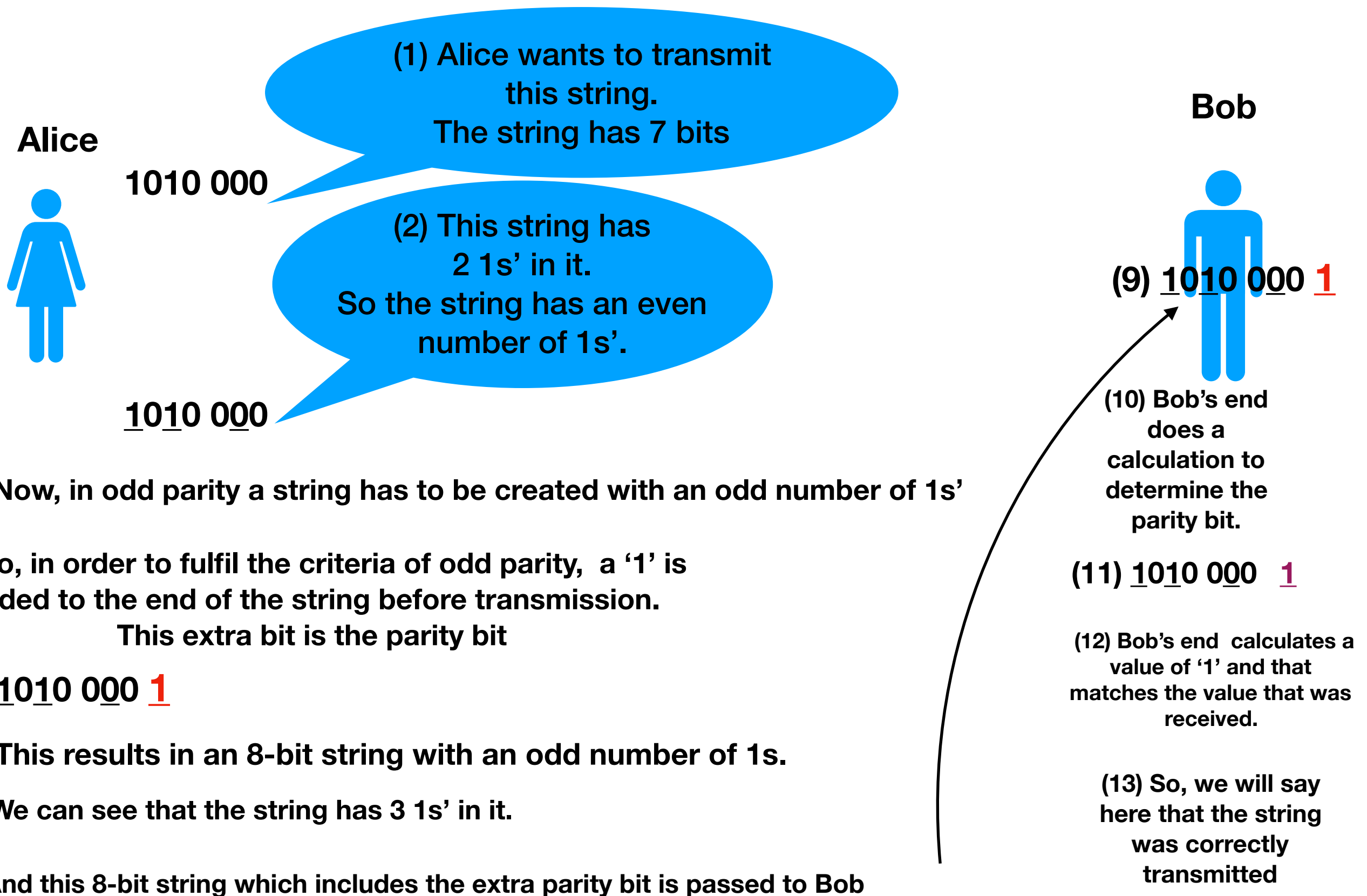
(10) At Bob's end a calculation is performed to determine the parity bit.

(11) 1010 010 0

(12) At Bob's end a value of '0' is calculated and that matches the value that was received.

(13) So, we will say here that the string was correctly transmitted

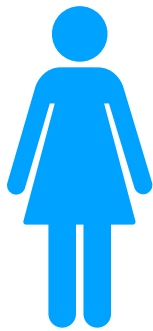
Another Example of Odd Parity Detecting Correct Transmission of Data



Detecting an Error in Transmission of Data with Odd Parity.

This can happen only if one bit is sent/read incorrectly.

Alice



1010 000

(1) Alice wants to transmit this string.
The string has 7 bits

(2) This string has 2 1s' in it.
So the string has an even number of 1s'.

1010 000

(3) Now, in odd parity a string has to be created with an odd number of 1s'

(4) So, in order to fulfil the criteria of odd parity, a value of '1' is added to the end of the string before transmission.

This extra bit is a parity bit

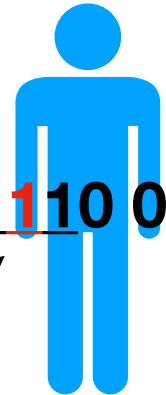
(5) 1010 000 1

(6) This results in an 8-bit string with an odd number of 1s.

(7) We can see that the string has 3 1s' in it.

(8) And this 8-bit string which includes the extra parity bit is passed to Bob .
This string passed to Bob has an error in it.

Bob



(9) 1110 000 1

(10) Bob's end does a calculation to determine the parity bit.

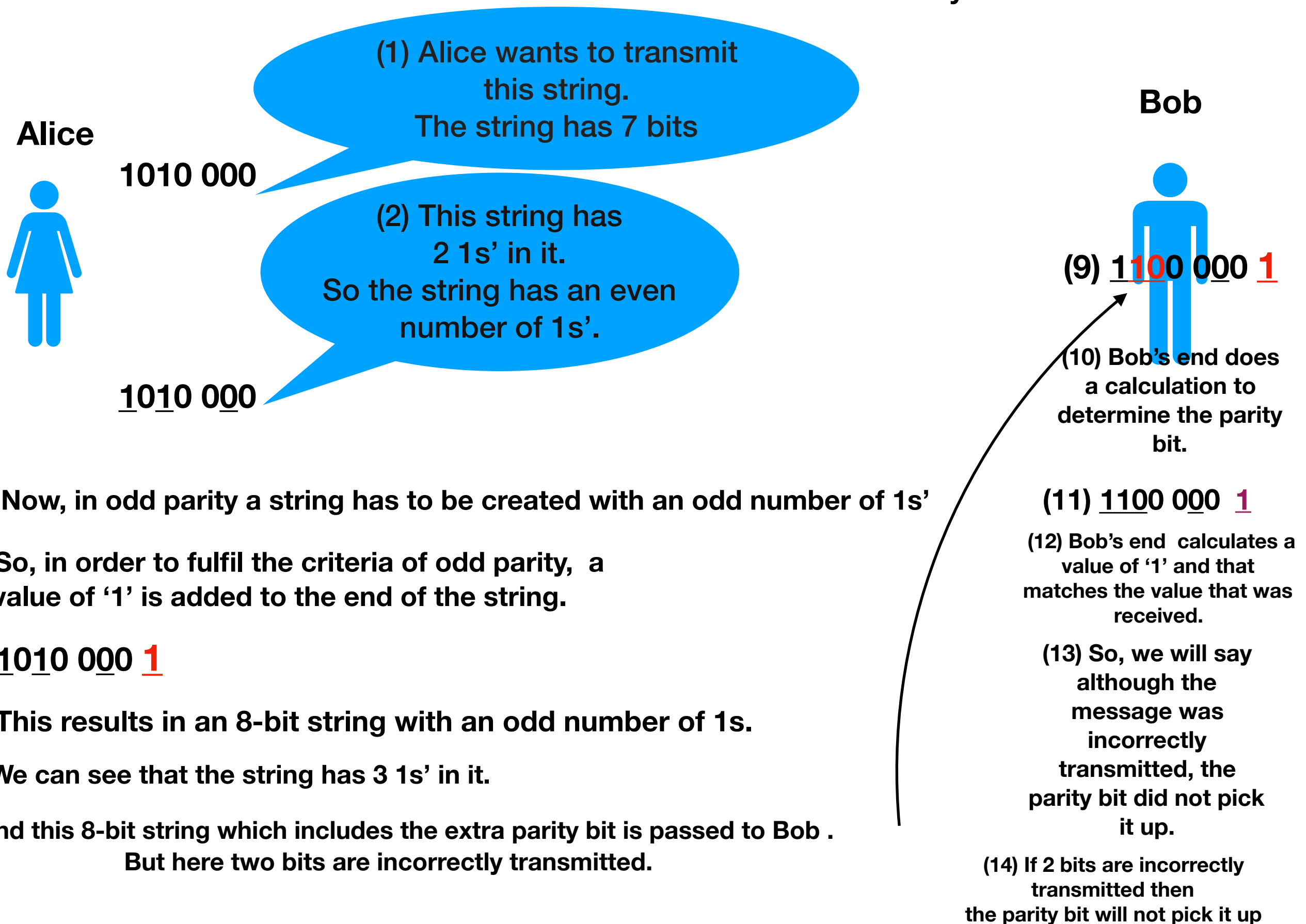
(11) 1110 000 0

(12) Bob's end calculates a value of '0' and that does not match the value that was received.

(13) So, we will say here that the string was not correctly transmitted

(14) Only if one bit of the binary string is sent incorrectly,
Then the computer can pick up on the error.

Incorrect Message sent but No Error Detected with Even Parity Bit - if 2 bits are transmitted/read/sent incorrectly



Question and Answers

If we are looking at Odd Parity, what should be the parity bit added to the end of these 7-bit binary codes to create the 8-bit binary codes?

Code 1

1010 101

Code 2

1010 010

Code 3

110 1001

Question and Answers

If we are looking at Odd Parity, what should be the parity bit added to the end of these 7-bit binary codes to create the 8-bit binary codes?

Code 1

1010 101

Code 1 has 4 1s'

**But in odd parity you
Need an odd number of 1s'**

**So you put an extra 1 at the end
For Odd Parity and you have 5 1s'**

1010 1011

**The last digit is
the parity bit.**

Code 2

1010 010

Code 2 has 3 1s'

**And in odd parity you
Need an odd number of 1s'**

**So you put an extra 0 at the end
For Odd Parity and you have 3 1s'**

1010 0100

**The last digit is
the parity bit.**

Code 3

110 1001

Code 3 has 4 1s'

**And in odd parity you
Need an odd number of 1s'**

**So you put an extra 1 at the end
For Odd Parity and you have 5 1s'**

110 10011

**The last digit is
the parity bit.**