Secret Transmissions

How to use Agent X's error checking system

Agent X wants to send the message abcd, where each letter represents 0 or 1.

She works out:

- a check digit x (either 0 or 1) so there are an even number of 1s in **xabd**
- a check digit y (either 0 or 1) so there are an even number of 1s in **yacd**
- a check digit z (either 0 or 1) so there are an even number of 1s in **zbcd**

Agent X then transmits the message **xyazbcd**.

The base camp can check whether the message they receive has been transmitted correctly by counting the number of 1s in xabd, yacd and zbcd.

If these are all even numbers, the message has been transmitted correctly, and they can read off the message Agent X sent by reading the 3rd, 5th, 6th and 7th digits.

If one or more of these strings xabd, yacd, zbcd contains an odd number of 1s, the base camp can work out which digit has been altered in transmission.

For example, suppose b has been altered in transmission:

> **xabd** and **zbcd** will contain an odd number of 1s.
> The fact that **yacd** has an even number of 1s in it means y, a, c and d must have been transmitted correctly.
> The only digit that is in both xabd and zbcd, but not in yacd, is b, so they can deduce that b is the incorrect digit.
> They can then correct the error and read off the message Agent X transmitted.

Another example: suppose base camp receives the message 0100111.

x	y	a	z	b	c	d
0	1	0	0	1	1	1

xabd: Even
yacd: Odd
zbcd: Odd

This means that x, a, b and d are all correct, one of y, a, c and d is incorrect, and one of z, b, c and d is incorrect. The digits that appear in both yacd and zbcd are c and d, but we know d is correct, so c must be the incorrect digit. So the message should have read 0100101, so Agent X sent 0101, or North-North-West.