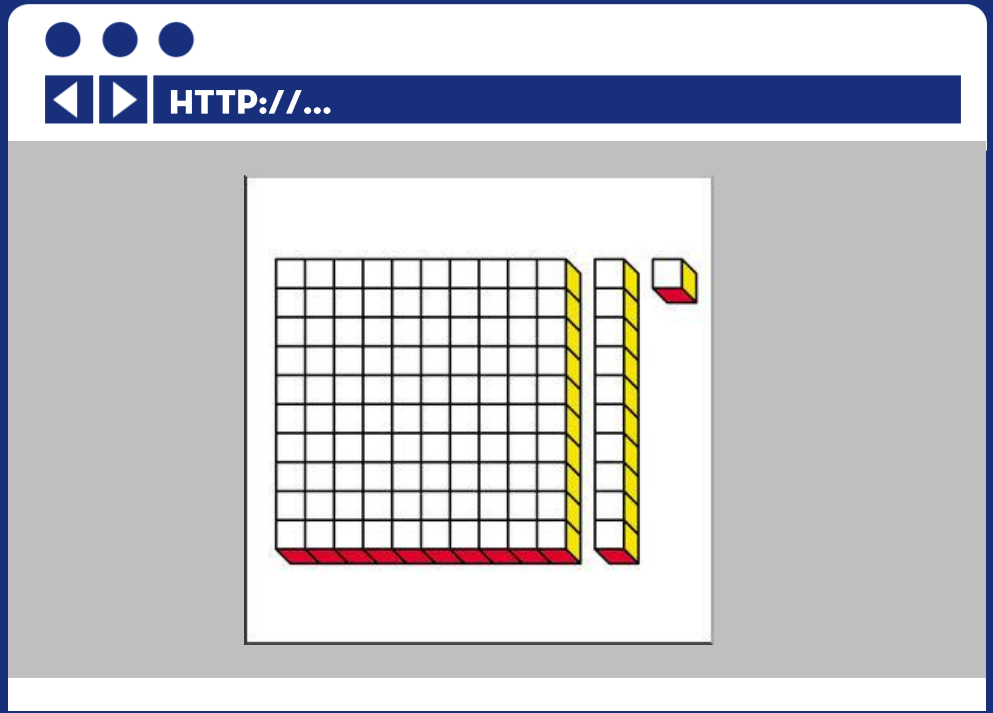
NUMBER SYSTEMS - DECIMAL AND BINARY

HOW WE COUNT...

THE PLACE VALUE SYSTEM

- NUMBERS ARE SYMBOLS THAT REPRESENT TANGIBLE, REAL-LIFE AMOUNTS
- RATHER THAN A DIFFERENT SYMBOL FOR EVERY DIFFERENT AMOUNT, WE COMBINE A SMALL SET OF SYMBOLS IN SPECIAL WAYS
- USING A PLACE VALUE SYSTEM, SYMBOLS FURTHER TO THE LEFT REPRESENT LARGER AMOUNTS, AND SYMBOLS FURTHER TO THE RIGHT REPRESENT SMALLER AMOUNTS



THE DECIMAL SYSTEM

TEN DIFFERENT SYMBOLS

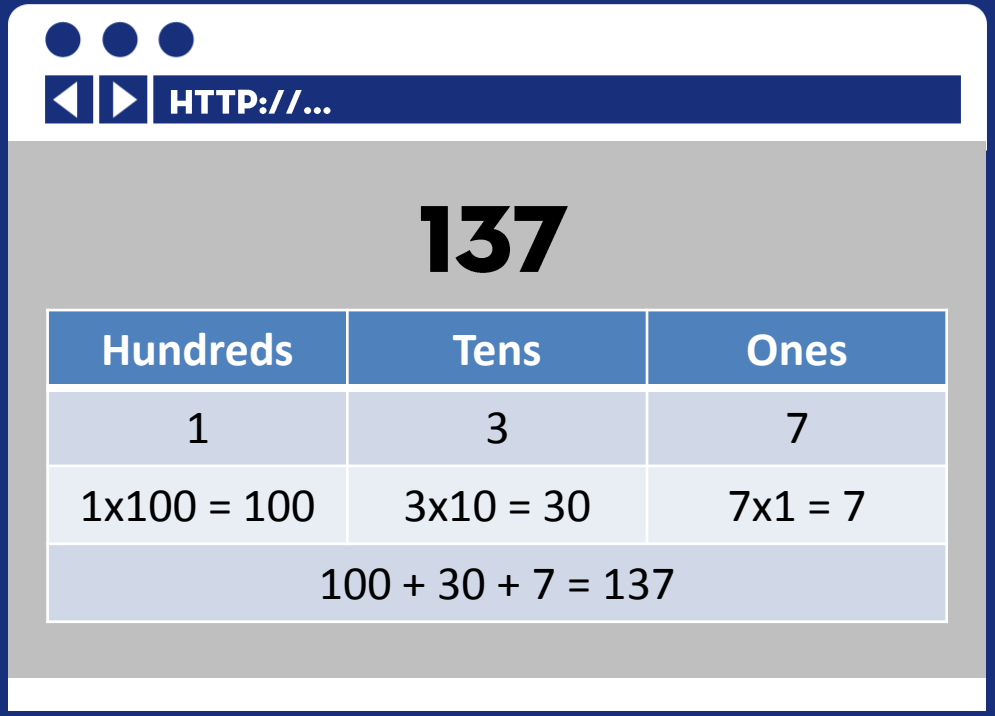
- WE ARE ACCUSTOMED TO USING TEN SYMBOLS (0-9)
- WHEN WE NEED BIGGER NUMBERS, WE USE MORE THAN ONE OF THESE SYMBOLS, AND DECODE THEM BASED ON THE VALUE THAT IS REPRESENTED BY THEIR POSITIONS, OR PLACES
- DECIMAL SYSTEM PLACE VALUES ARE POWERS OF TEN
  - $10^0 = 1$
  - $10^1 = 10$
  - $10^2 = 100$
  - $10^3 = 1000$
  - $10^4 = 10000$
  - $10^5 = 100000$
  - ETC...

A DECIMAL EXAMPLE

THE NUMBER 137

- 1 HUNDREDS
- 3 TENS
- 7 ONES

- 100 + 30 + 7 = 137

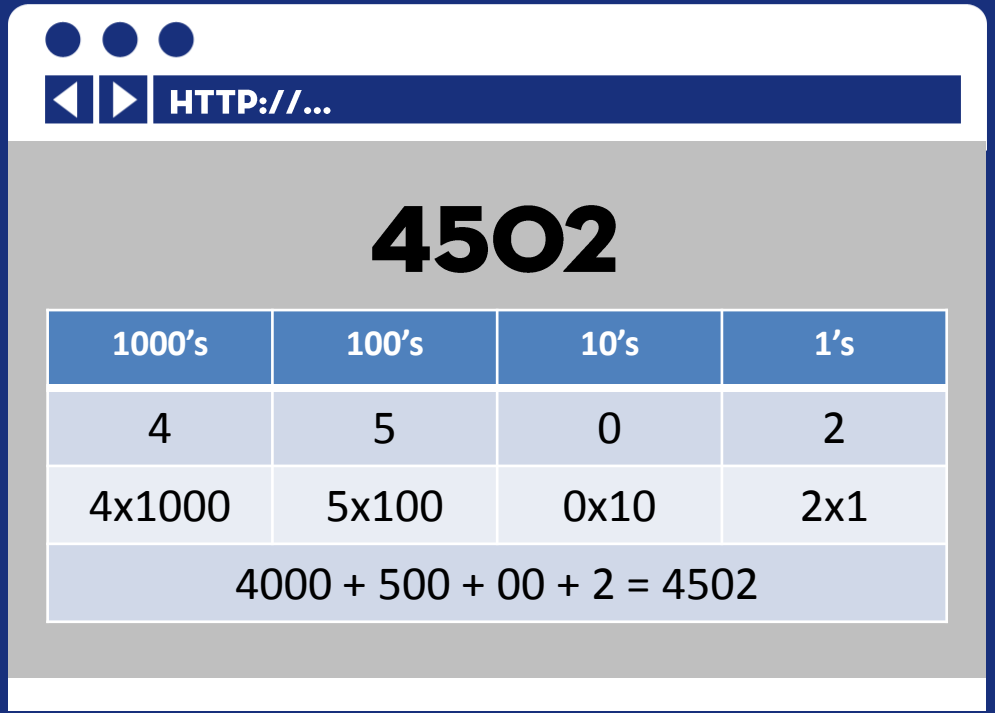


ANOTHER EXAMPLE

THE NUMBER 4502

- 4 THOUSANDS
- 5 HUNDREDS
- 0 TENS
- 2 ONES

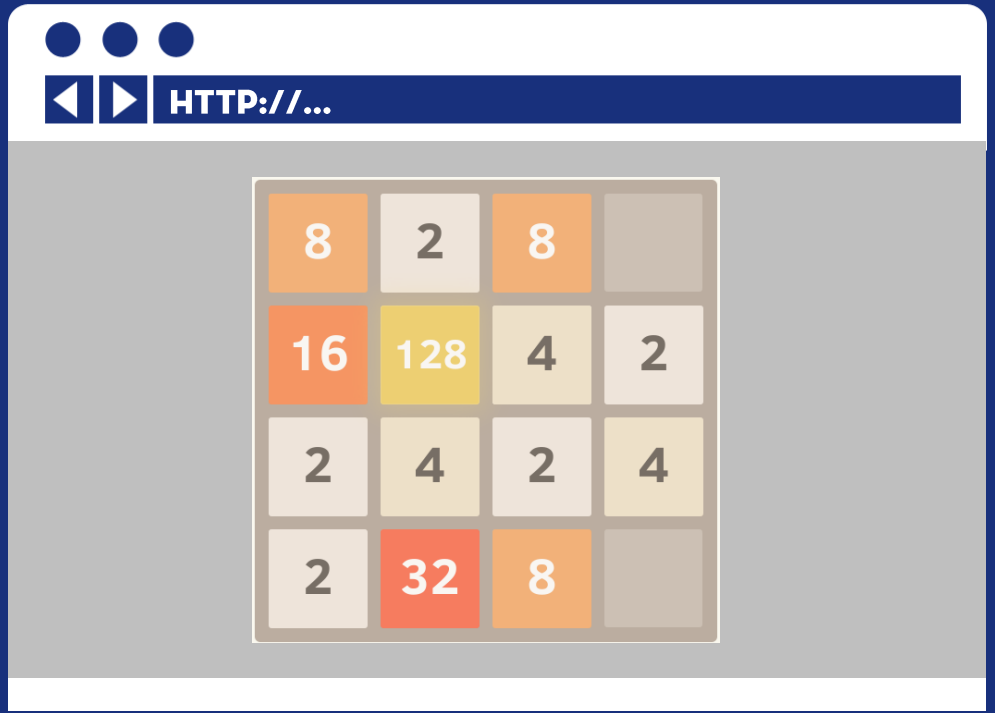
- 4000 + 500 + 00 + 2 = 4502



THE BINARY SYSTEM

TWO DIFFERENT SYMBOLS

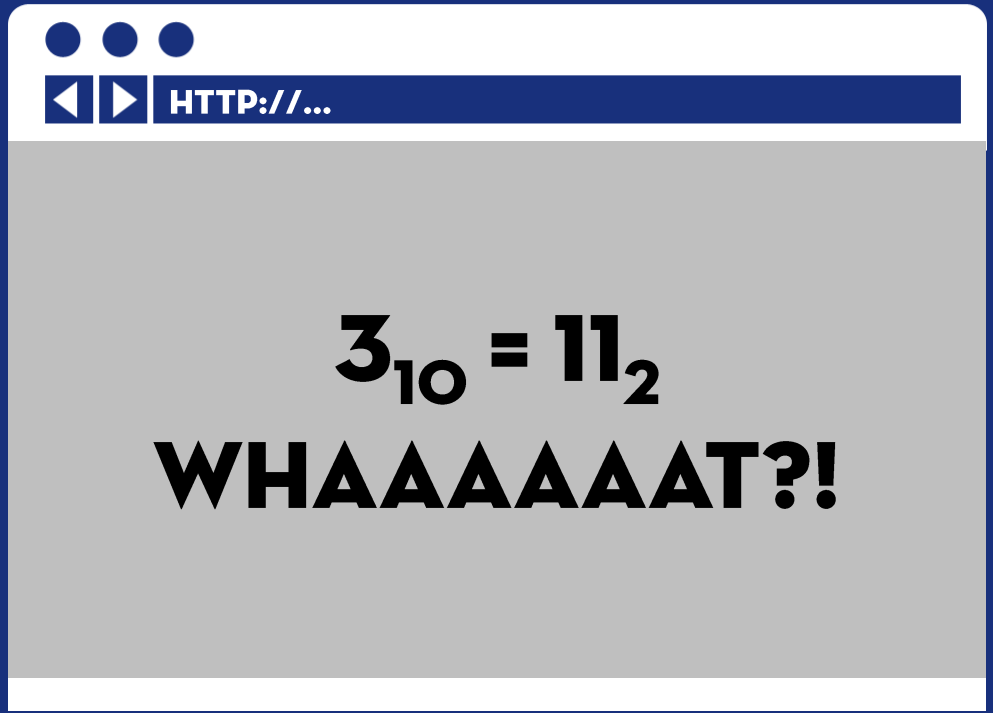
- BINARY USES ONLY TWO SYMBOLS (0 AND 1, CALLED 'BITS')
- CONVENIENT FOR COMPUTERS BECAUSE COMPUTERS CAN MOST EASILY REPRESENT DATA USING "ON" AND "OFF" SIGNALS
- EACH PLACE VALUE IS A POWER OF TWO
  - $2^0 = 1$
  - $2^1 = 2$
  - $2^2 = 4$
  - $2^3 = 8$
  - $2^4 = 16$
  - $2^5 = 32$
  - ETC...



DISTINGUISHING SYSTEMS

USING SUBSCRIPTS

- IN DECIMAL, '11' MEANS 'ELEVEN THINGS'
- IN BINARY, '11' MEANS 'THREE THINGS'
  - CONFIRM THIS!
- HOW DO WE KNOW THE DIFFERENCE?
- INDICATE BASE USING SUBSCRIPT AFTER THE NUMBER
- 11_2 - BINARY
- 11_{10} - DECIMAL



A B-D EXAMPLE

THE NUMBER 10001001_2

- 1 ONES
- 0 TWOS
- 0 FOURS
- 1 EIGHTS
- 0 SIXTEENS
- 0 THIRTY-TWOS
- 0 SIXTY-FOURS
- 1 ONE-HUNDRED-TWENTY-EIGHTS

- 128 + 8 + 1 = 137

- $10001001_2 = 137_{10}$

10001001_2

128's	64's	32's	16's	8's	4's	2's	1's
1	0	0	0	1	0	0	1
1x128	0x64	0x32	0x16	1x8	0x4	0x2	1x1
128				8			1
128+8+1 = 137							

ANOTHER B-D

THE NUMBER 01001101_2

- 1 ONES
- 0 TWOS
- 1 FOURS
- 1 EIGHTS
- 0 SIXTEENS
- 0 THIRTY-TWOS
- 1 SIXTY-FOURS
- 0 ONE-HUNDRED-TWENTY-EIGHTS

- 64+8+4+1 = 77

- $01001001_2 = 77_{10}$

01001101_2

128's	64's	32's	16's	8's	4's	2's	1's
0	1	0	0	1	1	0	1
0x128	1x64	0x32	0x16	1x8	1x4	0x2	1x1
	64			8	4		1
64+8+4+1 = 77							

CONVERTING D-B

DECIMAL TO BINARY

- A FEW DIFFERENT METHODS, BUT ONE FAIRLY BASIC ONE IS TO REPEATEDLY DIVIDE THE NUMBER BY TWO
- AFTER EACH DIVISION, RECORD THE RESULT (QUOTIENT) AND THE LEFTOVER (REMAINDER)
- WHEN YOUR LAST QUOTIENT IS ZERO, YOU ARE DONE.
- YOUR ANSWER IS THE LIST OF DIGITS IN THE REMAINDER COLUMN FROM BOTTOM TO TOP

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$$137_{10} = 10001001_2$$

Number	÷ 2 Quotient	Remainder
137	68	1
68	34	0
34	17	0
17	8	1
8	4	0
4	2	0
2	1	0
1	0	1

CONVERTING D-B

DECIMAL TO BINARY

- TRY IT!
- WHAT IS THE NUMBER 207_{10} IN BINARY?

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$$207_{10} = ?_2$$

Number	÷ 2 Quotient	Remainder
207		

THE END!