

Binary



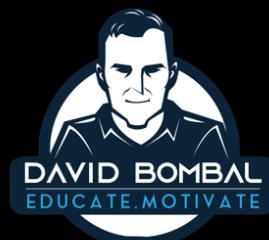
Binary

- Why do we care?
 - Subnetting
 - Access lists
 - Used in many other places

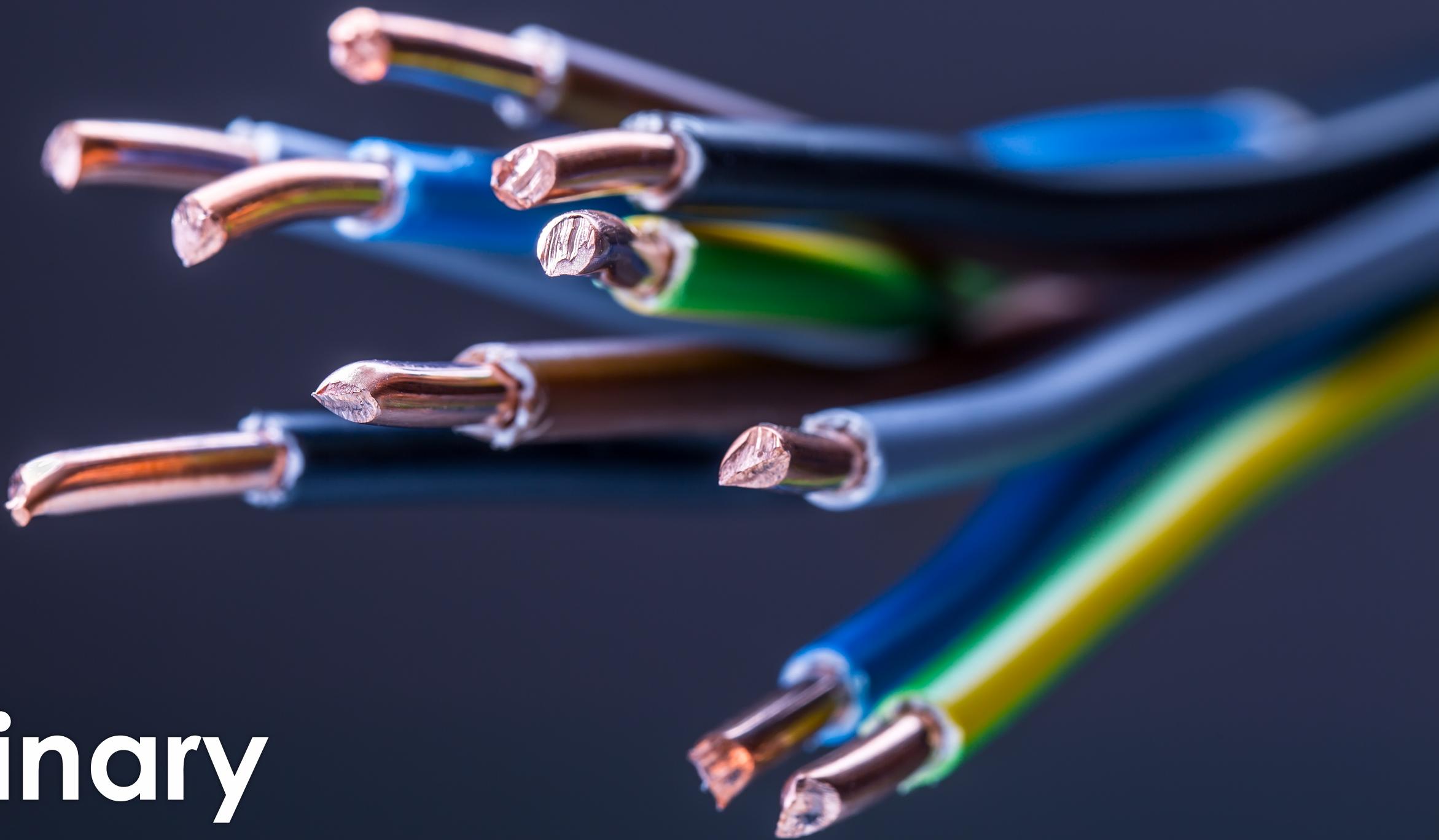


Joke

- There are only 10 types of people in the world.
- Those that understand binary and those that don't.



Binary



Binary

- All computers function by using a system of switches that can either be on or off
 - Off = 0
 - On = 1
- Binary values = 0 or 1



Binary

- Cable
 - Either has current or doesn't
 - Binary values = 0 or 1

Binary



0

Binary



1



00



10



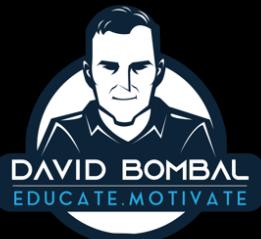
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Binary

- 2 states
- 2 cables
- $2 \times 2 = 4$
- Or $2^2 = 4$



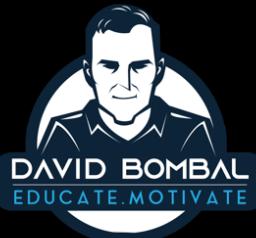
Binary

- And so on: 4 cables gives 16 binary values:
- 0000 • 1000
- 0001 • 1001
- 0010 • 1010
- 0011 • 1011
- 0100 • 1100
- 0101 • 1101
- 0110 • 1110
- 0111 • 1111
- 2 states and 4 cables: $2^4 = 16$



Binary

- 2 states
- 4 cables
- $2 \times 4 = 16$
- Or $2^4 = 16$



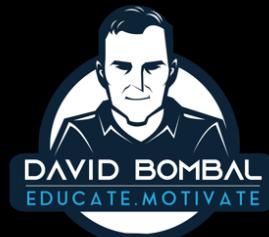
Binary

- 2 to the power of 0 (2^0) = 1
- 2 to the power of 1 (2^1)
 - which is 2 multiplied together 1 time (2×1) = 2
- 2 to the power of 2 (2^2)
 - which is 2 multiplied together 2 times (2×2) = 4
- 2 to the power of 3 (2^3)
 - which is 2 multiplied together 3 times ($2 \times 2 \times 2$) = 8
- 2 to the power of 4 (2^4)
 - which is 2 multiplied together 4 times ($2 \times 2 \times 2 \times 2$) = 16



Binary

- 2 to the power of 5 (2^5)
 - which is 2 multiplied together 5 times ($2 \times 2 \times 2 \times 2 \times 2$) = 32
- 2 to the power of 6 (2^6)
 - which is 2 multiplied together 6 times ($2 \times 2 \times 2 \times 2 \times 2 \times 2$) = 64
- 2 to the power of 7 (2^7)
 - which is 2 multiplied together 7 times ($2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$) = 128
- 2 to the power of 8 (2^8)
 - which is 2 multiplied together 8 times ($2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$) = 256



A table to remember

Base	Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary		1	1	1	1	1	1	1	1
Decimal		128	64	32	16	8	4	2	1



Example 1

- If all binary bits are a one, the binary equivalent of 255 is:

Base	Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary		1	1	1	1	1	1	1	1
Decimal		128	64	32	16	8	4	2	1

- $128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 = 255$

- Or written this way:

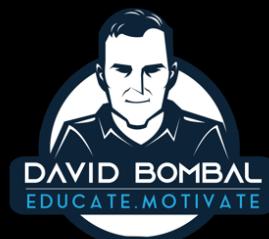
- 11111111 in binary = 255 in decimal

Example 2

- What is the binary equivalent of 1 in decimal?

Base Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary	0	0	0	0	0	0	0	1
Decimal	128	64	32	16	8	4	2	1

- 1 in binary = 1 in decimal
- Or written this way:
 - 00000001 in binary = 1 in decimal



Example 3 Question:

- What is the binary equivalent of 192 in decimal?

Base	Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary	0	0	0	0	0	0	0	0	0
Decimal	128	64	32	16	8	4	2	1	



Example 3: Answer

- What is the binary equivalent of 192 in decimal:

Base	Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary		1	1	0	0	0	0	0	0
Decimal		128	64	32	16	8	4	2	1

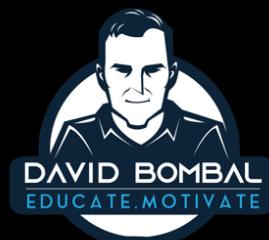
- $128 + 64 = 192$ in decimal
- Or written this way:
 - 11000000 in binary = 192 in decimal



Example 4: Question

- What is the binary equivalent of 253 in decimal?

Base	Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary		0	0	0	0	0	0	0	0
Decimal		128	64	32	16	8	4	2	1



Example 4: Answer

- What is the binary equivalent of 253 in decimal:

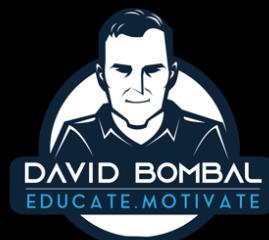
Base	Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary		1	1	1	1	1	1	0	1
Decimal		128	64	32	16	8	4	2	1

- $128 + 64 + 32 + 16 + 8 + 4 + 1 = 253$ in decimal
- Or written this way:
 - 11111101 in binary = 253 in decimal

IP Address Example

- An IPv4 address is an address used to uniquely identify a device on an IP network
- 4 octets in length
- Value in each octet is 8 bits (8 cables) in the range 0 to 255

10.	129.	16.	123	(decimal)
00001010.	10000001.	00010000.	01111011	(binary)



IP Address Example

- IP address represented in both binary and decimal:

10.	129.	16.	123	(decimal)
00001010.1000001.00010000.01111011				(binary)



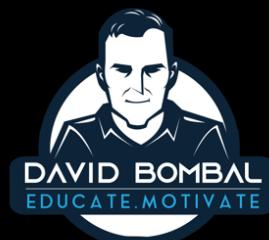
IP Address Example

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10.	129.	16.	123	(decimal)
00001010.10000001.00010000.01111011				(binary)

Base	Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary		0	0	0	0	1	0	1	0
Decimal		128	64	32	16	8	4	2	1

- $8 + 2 = 10$
 - 00001010 in binary = 10 in decimal



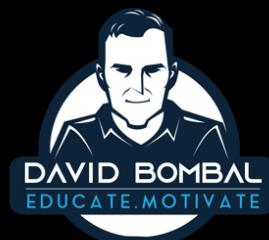
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Base	Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary		1	0	0	0	0	0	0	1
Decimal		128	64	32	16	8	4	2	1

- $128 + 1 = 129$
 - 10000001 in binary = 129 in decimal



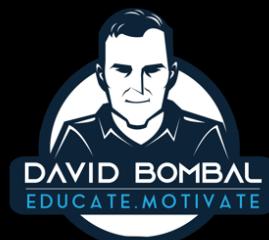
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Binary		0	0	0	1	0	0	0	0
Decimal		128	64	32	16	8	4	2	1

- $16 = 16$
 - 00001000 in binary = 16 in decimal



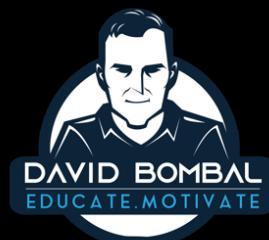
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Base	Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary		0	1	1	1	1	0	1	1
Decimal		128	64	32	16	8	4	2	1

- $64 + 32 + 16 + 8 + 2 + 1 = 123$
 - 01111011 in binary = 123 in decimal



Calculators

- Binary, Decimal and Hexadecimal Converter:
 - <https://davidbombal.com/binary-decimal-hexadecimal-converter/>
- Visual Binary to Binary:
 - <https://davidbombal.com/decimal-to-binary/>
- Subnet Calculator:
 - <https://davidbombal.com/subnetting-concepts-calculator/>



Test yourself

- Unlimited tests:
 - <https://davidbombal.com/free-quiz/>
 - <https://davidbombal.com/binary-to-decimal-quiz/>
 - <https://davidbombal.com/decimal-to-binary-quiz/>



Binary

