



Thomas Watson

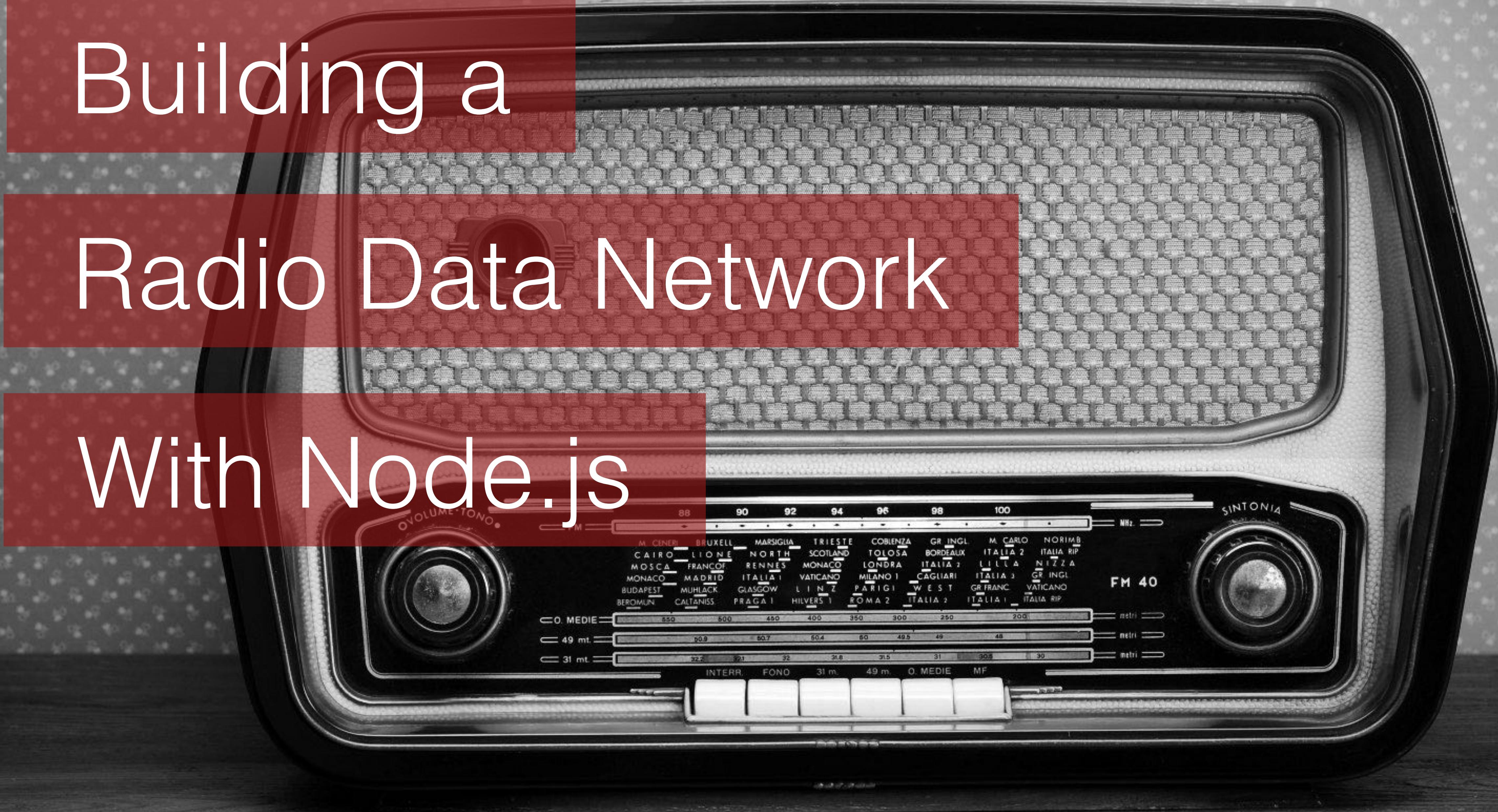
@wa7son

github.com/watson

Building a

Radio Data Network

With Node.js



Who am I?

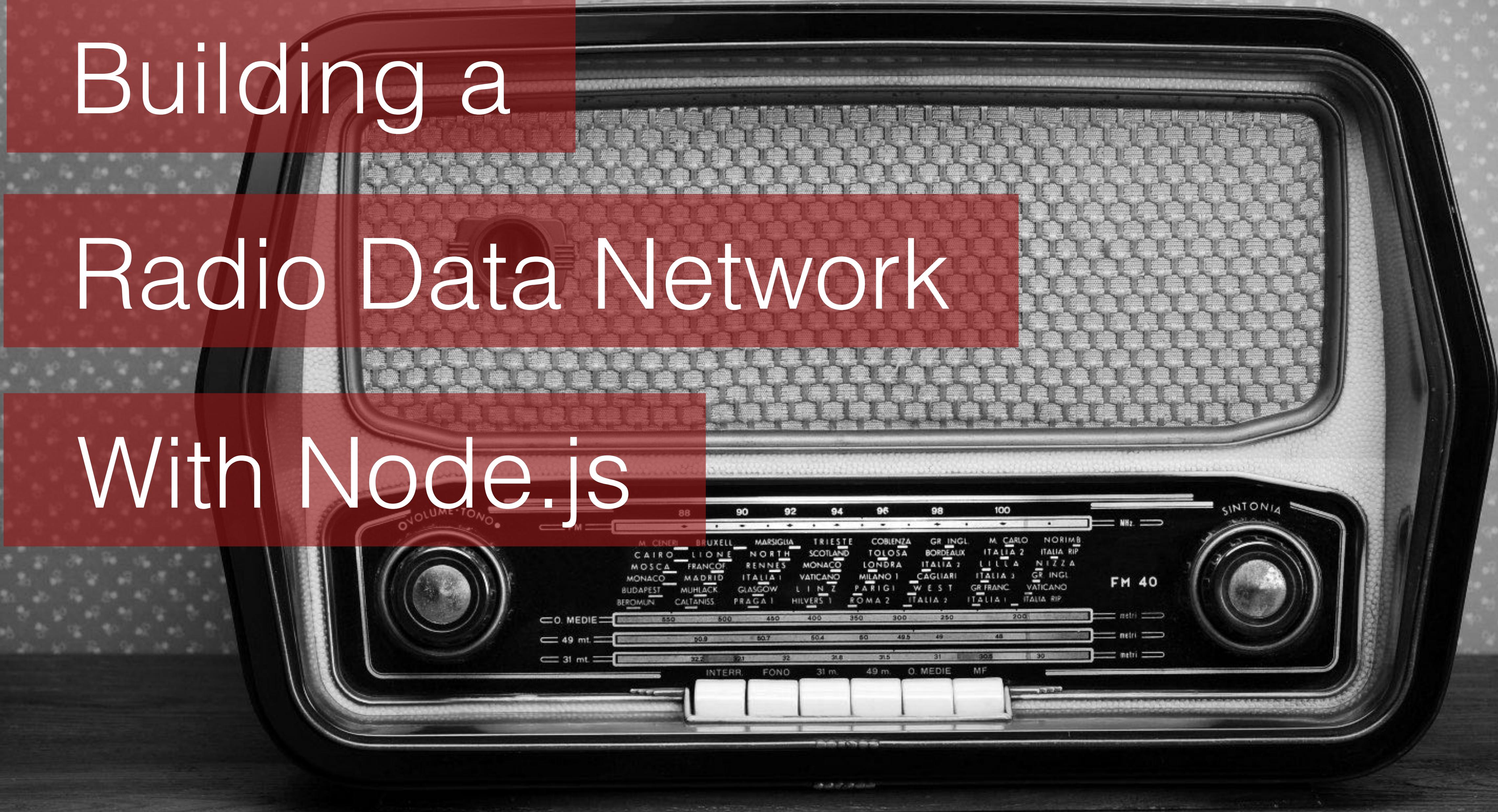
- Thomas Watson
- Open Source developer at github.com/watson
- Node.js Engineer at Elastic
- Member of the Diagnostics Working Group under the Node.js Foundation
- Tweets as @wa7son



Building a

Radio Data Network

With Node.js



Reimplementing WiFi

In Software



Software Defined Radio

Ettus
A National Instruments Company

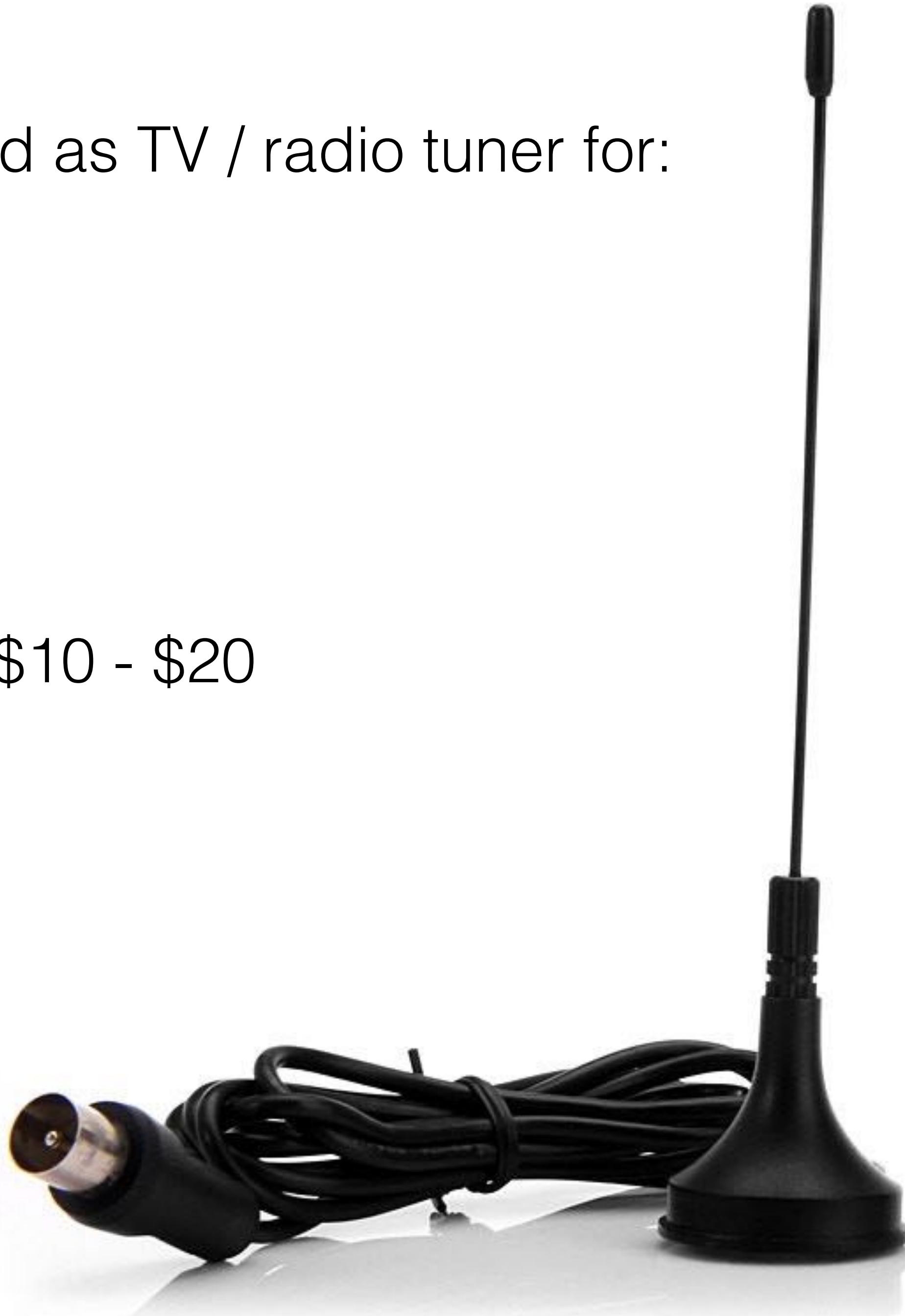
Expensive: \$5,000+



Marketed as TV / radio tuner for:

- DVB-T
- DAB
- FM

Cheap: \$10 - \$20



Contains a Realtek RTL2832U chip

💻 Hackable! 💻

Supports approx. 24 MHz – 1766 MHz



Funded by:



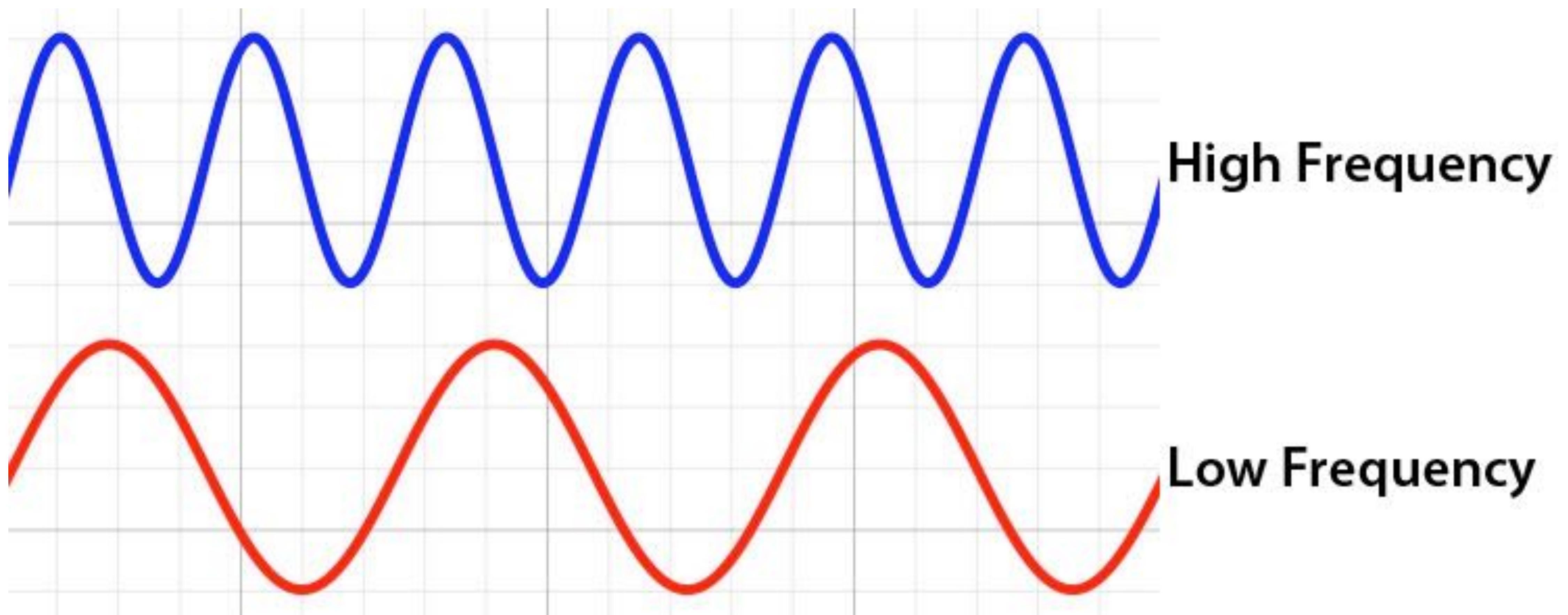
Affordable: \$299



Radio 101



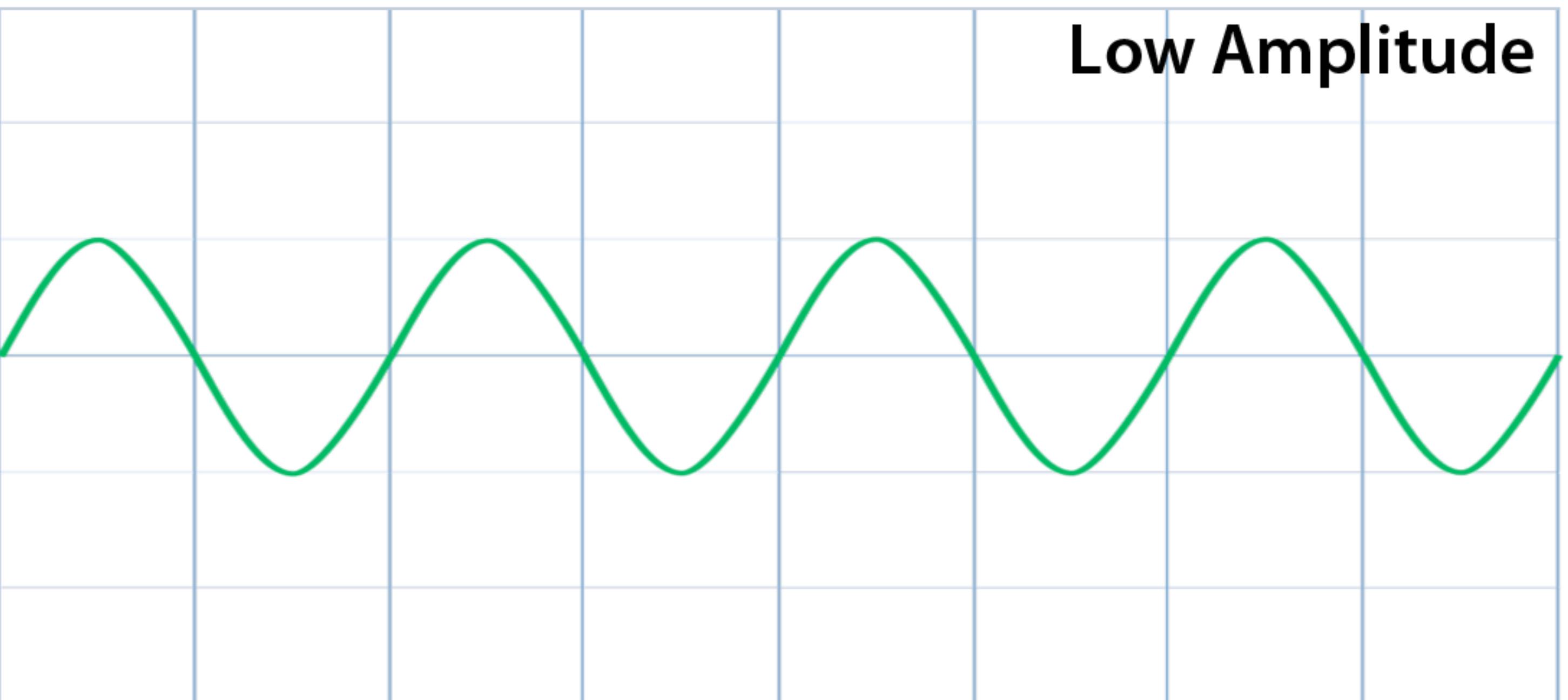
@wa7son

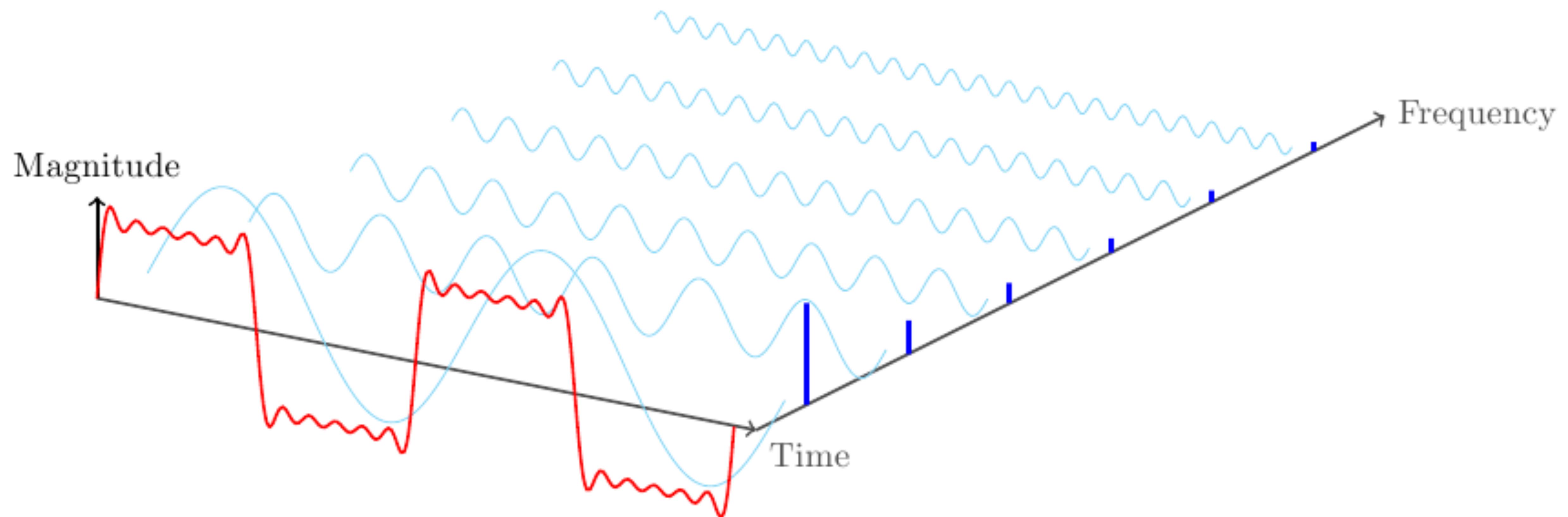


High Amplitude



Low Amplitude



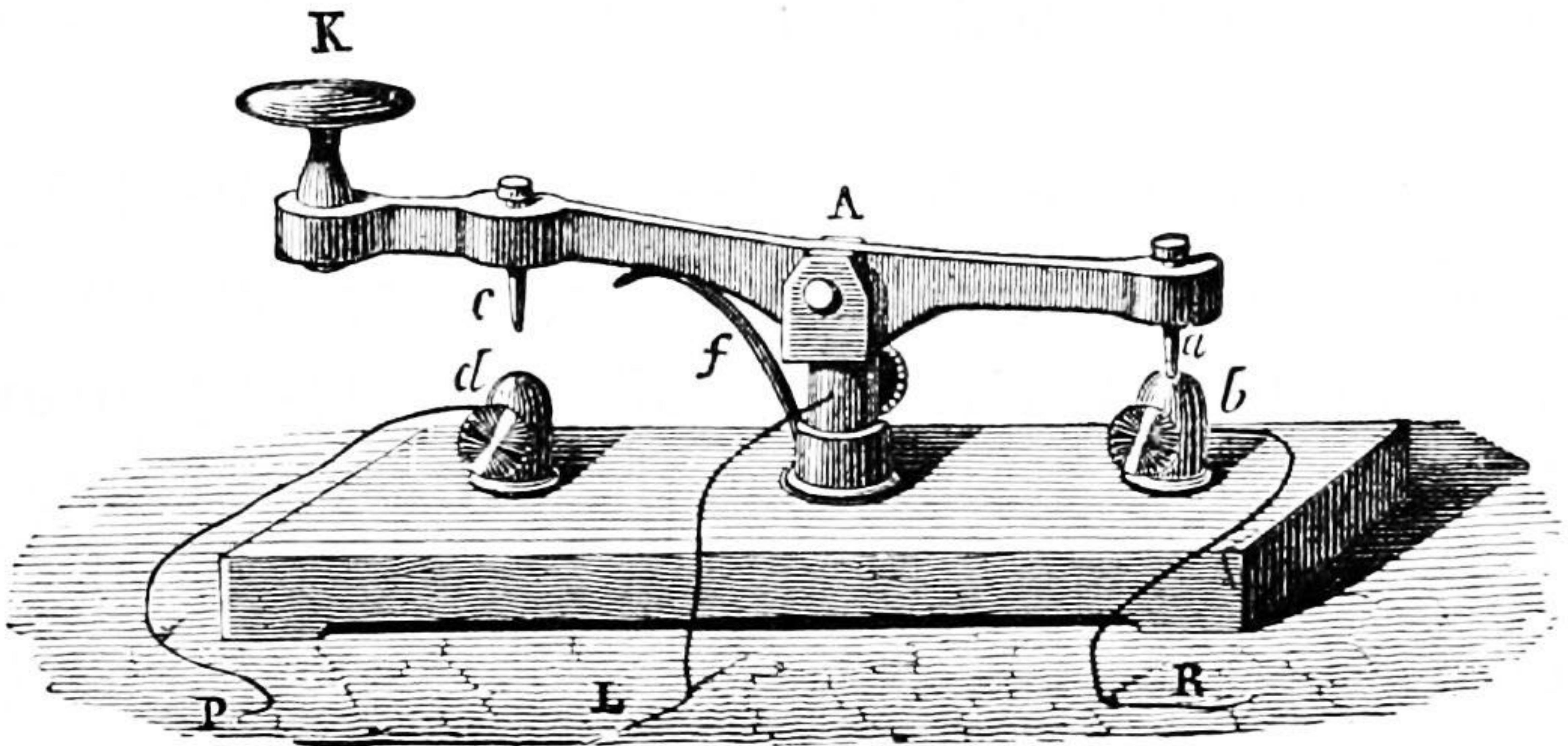


Modulation

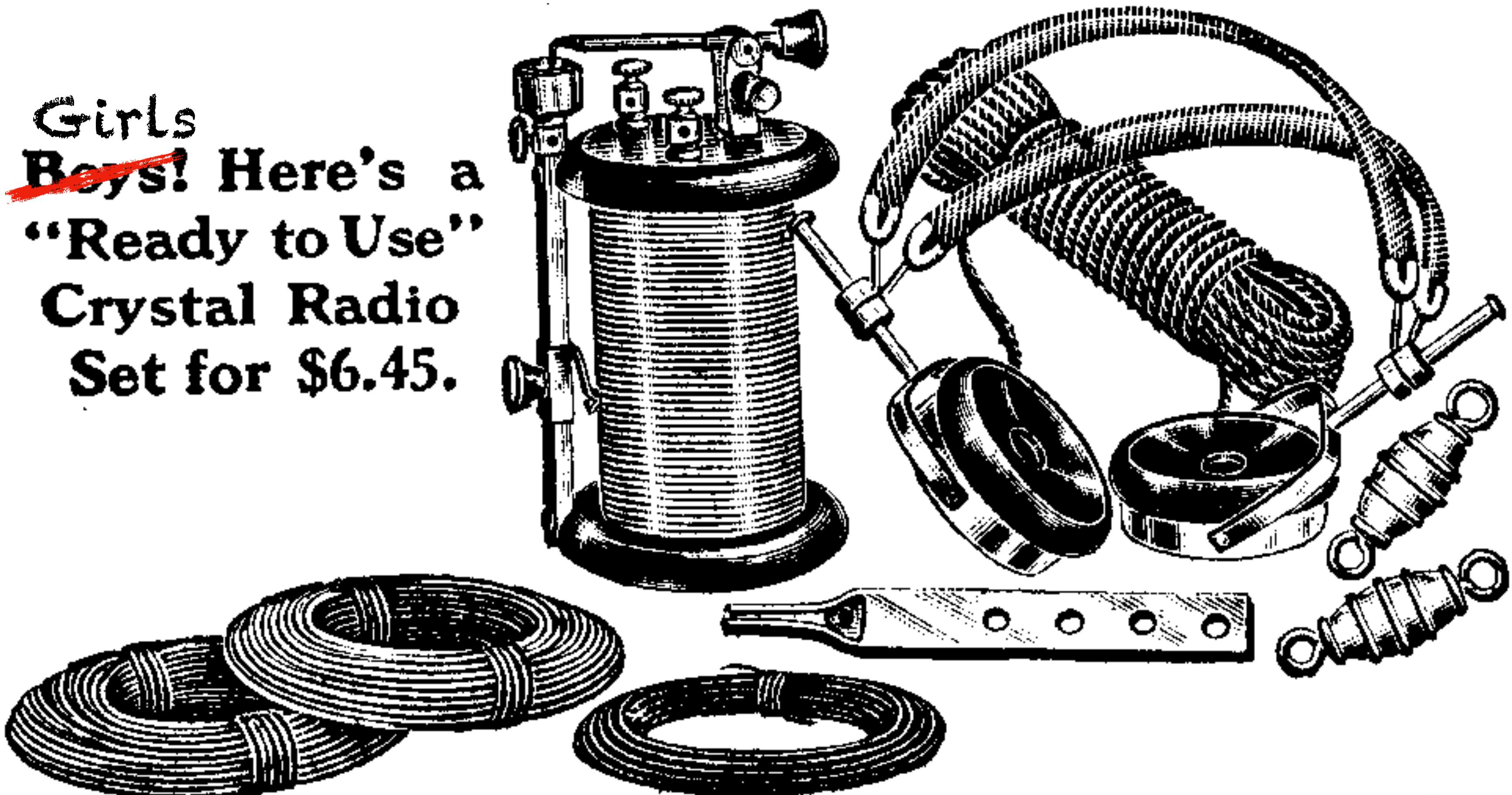
“In electronics and telecommunications, modulation is the process of varying one or more properties of a periodic waveform, called the carrier signal, with a modulating signal that typically contains information to be transmitted.”

- Wikipedia



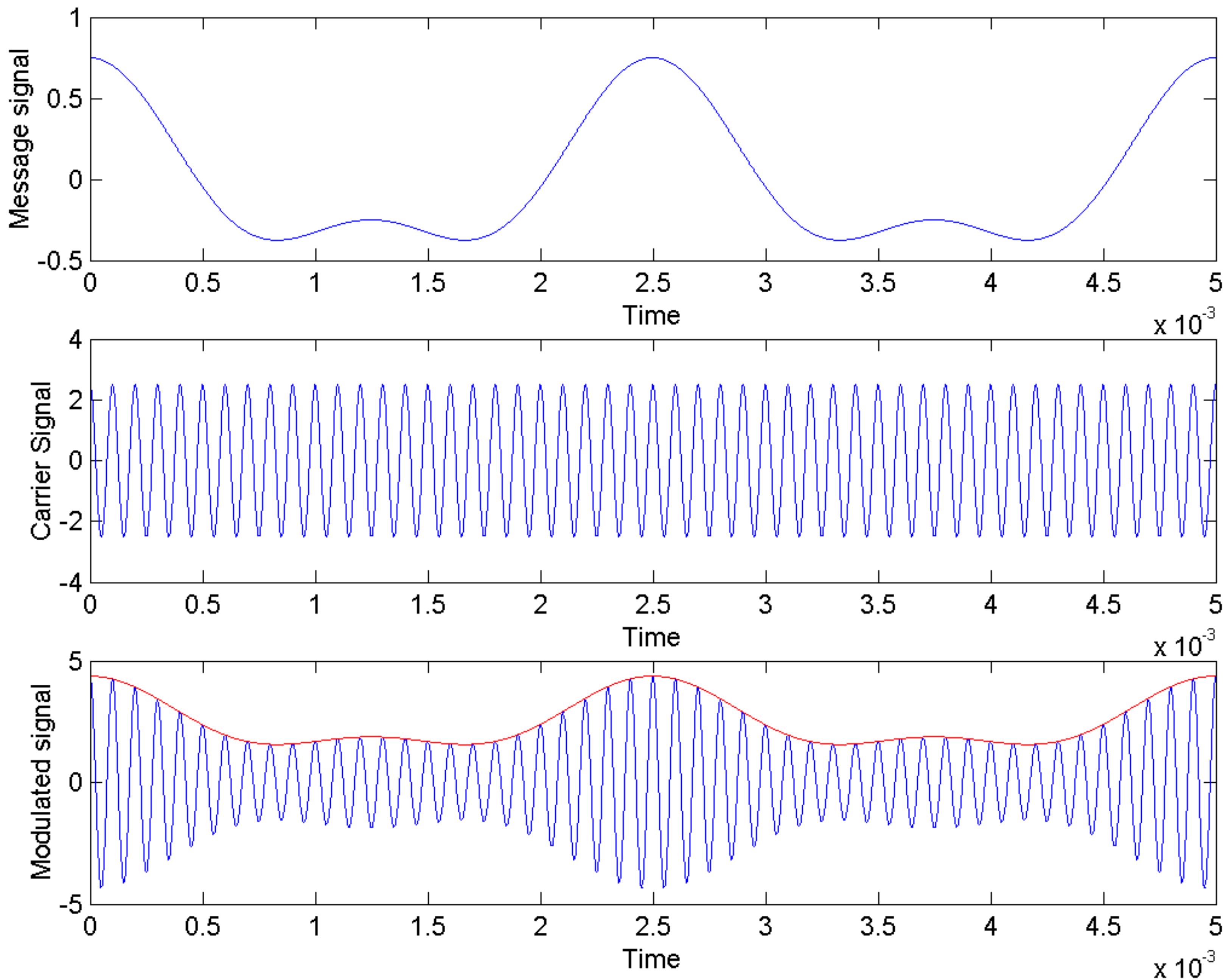


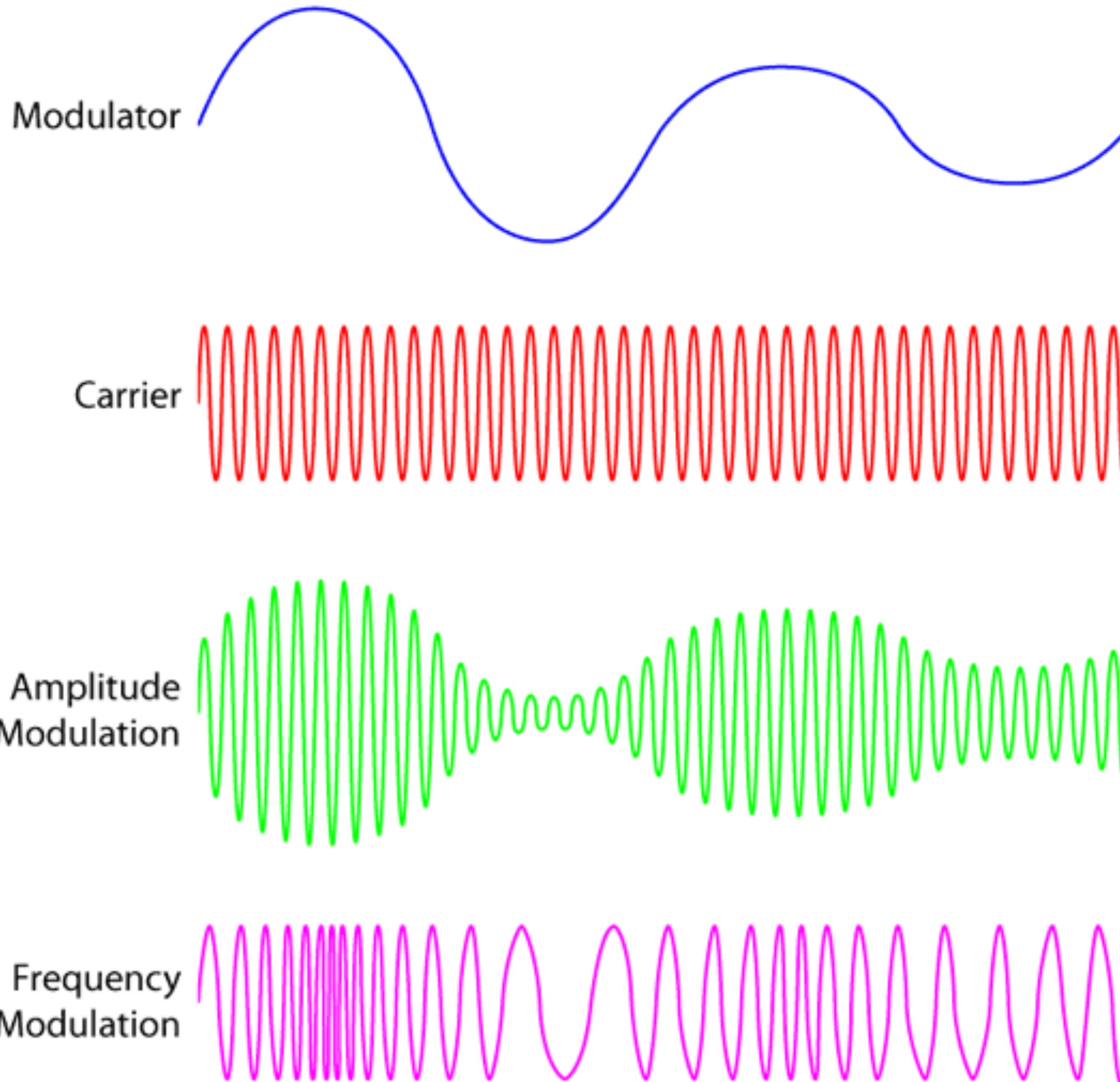
**Girls
~~Boys!~~ Here's a
“Ready to Use”
Crystal Radio
Set for \$6.45.**



All you have to do is to put up the aerial and attach your ground connection with the materials included, put on the ear phones, also included, and you can hear voices or music within a radius of at least 25 miles, depending upon the power of the broadcasting station. This set will tune up to a wave length of 600 meters. No tubes or batteries necessary. Set is complete with crystal, aerial wire, insulators, phones and instructions for connecting set. Shipping weight, 5 pounds.

49T4712\$6.45



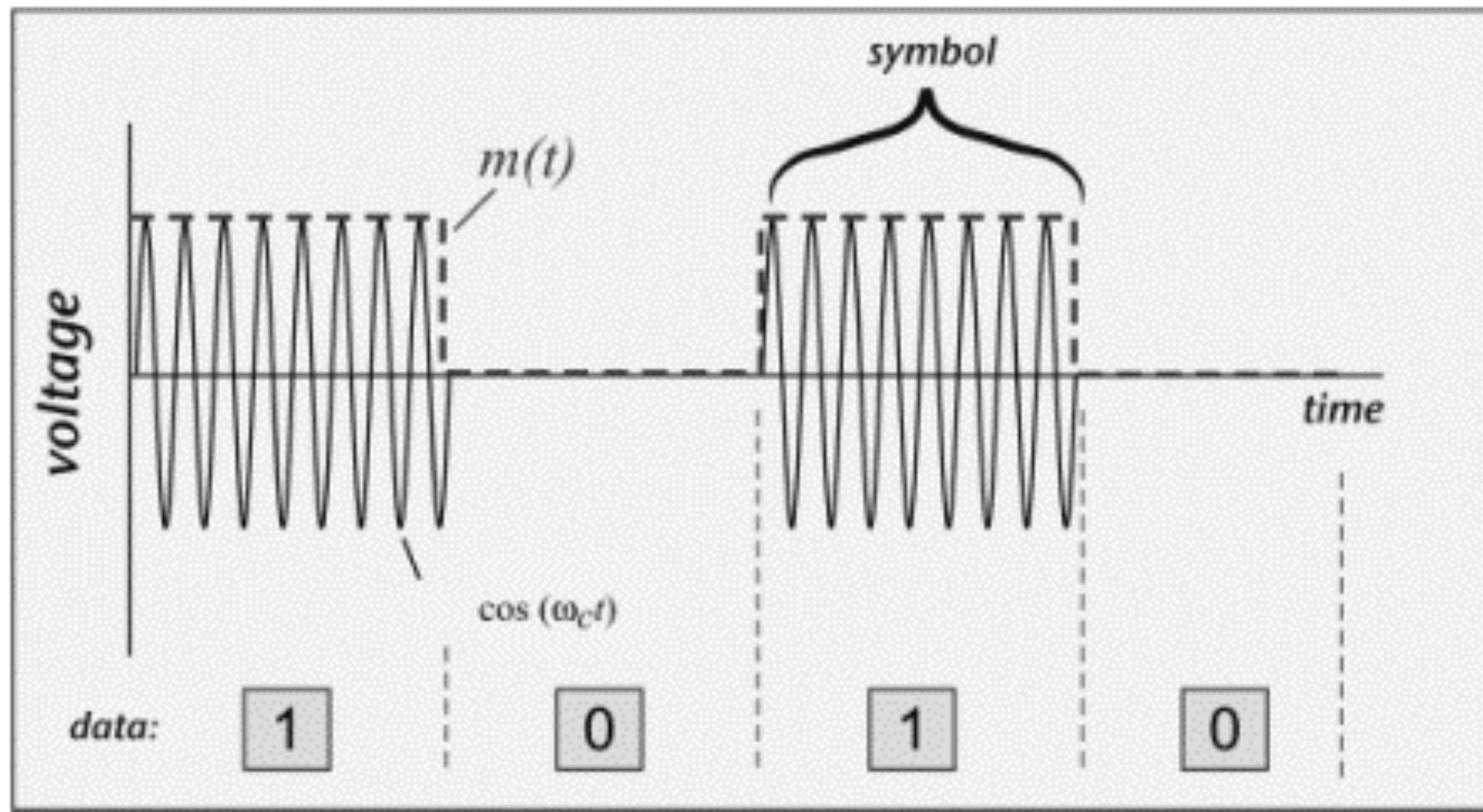


Digital Modulation



0110101110...

On/Off Keying (OOK)



Symbols

0: No voltage

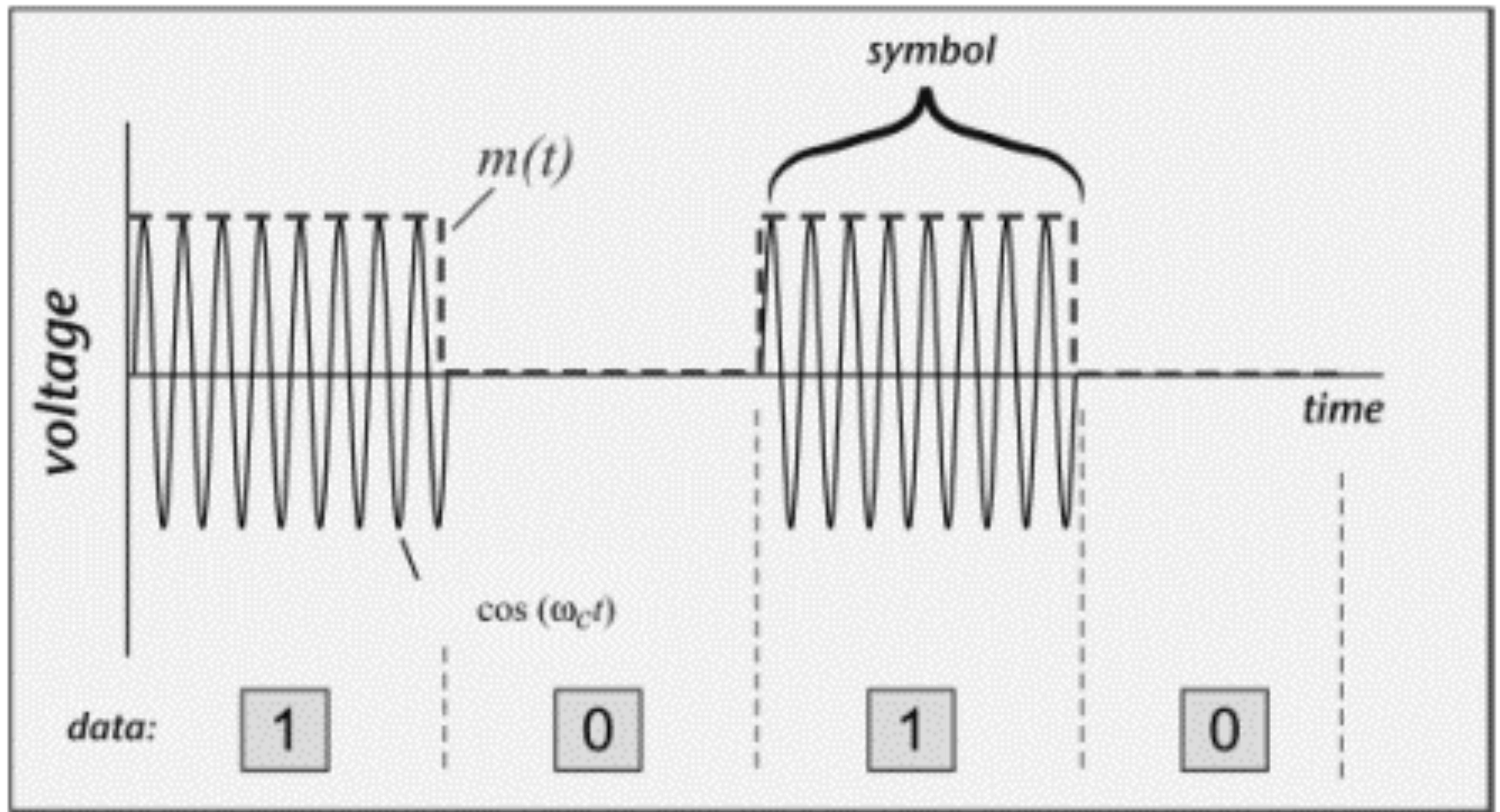
1: High voltage

1 bit = 1 symbol

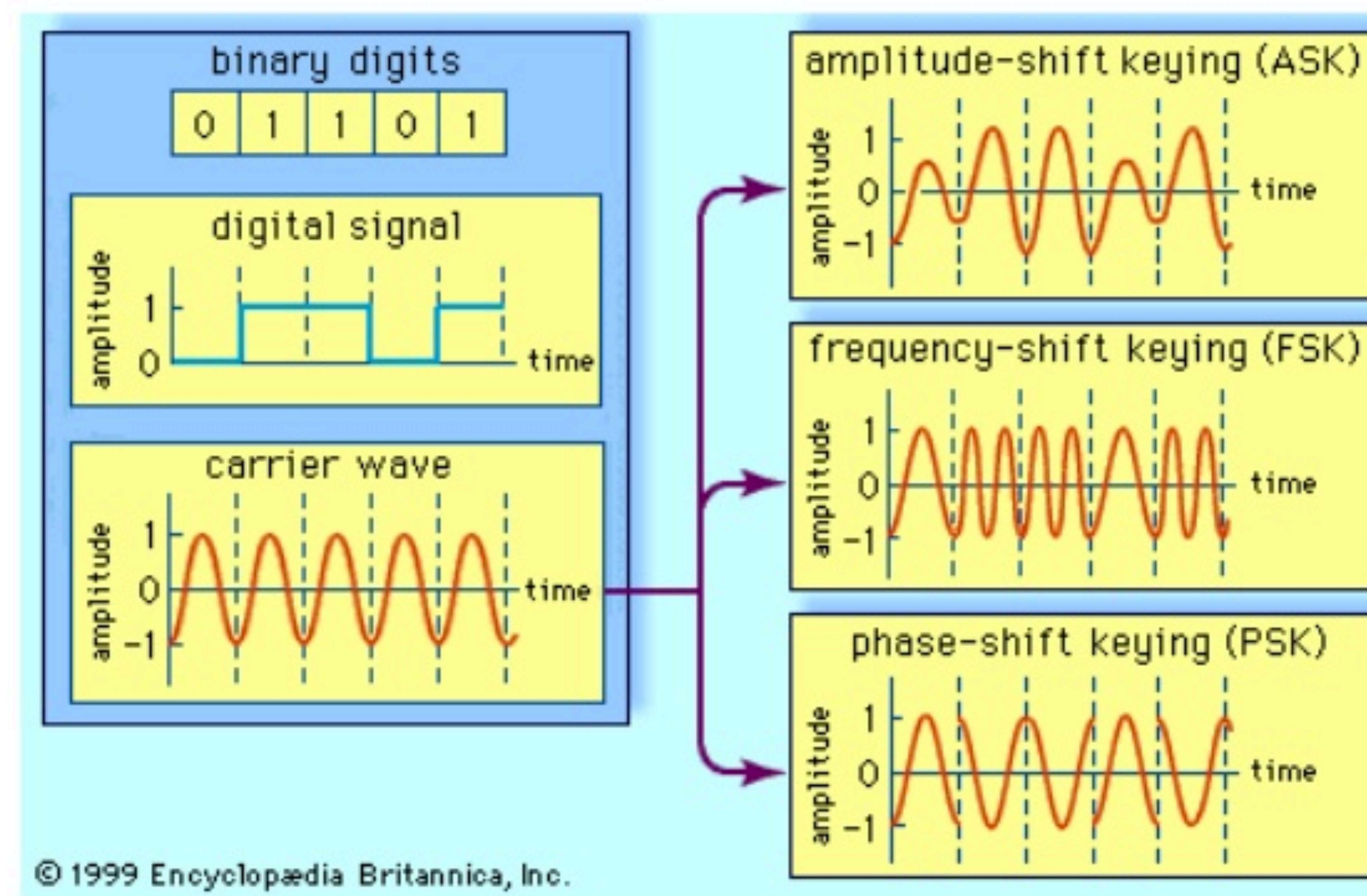
Symbol rate

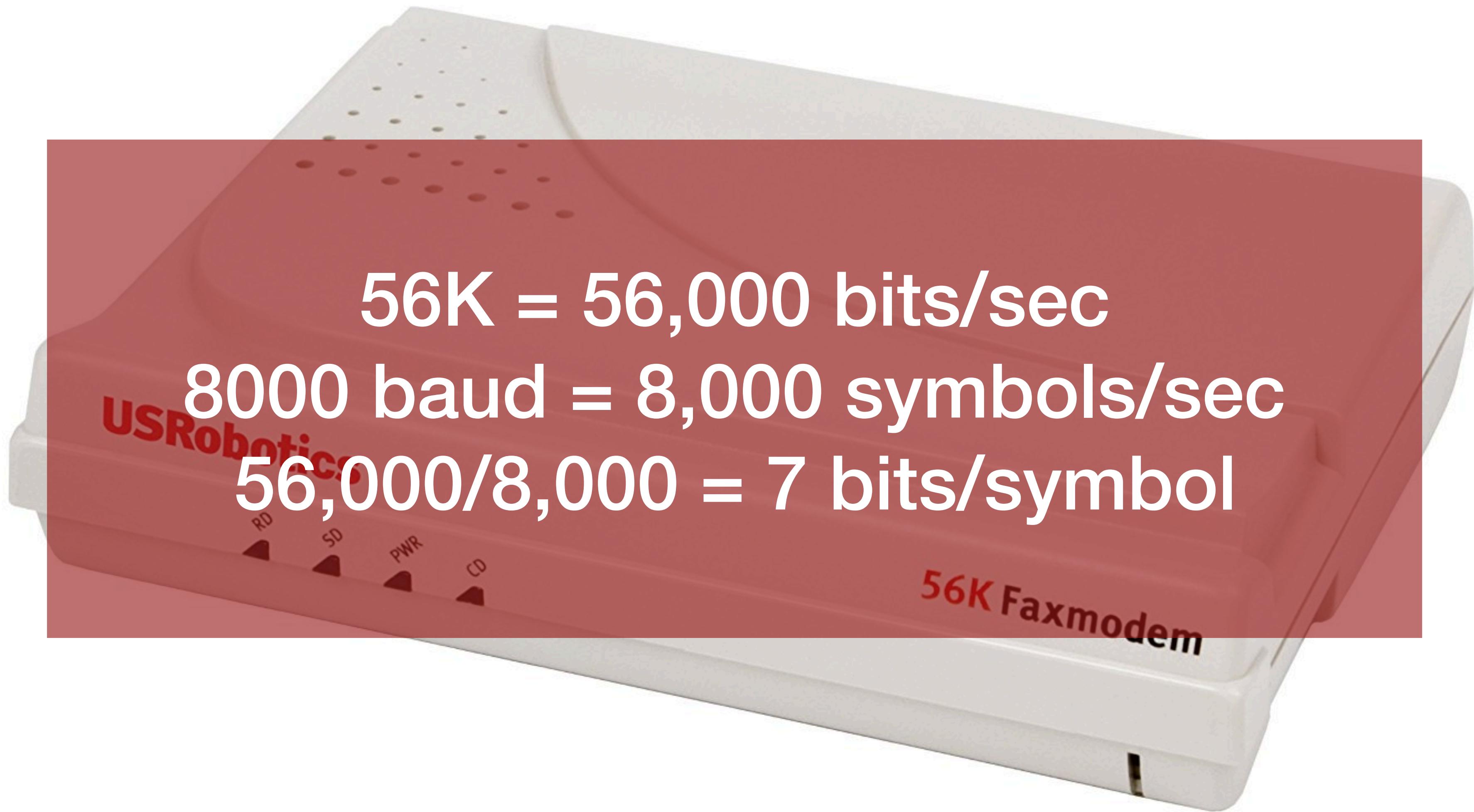
=

Bit rate



The Three Basic Modulation Types





$56K = 56,000 \text{ bits/sec}$

$8000 \text{ baud} = 8,000 \text{ symbols/sec}$

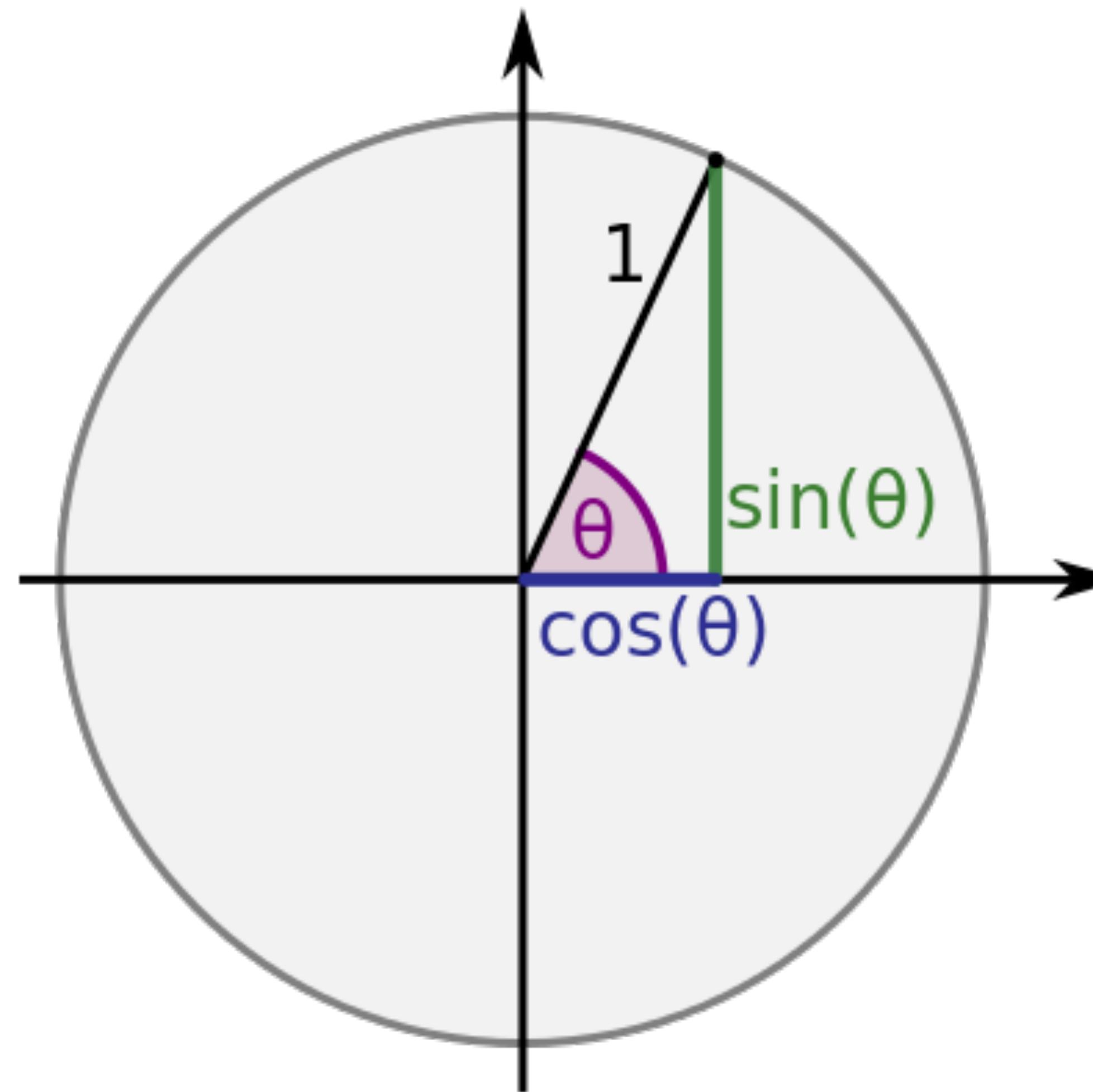
$56,000/8,000 = 7 \text{ bits/symbol}$

One Modulation To Rule Them All

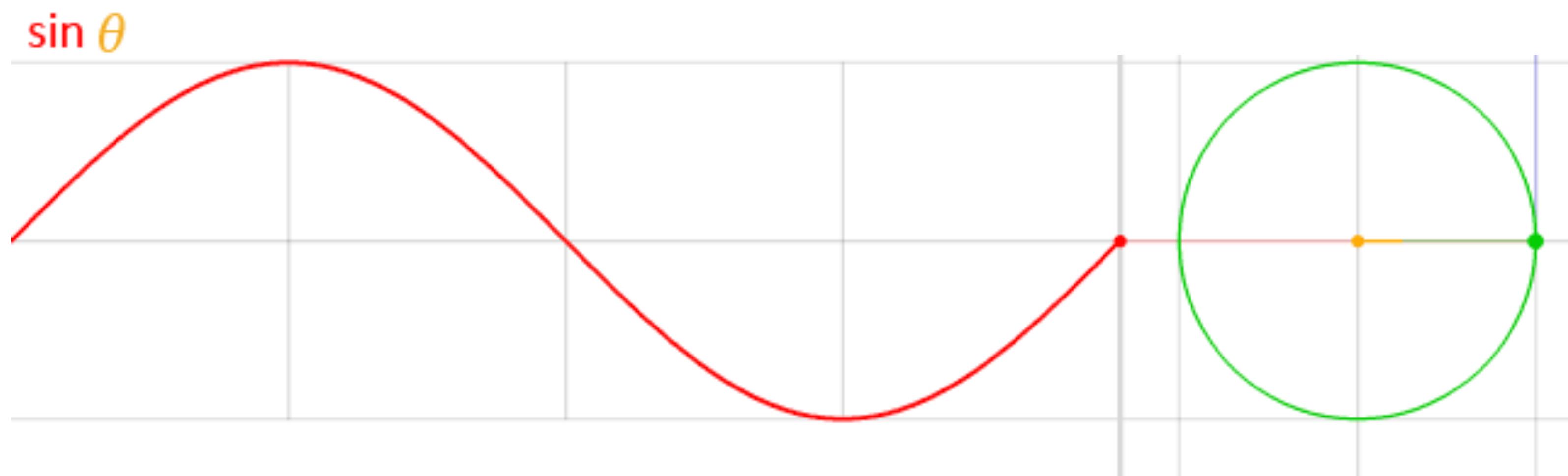


Quadrature Amplitude Modulation

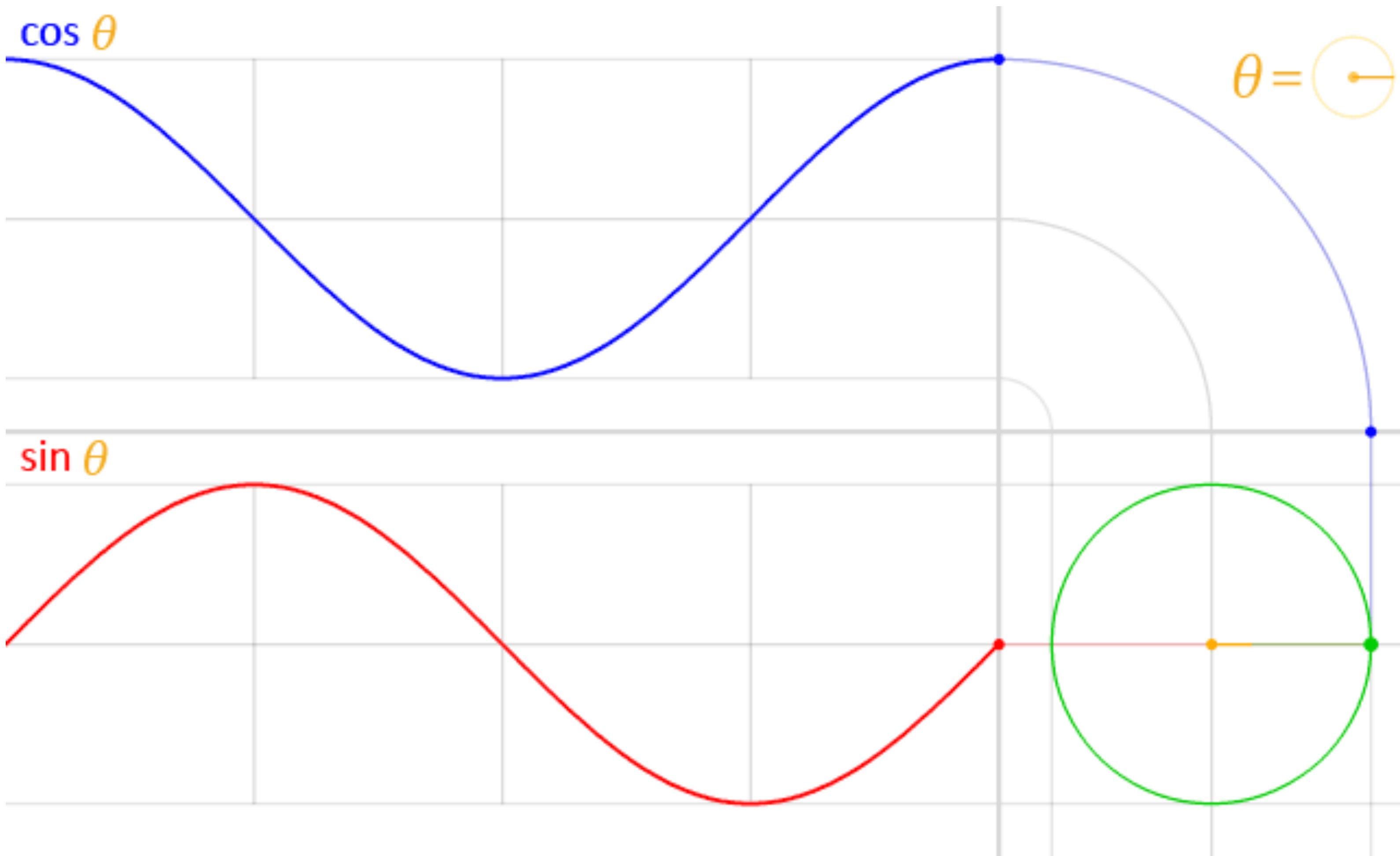
Remember Trigonometry?



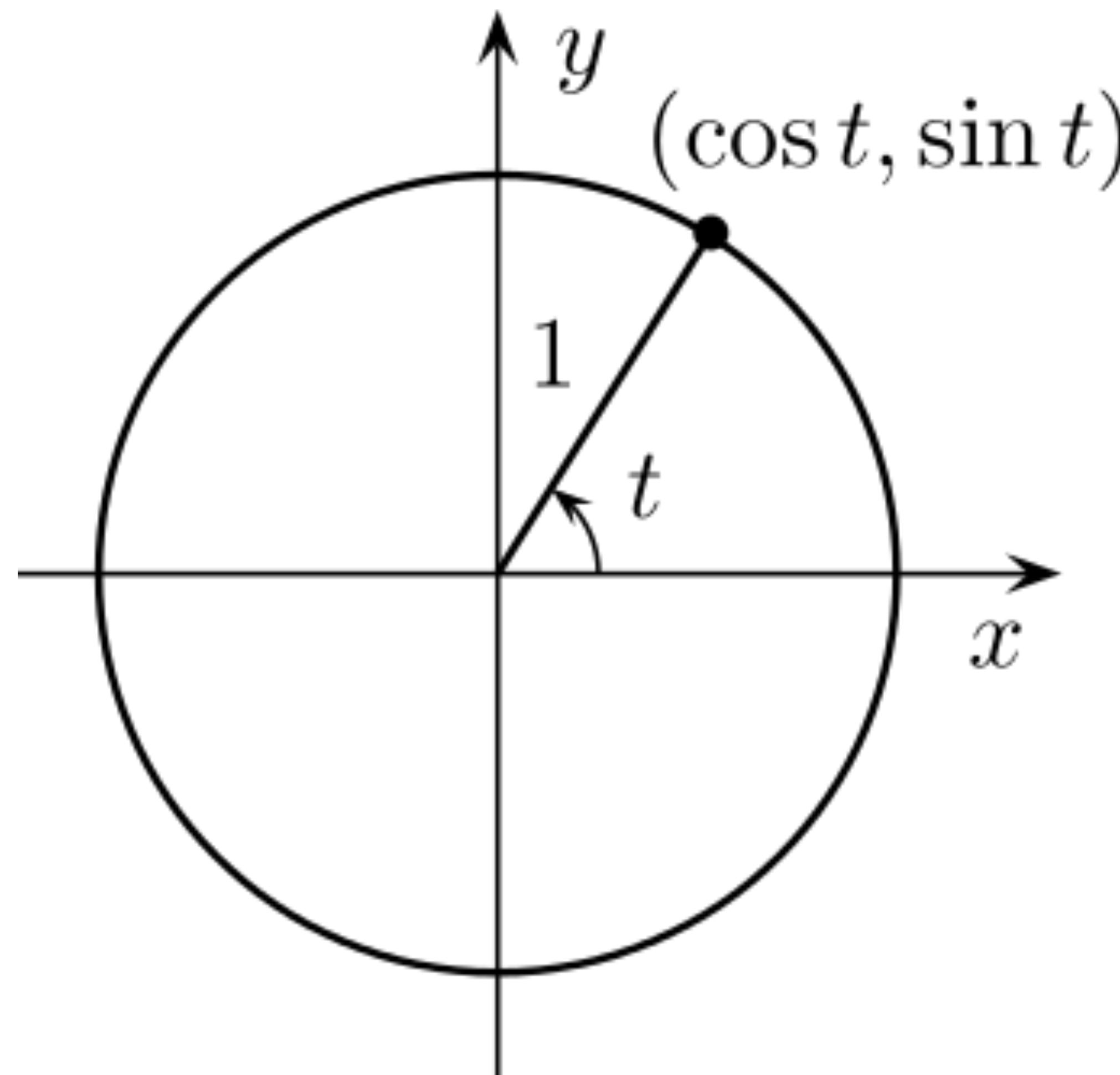
What is a sine wave?



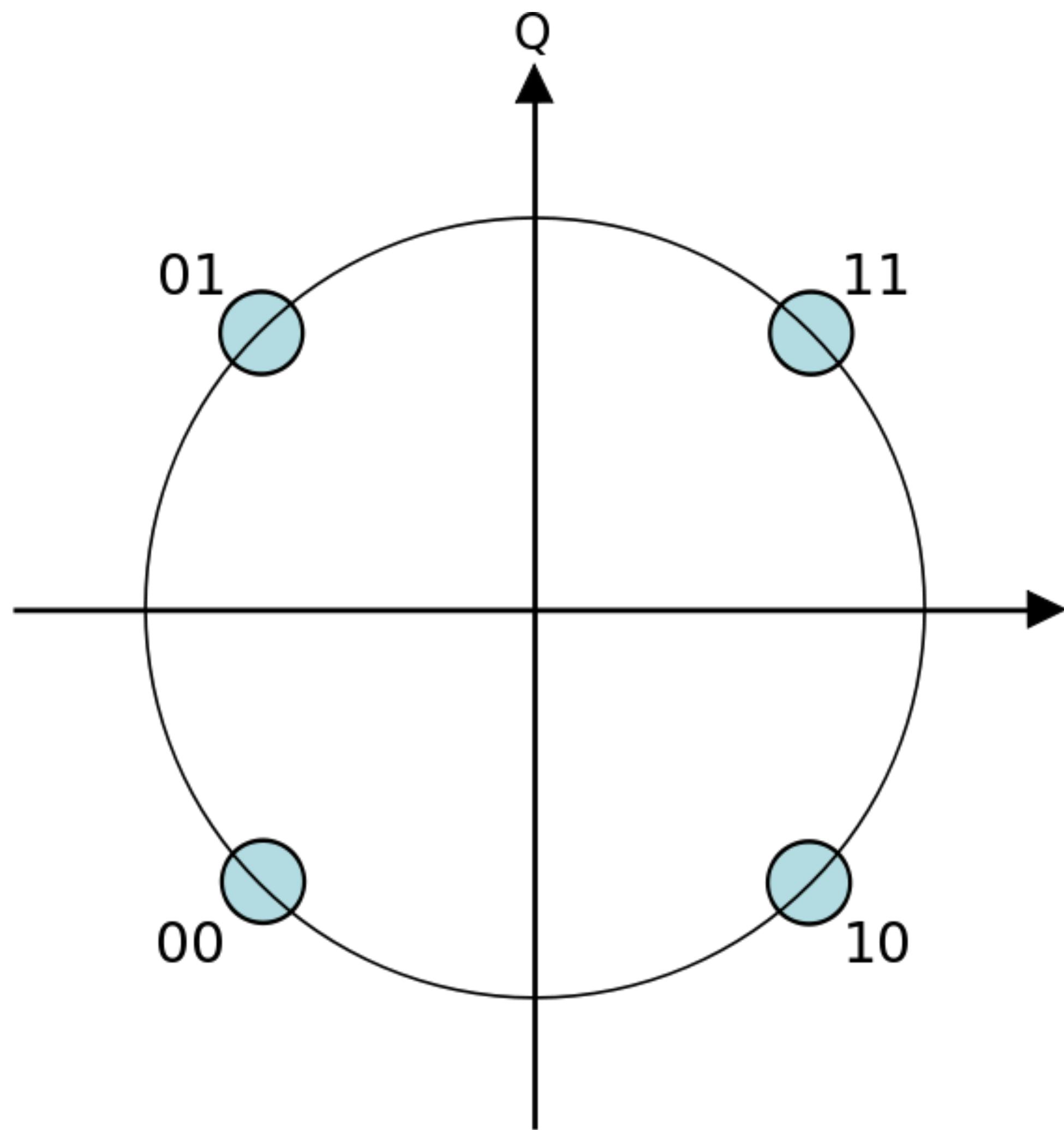
What is a sine wave?



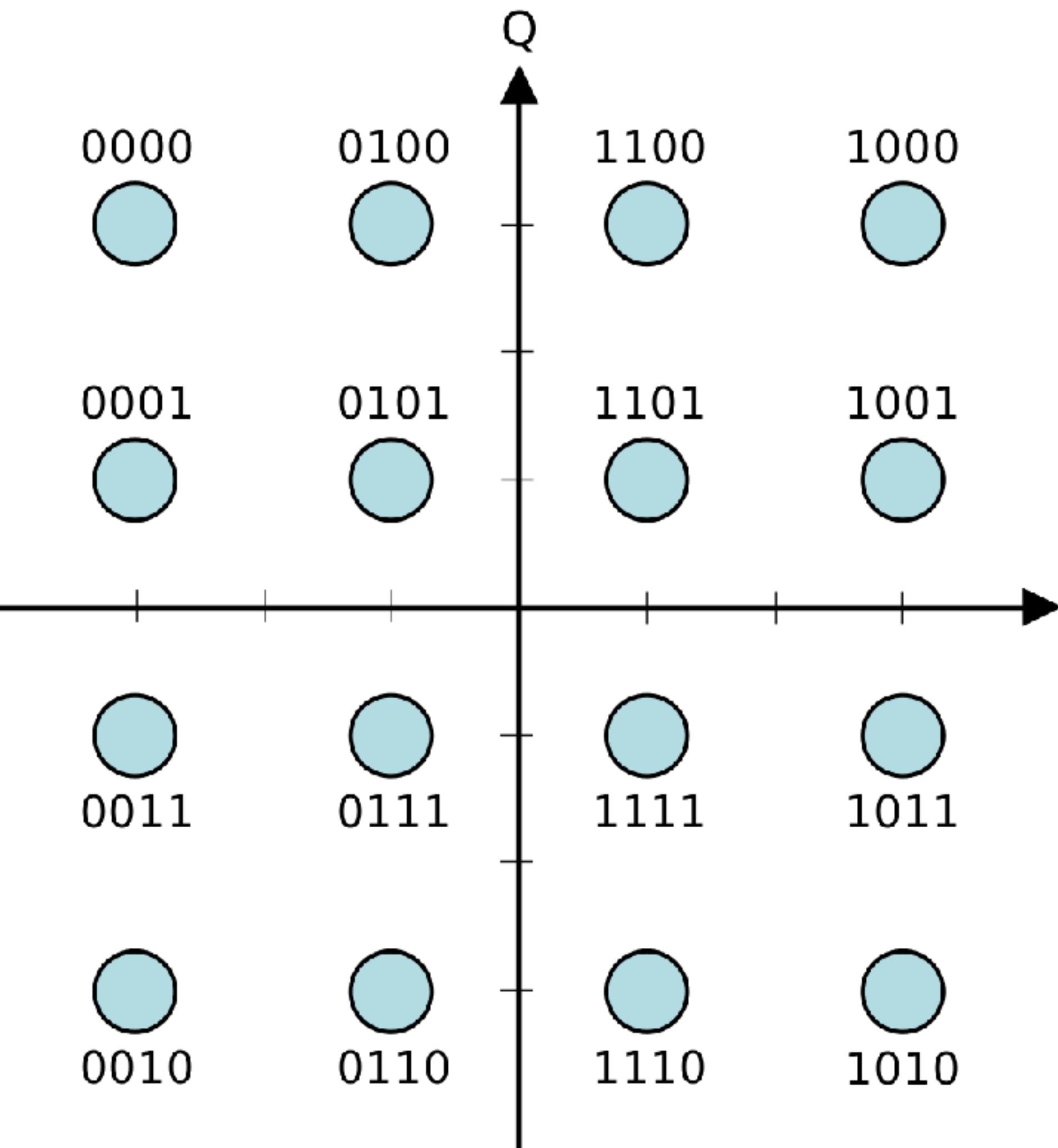
The Unit Circle



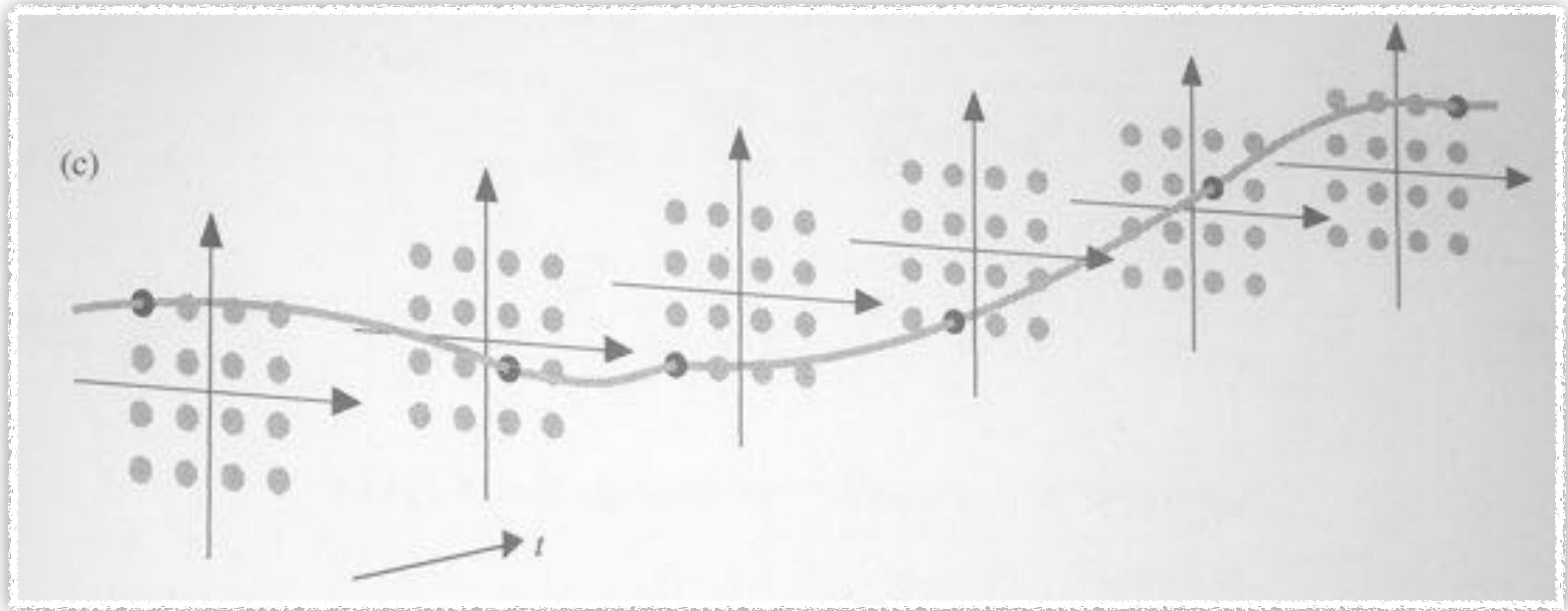
4 QAM Modulation



16 QAM Modulation



16 QAM Modulation



Error Correction

Error-Correction Codes

- 1949 - Golay Codes (Voyager 2: Jupiter and Saturn missions in '79-'81)
- 1950 - Hamming Codes (ECC memory)
- 1954 - Reed-Muller Codes (Mariner spacecraft in '69-'77)
- 1960 - Reed-Solomon Codes (Voyager 2 in '77 + CD, DVD, Blu-ray, Barcodes)
- 1993 - Turbo Codes (3G/4G e.g. UMTS+LTE + deep space satellite communication)

```
npm install @ronomon/reed-solomon
```

Demo

References

[github.com / watson / monster-drift](https://github.com/watson/monster-drift)

[github.com / mappum / node-hackrf](https://github.com/mappum/node-hackrf)

greatscottgadgets.com / sdr

@wa7son



Gracias

@wa7son

github.com/watson

