So What the Heck Is This Radio Thing, Anyway?

Who am I?

Computer geek, ham radio operator, electronics fiddler, RC pilot, cat and dog servant, etc...

A Brief History of Radio

- Spark-gap transmitter (late 1800s to early 1900s)
- Crystal radio receiver (early 1900s through around 1930)
- Vacuum tubes (early 1900s)
- Transistor radios (mid-1950s onward)
- Software-defined radios (mid-1980s, more widespread mid-90s)

What is SDR?

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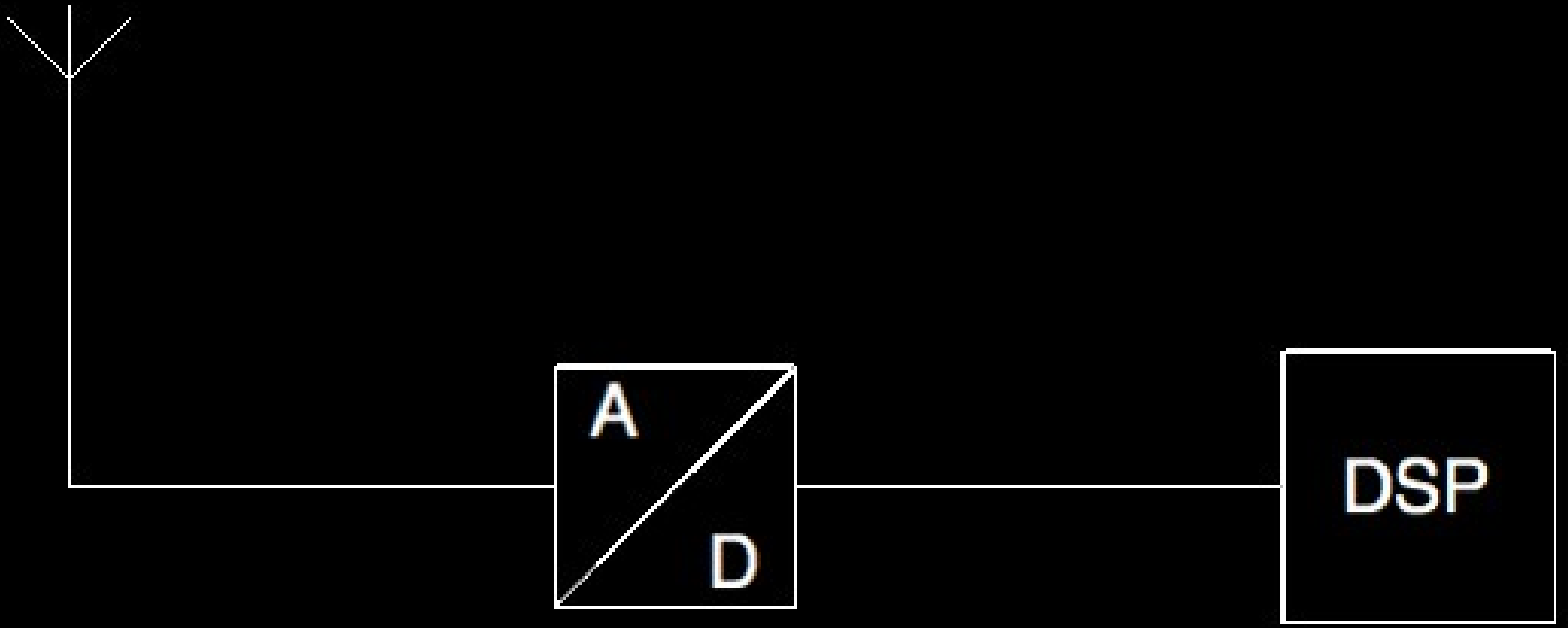

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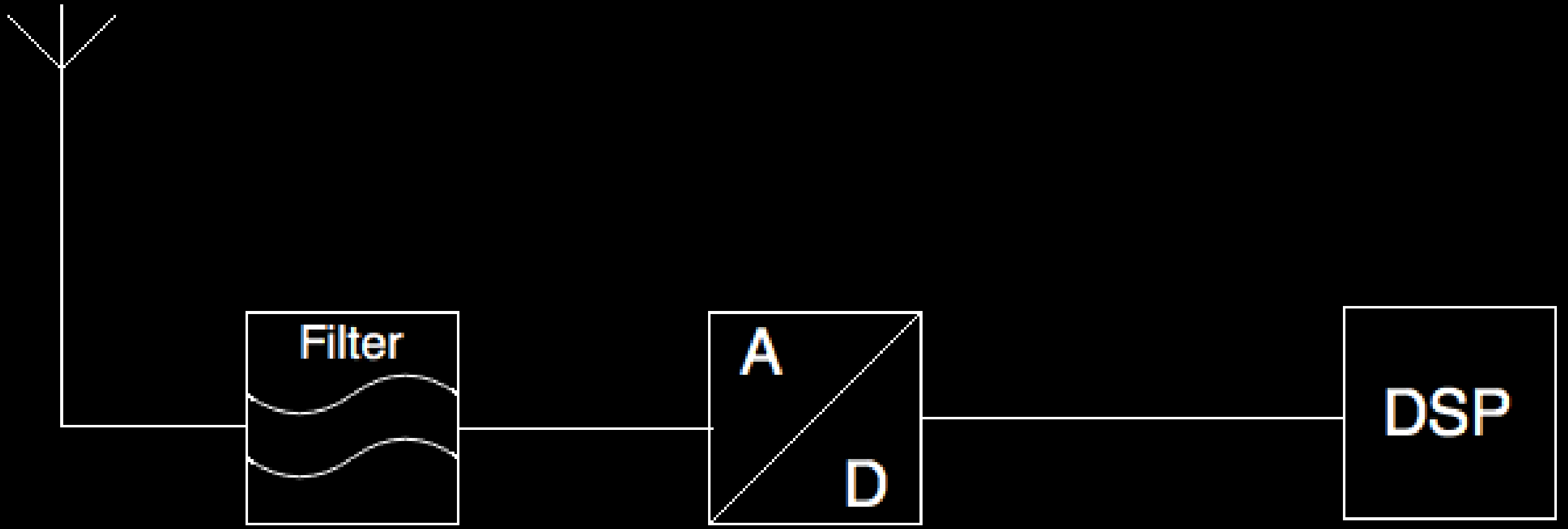

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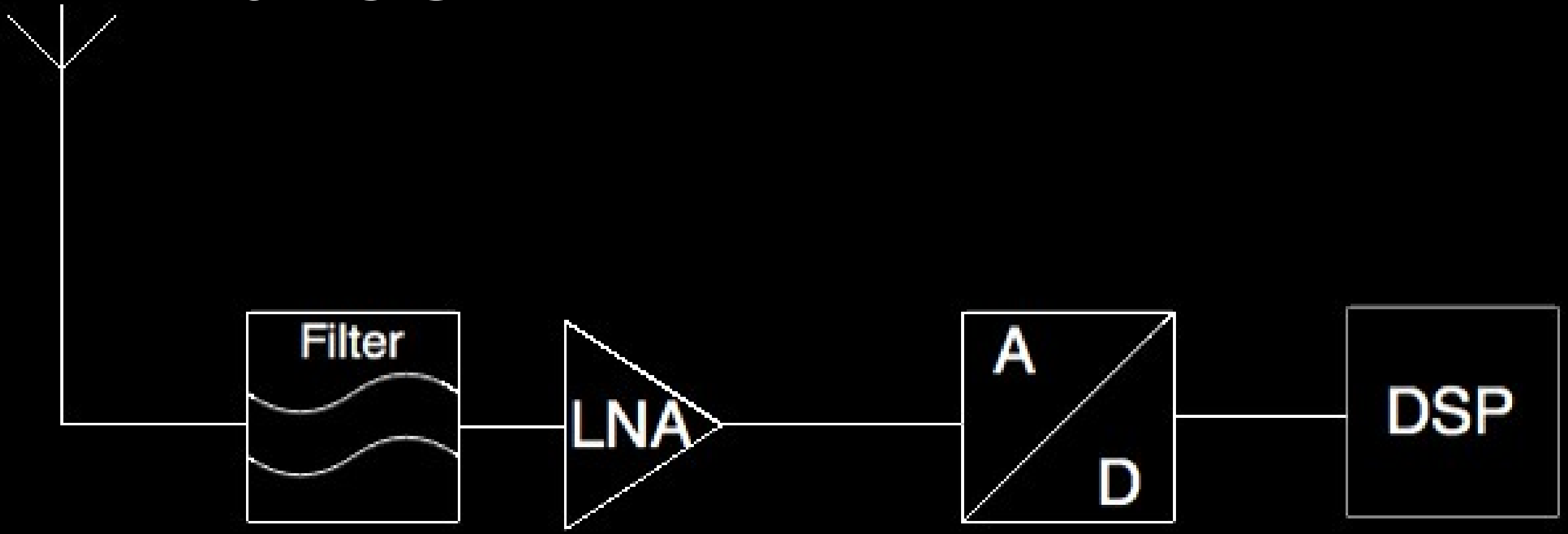

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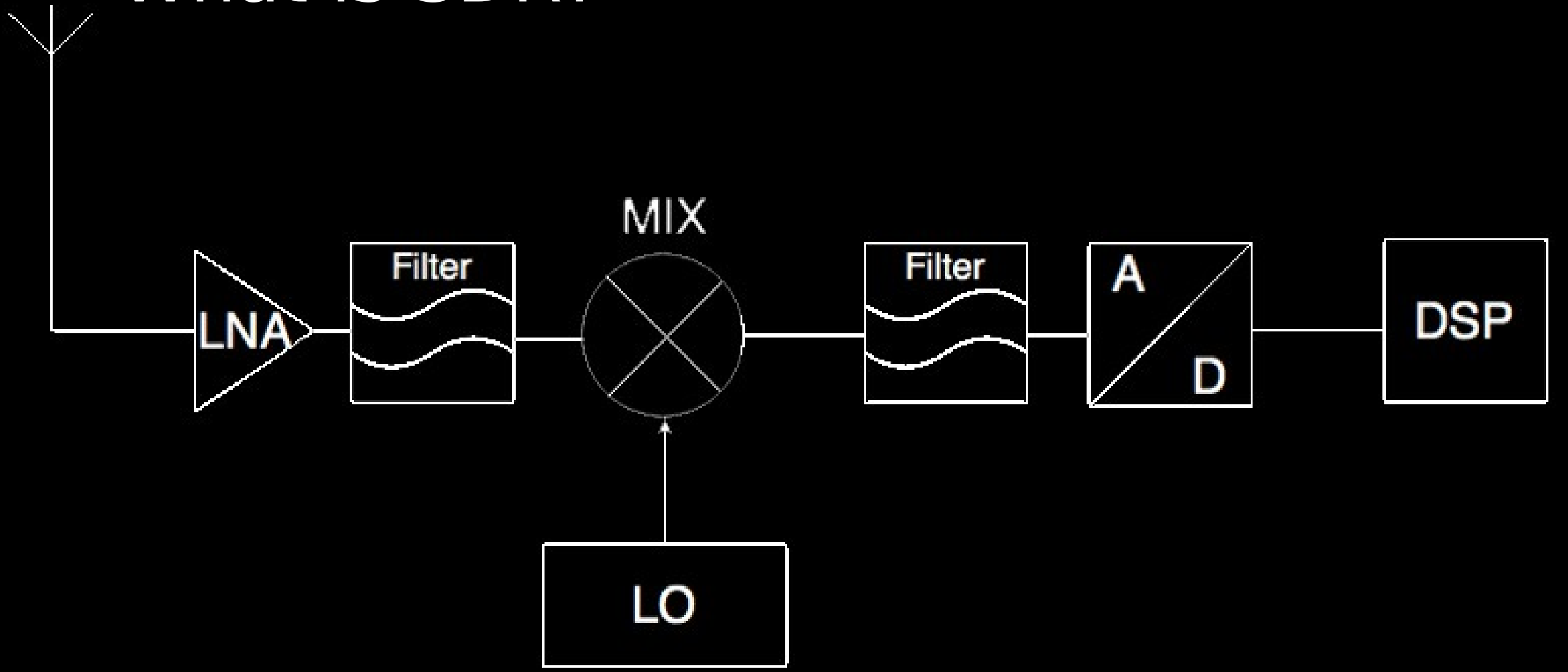

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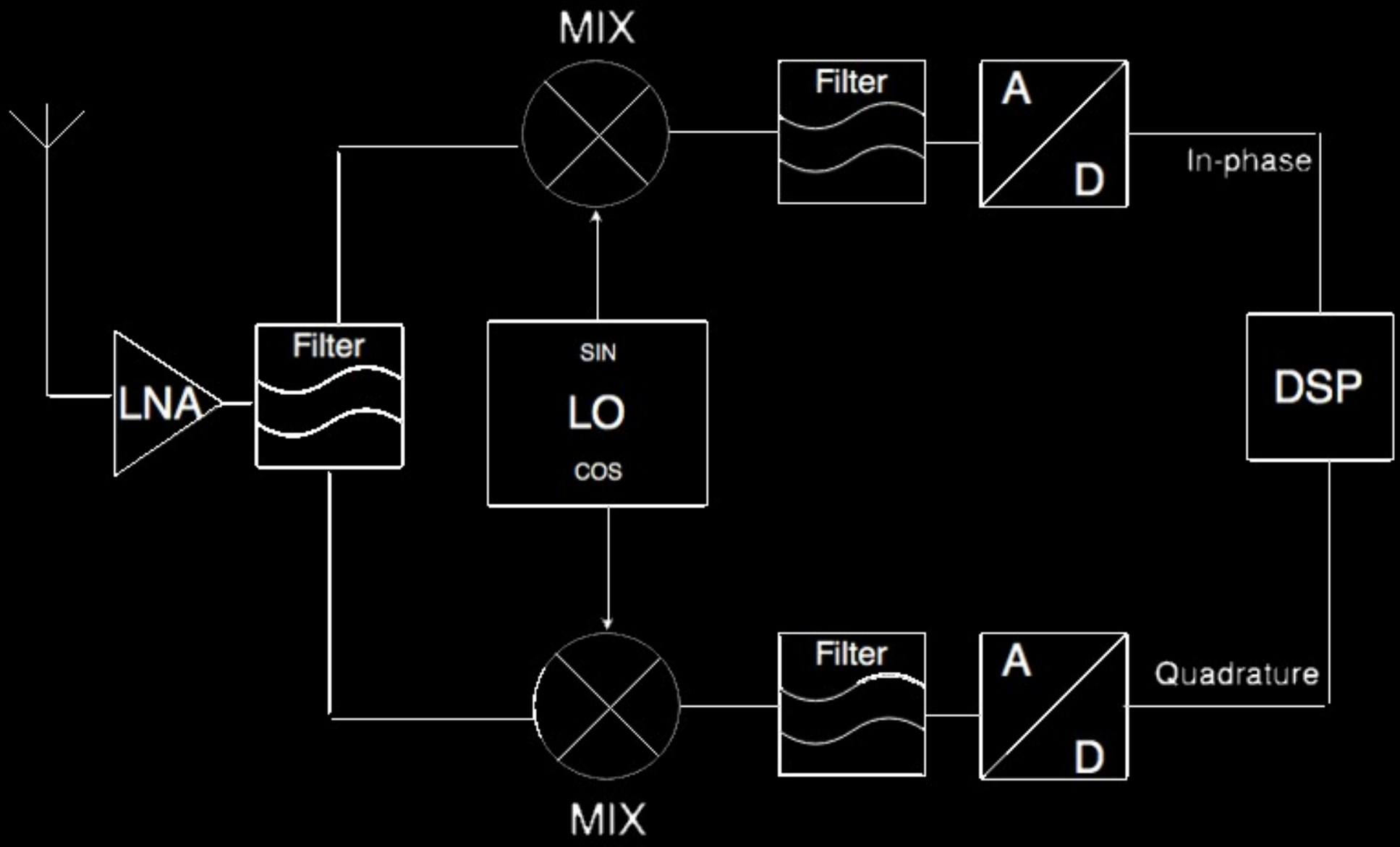
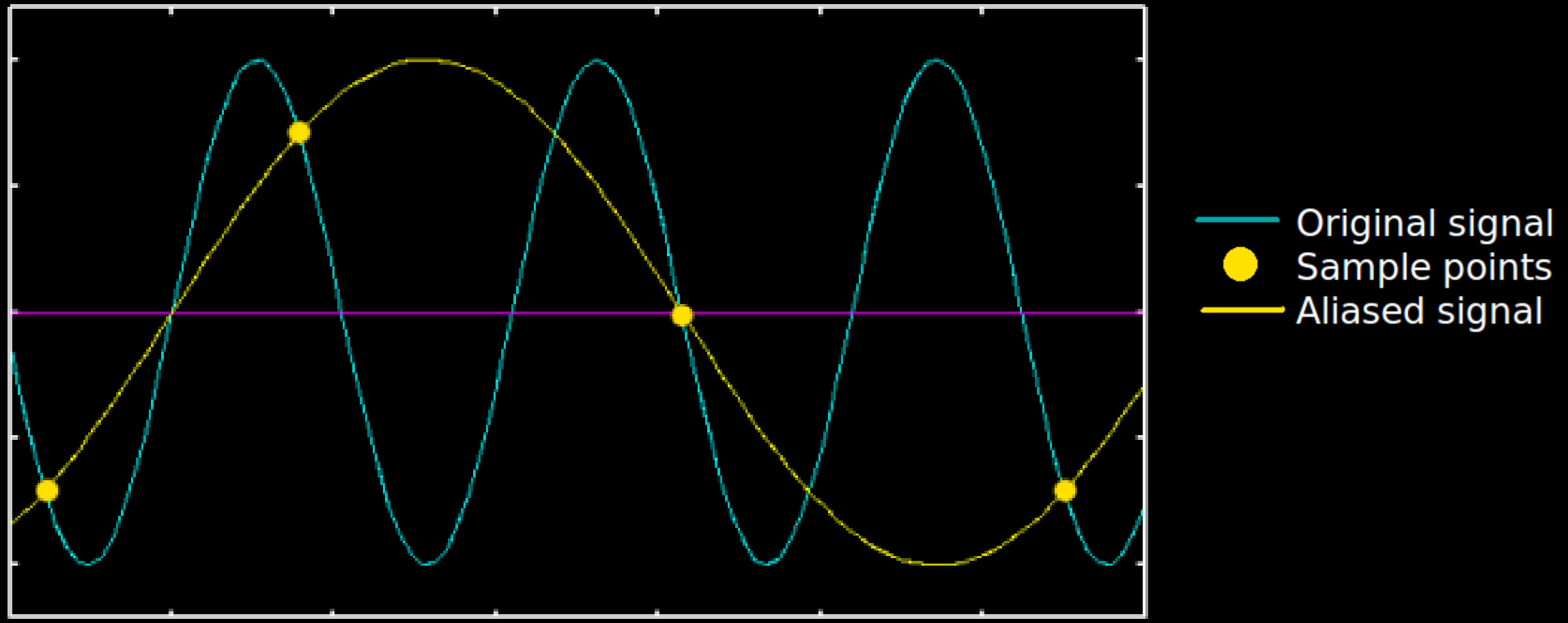

MIX
Filter
A
D
In-phase
LNA
Filter
SIN
LO
COS
DSP
Filter
A
D
Quadrature
MIX

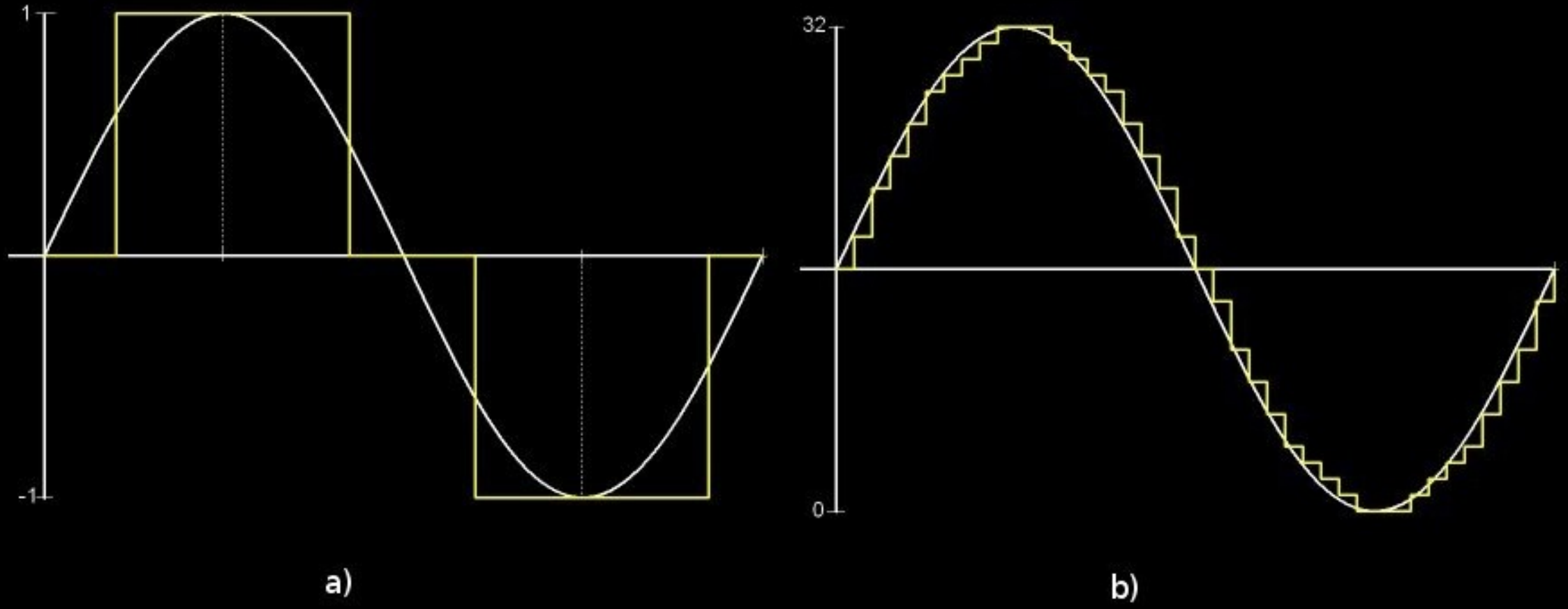
You mentioned this Nyquist guy...

Sample at a rate at least twice the frequency of the signal, otherwise...

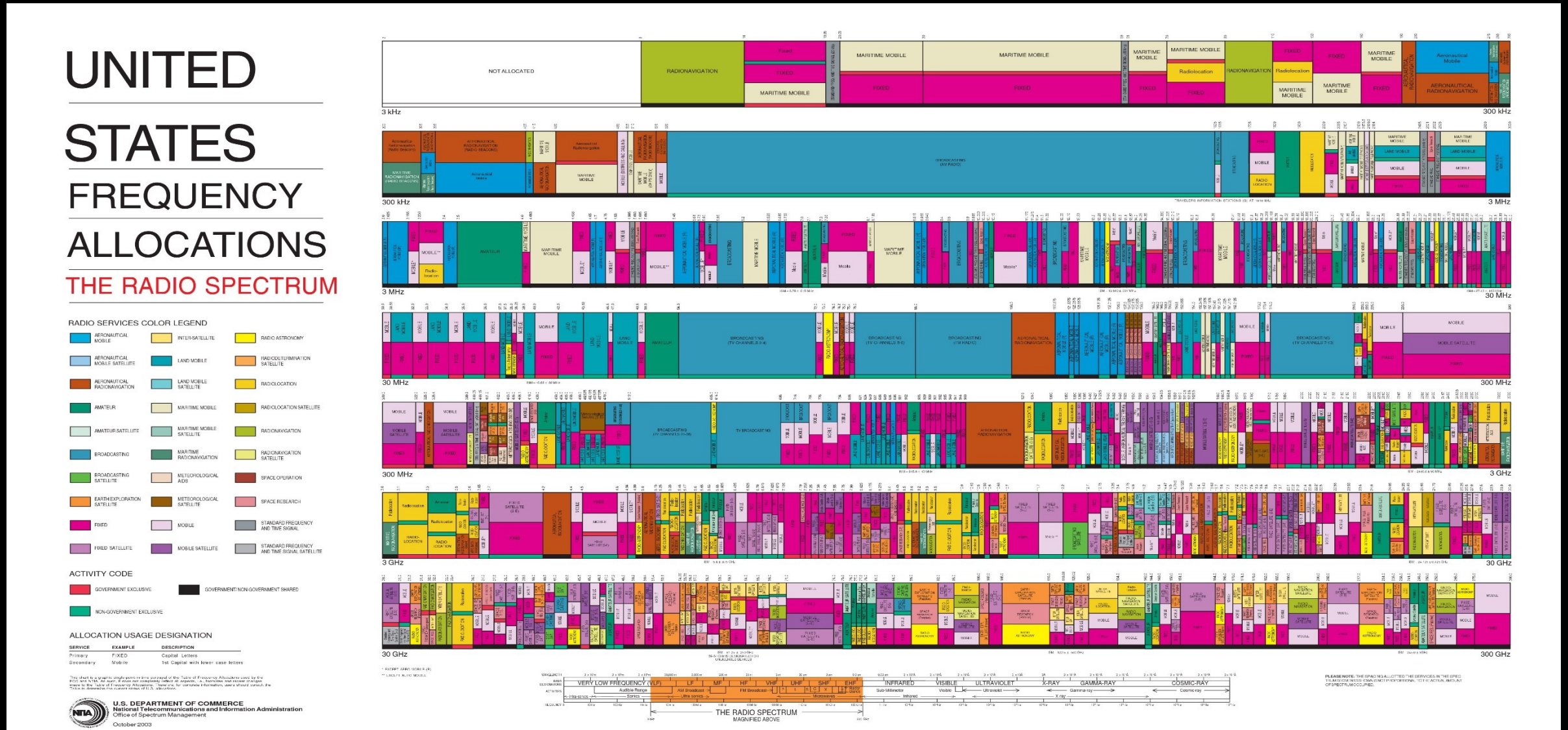


Is sample rate the only important thing?

Bit depth is important to amplitude-modulated signals & dynamic range



Okay, so what are we actually receiving?



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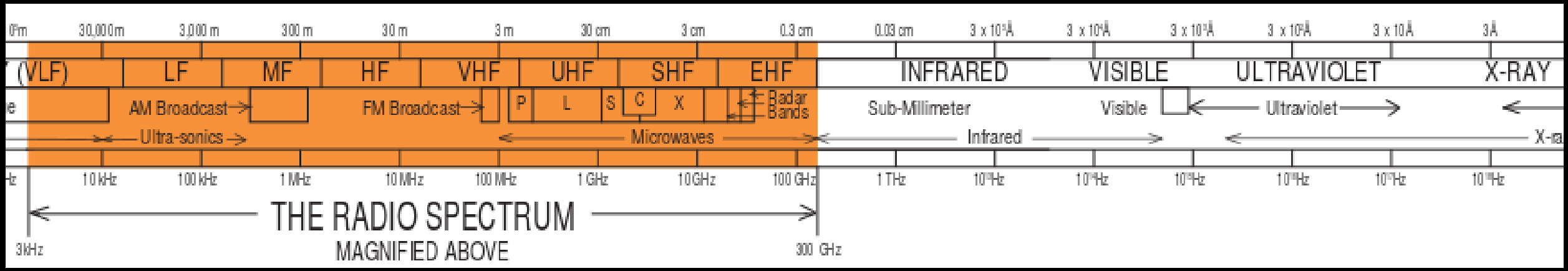

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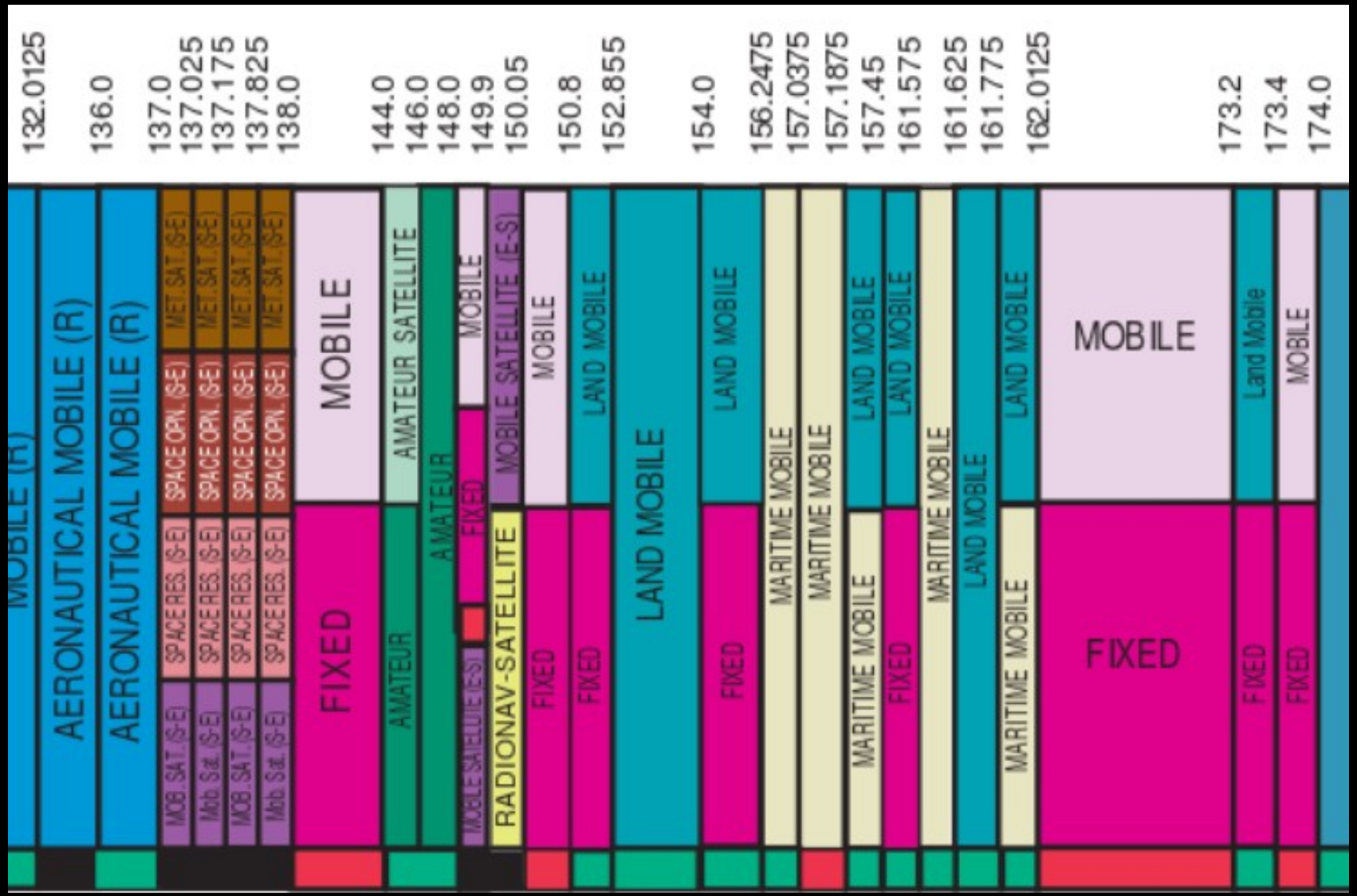
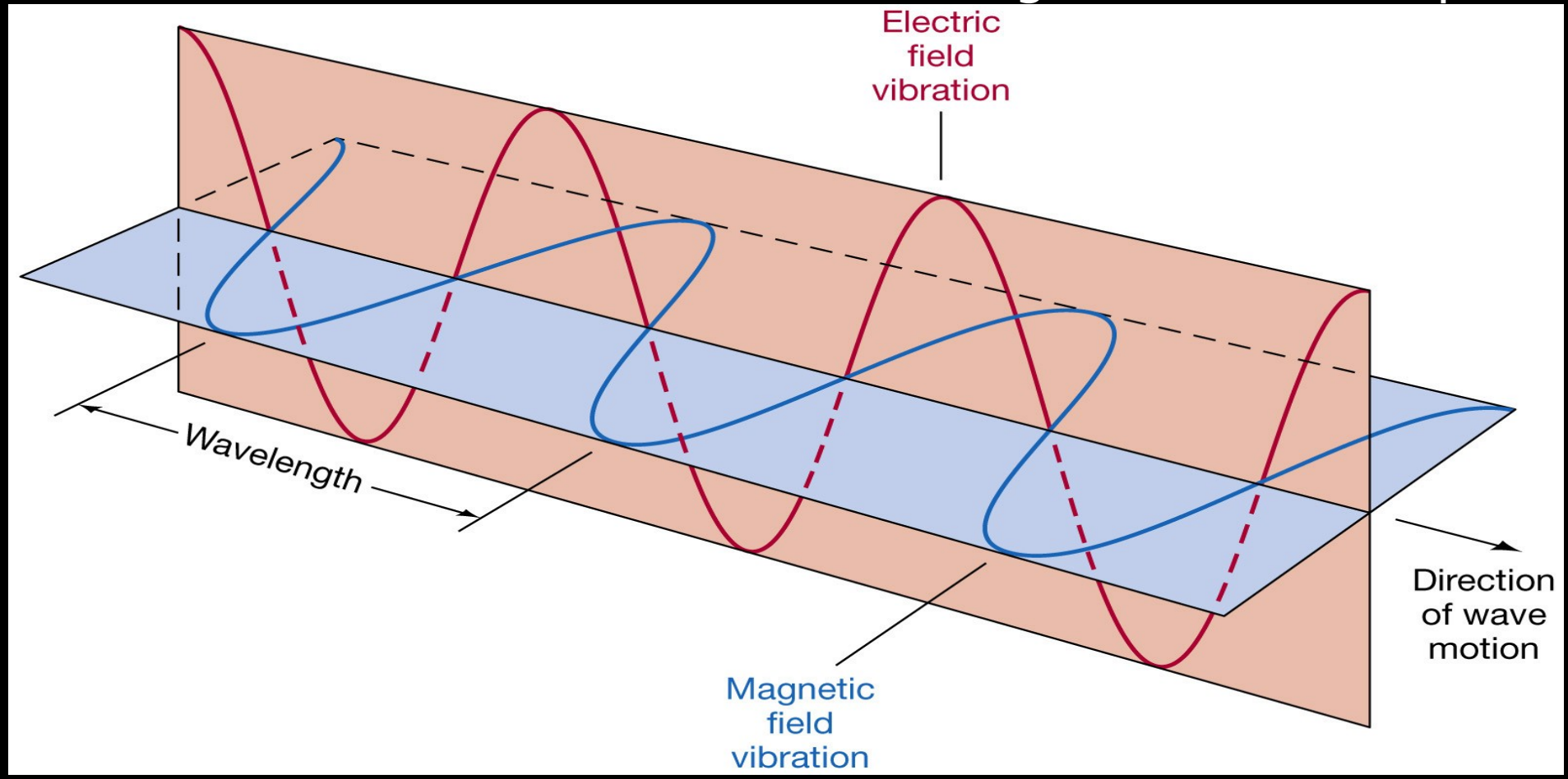


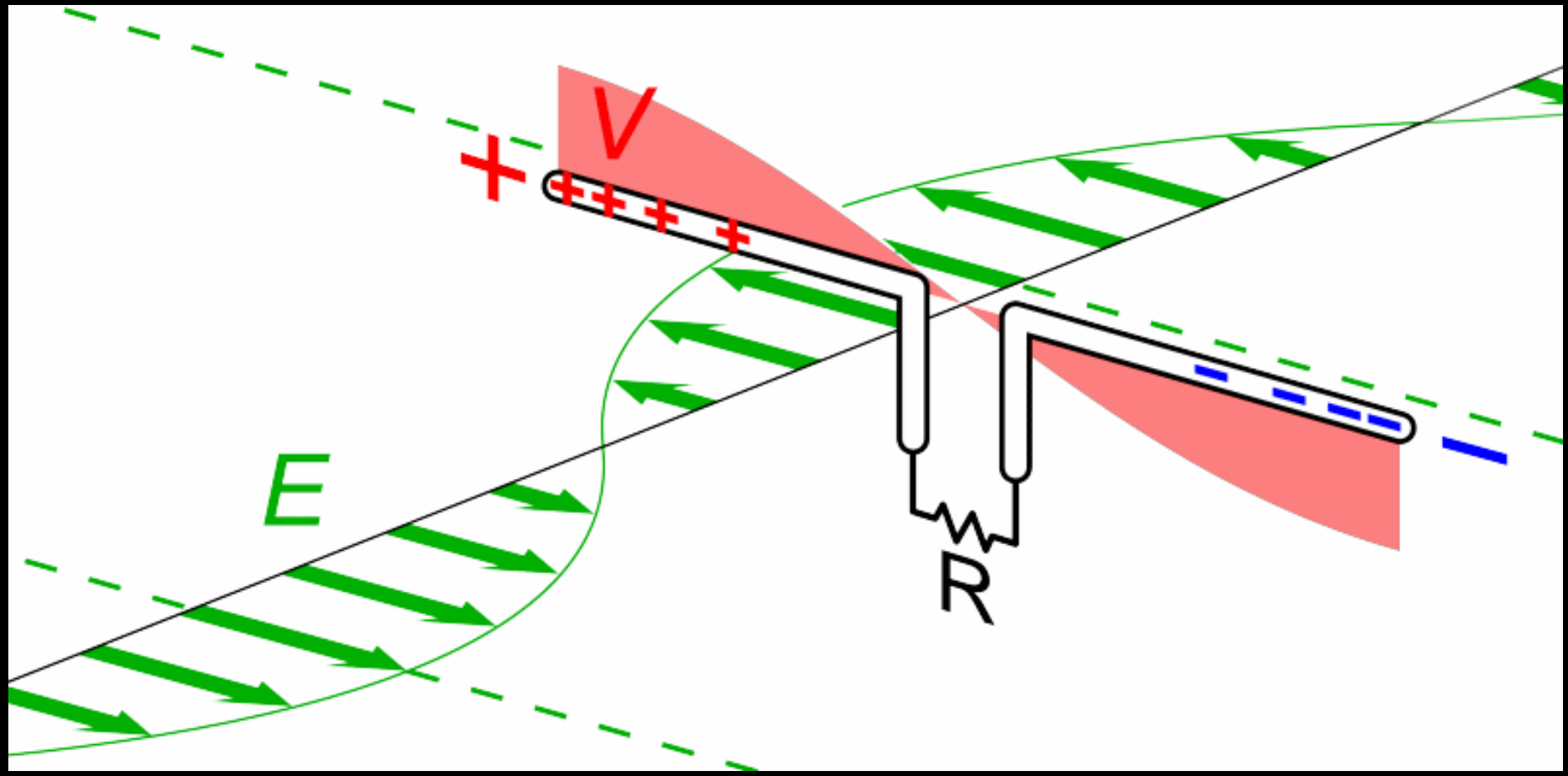
But what is an electromagnetic wave?

Transverse wave with electric field and magnetic field components



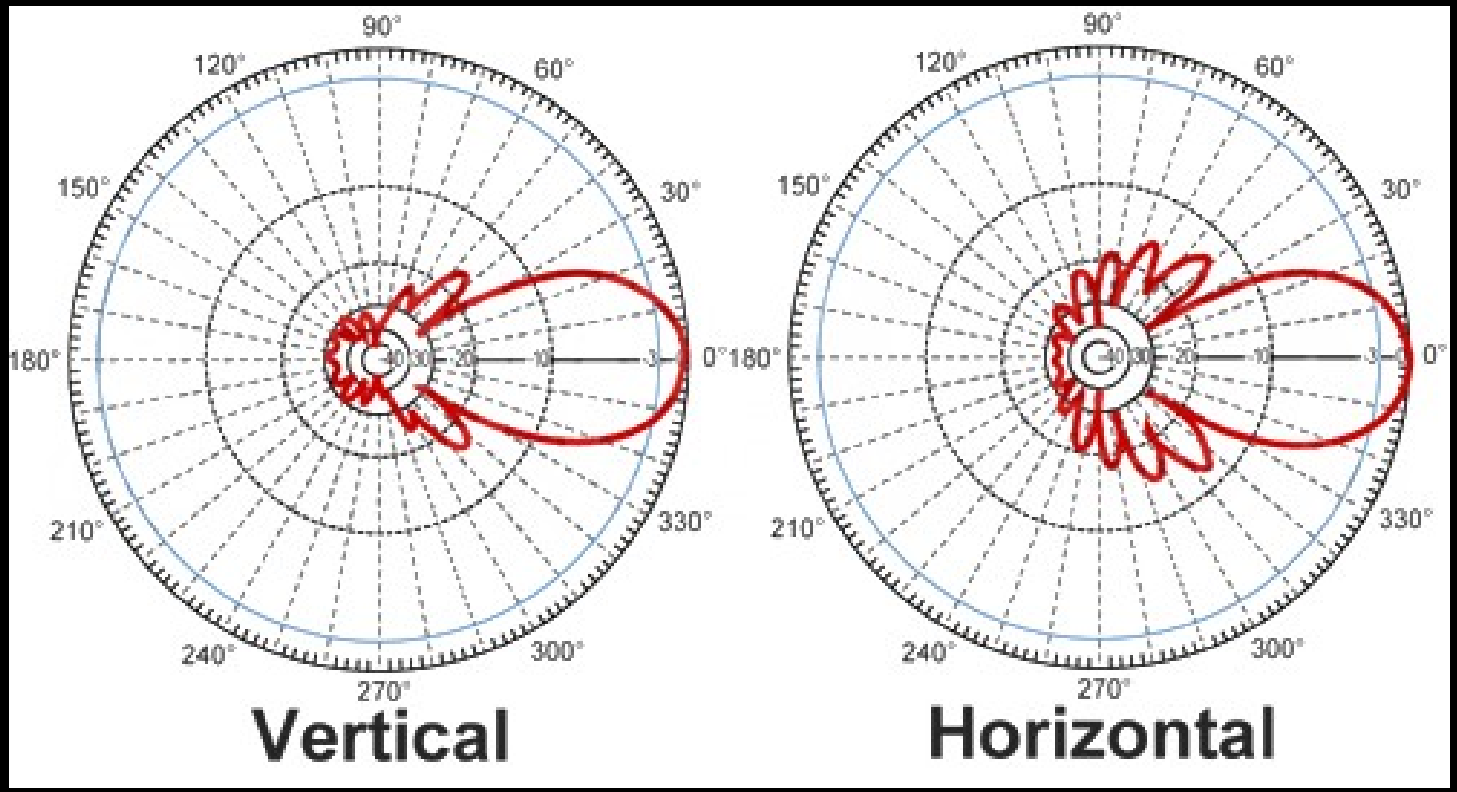
How do we receive the wave?

With an antenna!



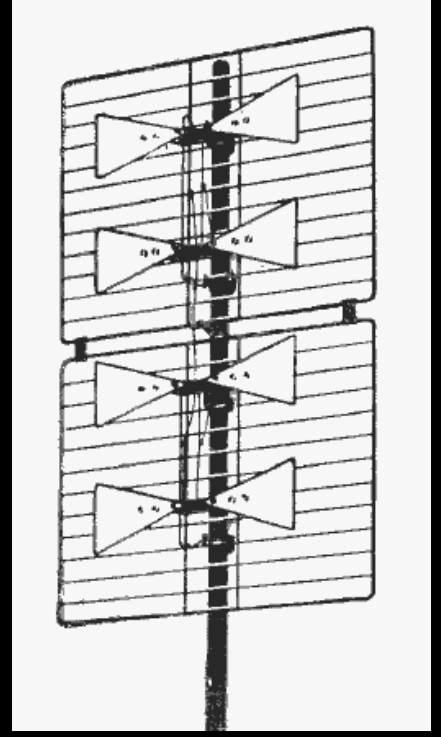
Tell me more about antennas...

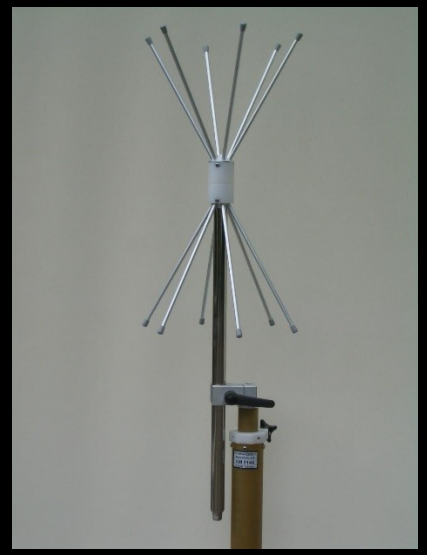
- Tuned to radiate for frequency and bandwidth
- Gain expressed in dBi (tTX power expressed in dBm)
- Polar radiation charts



MOAR ANTENNAS

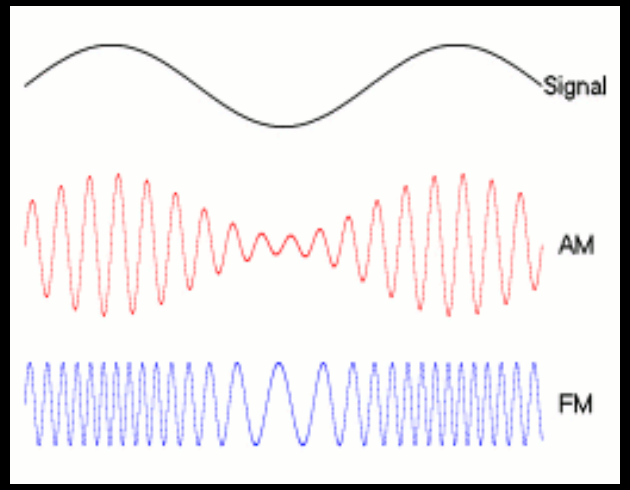
Many different types...

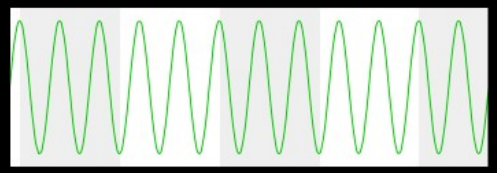


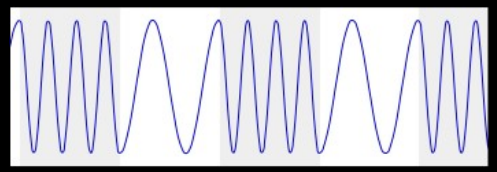


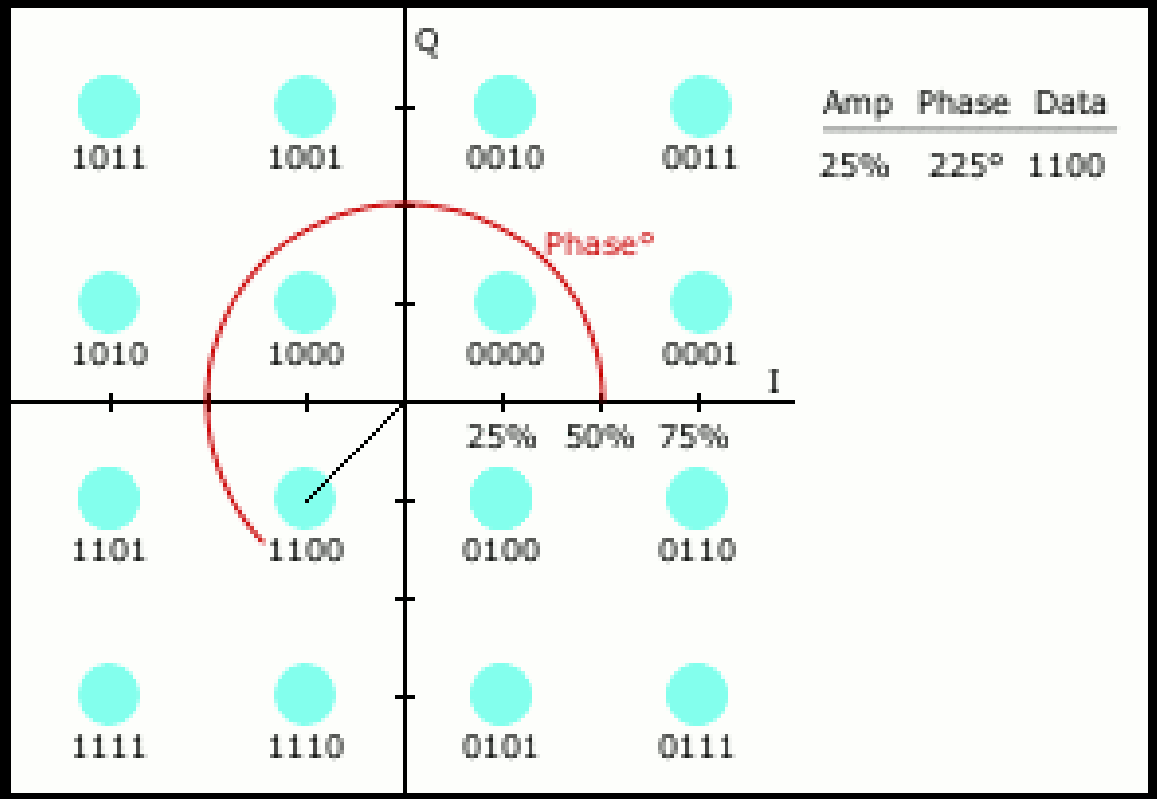
So how do we use all this to communicate?

- Modulation!
  - Analog
    - AM
    - FM
  - Digital
    - OOK
    - FSK
    - PSK
    - QAM
    - OFDM









Just how much data can we send?

Ask information theorists!

- Channel capacity
- Shannon-Hartley theorem

$$Capacity \approx 0.332 \times Bandwidth \times 10 \log(10) \frac{Signal}{Noise}$$

- Example:
  - 20MHz bandwidth
  - -70dB signal
  - -90dB noise
  - 86mbit/sec
  - Better SNR? -60dB signal, -110dB noise, 112mbit/sec
  - Double bandwidth? -60dB signal, -110dB noise, 40MHz BW, 225mbit/sec

Where do I go to learn more?

- For RF:
  - Amateur Radio license! Today (Tuesday) at 7pm
    - http://conham.org/exams.html
    - http://www.kb6nu.com/study-guides/
    - http://www.arrl.org/ham-radio-license-manual
  - ARRL Handbook, http://www.arrl.org/arrl-handbook-2015
  - RF for non-RF engineers, http://www.ti.com/lit/ml/slap127/slap127.pdf
  - NXP RF Basics, https://www.youtube.com/watch?v=FVmTooGICNc
- For SDR:
  - Michael Ossman's videos, http://greatscottgadgets.com/sdr/
  - Wireless CTF training, http://sdr.ninja/training-events/sdr-wctf/

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