DARA Training 2024
Lecture - Introduction to Signal Processing

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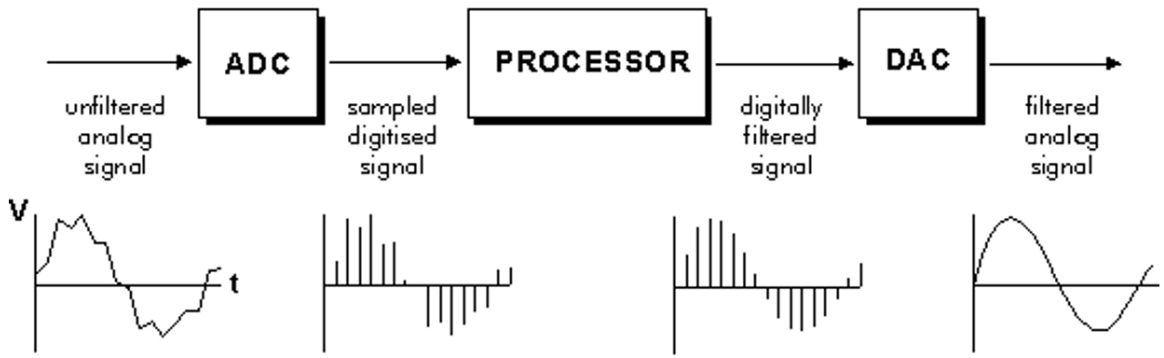
Outline

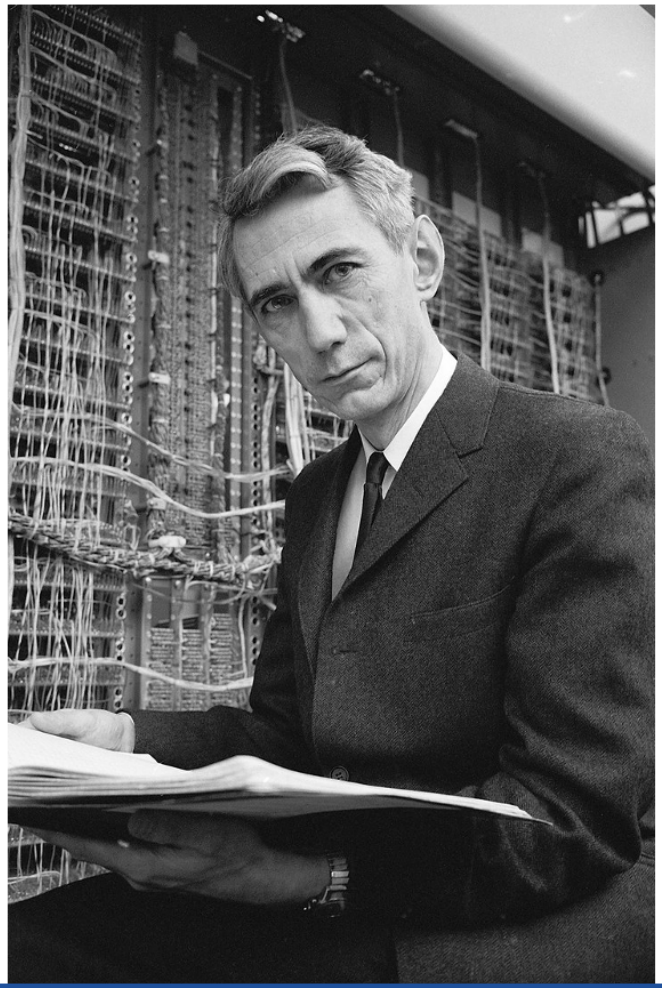
- What is Signal Processing?

Signal processing is an extensive and very diverse field. Signal Processing is not the transmission or propagation of signals, but rather the changes made to the signals to improve the transmission and propagation of these signals.



Conversion of signals

Claude Elwood Shannon

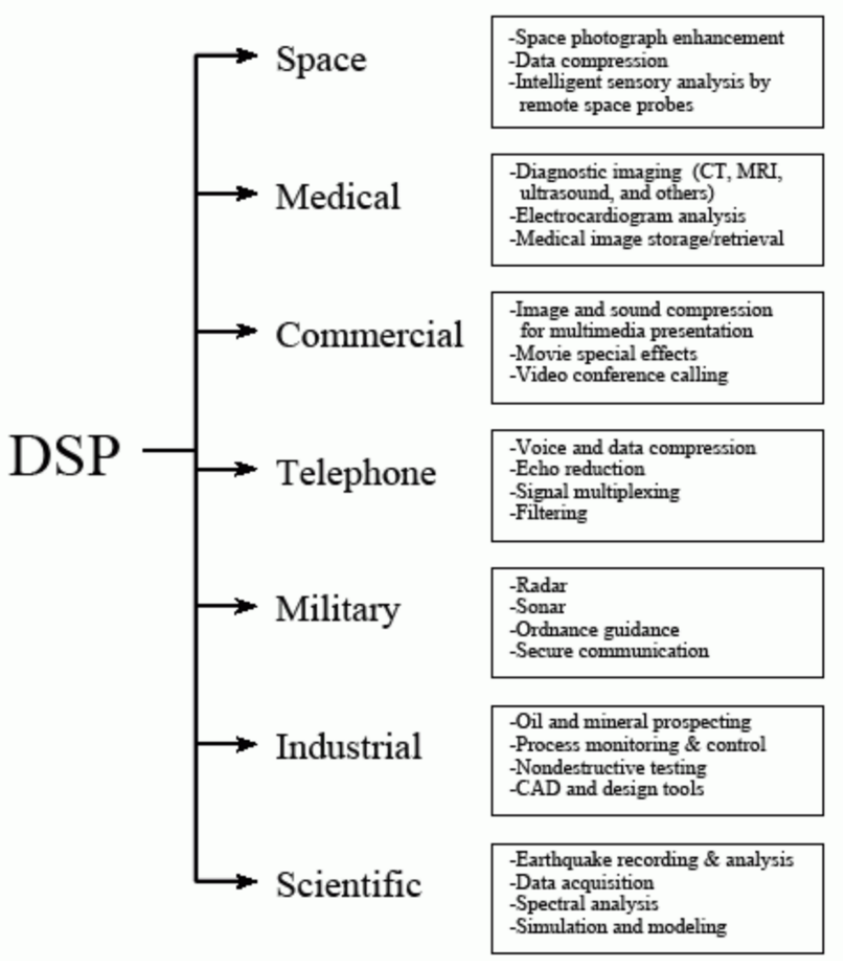


Claude Elwood Shannon is considered as the founding father of the electronic communications age. Shannon noticed the similarity between Boolean algebra and the telephone switching circuits, so he applied Boolean algebra to electrical systems at the Massachusetts Institute of Technology (MIT) in 1940. Later he joined the staff of Bell Telephone Laboratories in 1942. While working at Bell Laboratories, he formulated a theory explaining the communication of information and worked on the problem of most efficiently transmitting information. The mathematical theory of communication was the climax of Shannon's mathematical and engineering investigations. The concept of entropy was an important feature of Shannon's theory, which he demonstrated to be equivalent to a shortage in the information content (a degree of uncertainty) in a message.

Background/History

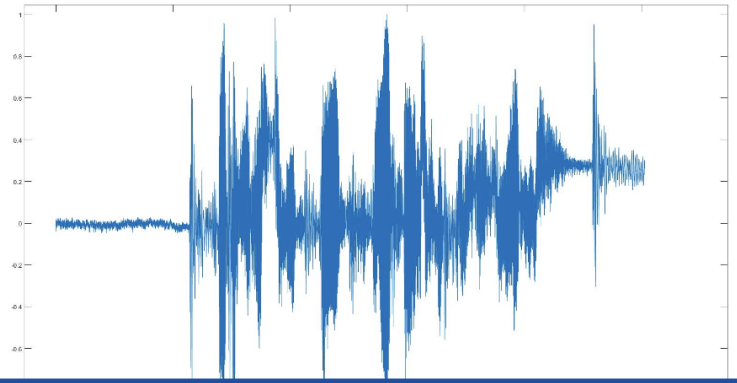
- 1950's
  The '50s was the start of audio equipment such as the hi-fi and tape recorders.
- 1960's
  Radar and Sonar was the ground breaking work of the 60's. Along with this was the. Improvement of telephones, satellite communication, the moon landing and coding schemes.
- 1970's
  Digital Signal Processing originated in the 70's
- 1980's
  The 80's saw the first personal computers from IBM and Apple, as well as CD's, Walkman's, cellphones and DSP chips. The 80's also created the DARPA Net.
- 1990's
  The 90's created the interconnected network, HD formats and better DSP methods
- 2000's
  The new millennium created neural networks for the use in parallel computing and aircraft.
- 2010's
  In recent years signal processing has become a major part of our everyday life's.

Background/History



What are Signals?

- A signal is something that represents information.
- A signal is usually a function of time that represents a physical variable
- Examples of Signals:
  - Audio
  - Visual
  - Biological
  - Astronomy
- Can you think of any more?



What are Systems?

- A system is a generator of signals, or transforms signals.
- A system is a combination of interconnected components to perform a specific task.
- Examples of Signals:
  - Mechanical
  - Acoustic
  - Electrical
  - Astronomy
- Can you think of any more?

Why is it important to study signals and systems?

- Model Systems:
  Use mathematics to predict what the signals will do
- Analyze Systems:
  How does the system affect signals.
- Design System:
  Design a system to transform a signal in a certain way
- Test System:
  Test the actual system
- Implement System:
  Implement the actual system

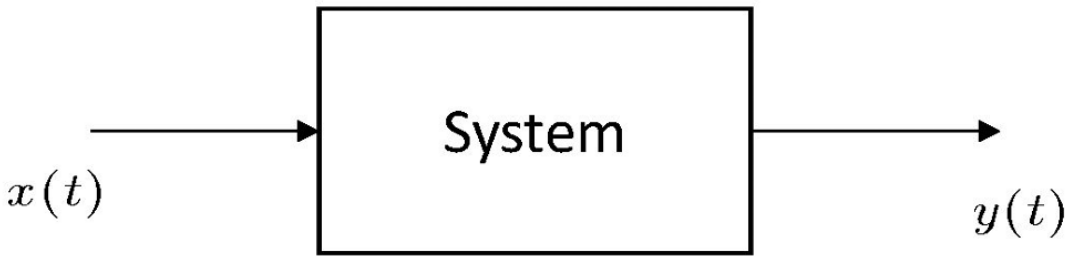


Figure: Apache Attack Helicopter

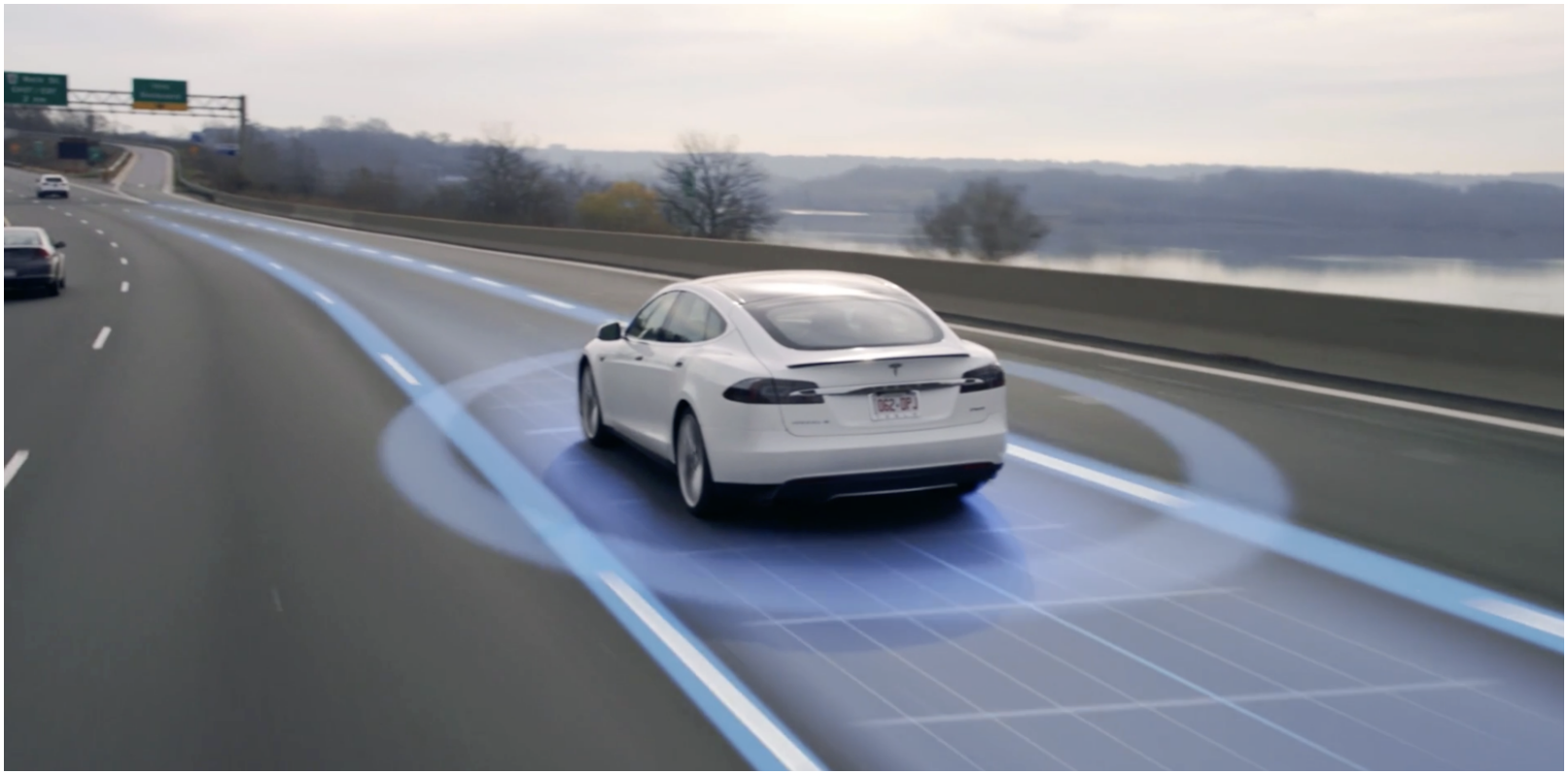


Figure: Tesla Model 3 Autopilot

Figure: Falcon Heavy Side Boosters

Figure: HartRAO 26 m and 15 m Telescopes

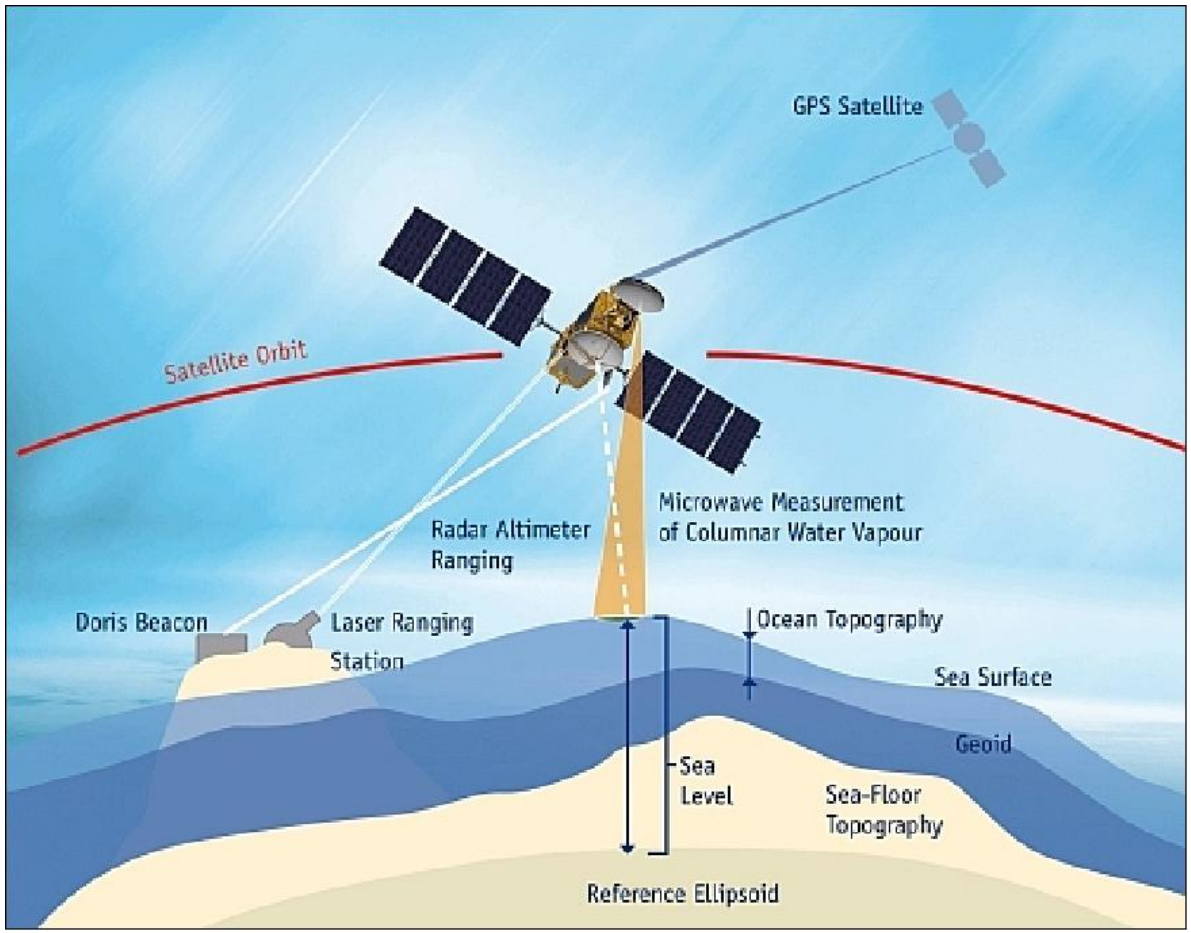


Figure: Tracking and Telemetry

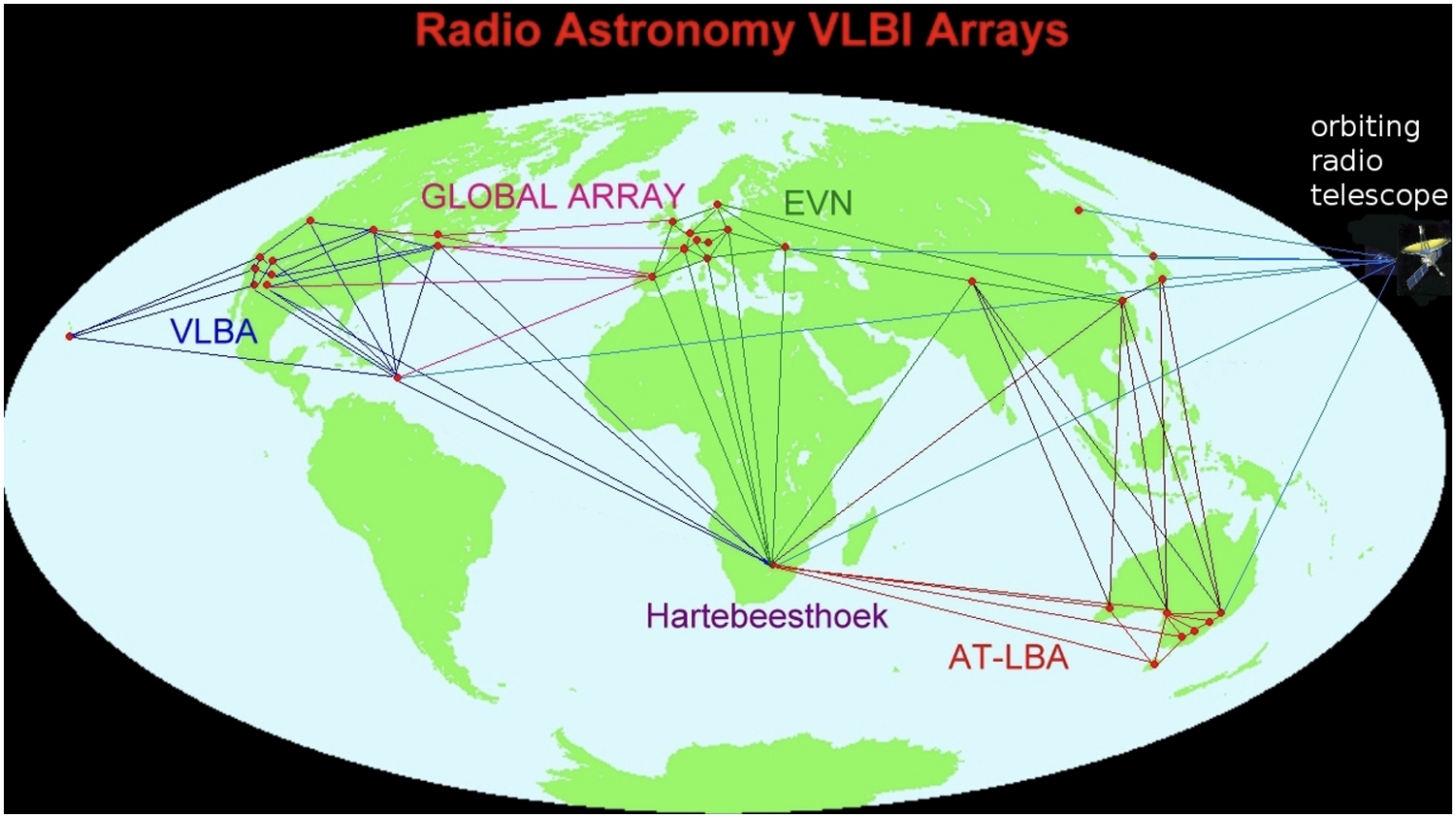
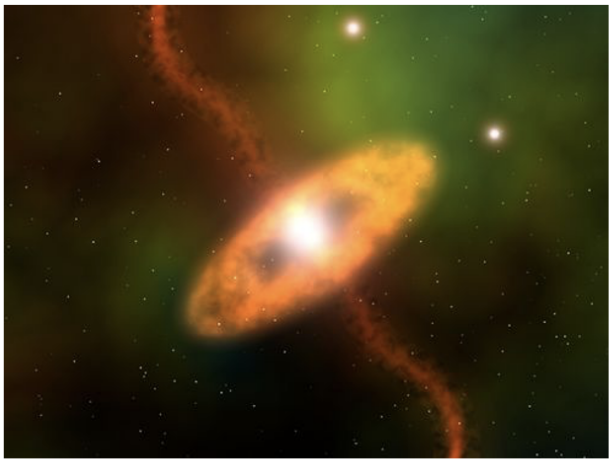
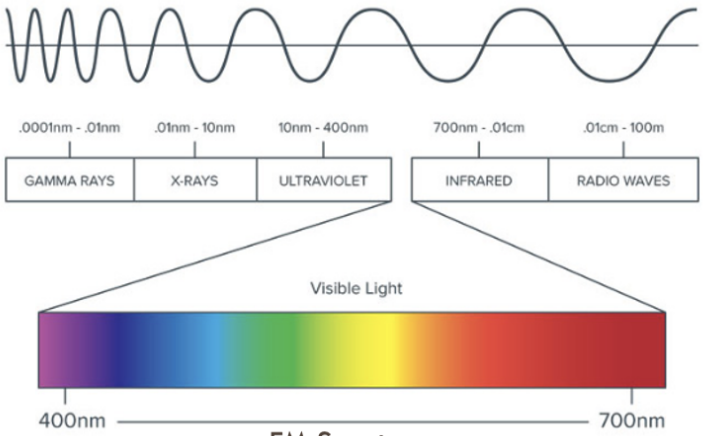


Figure: Very Long Baseline Interferometry (VLBI)



MASER Illustration



EM Spectrum

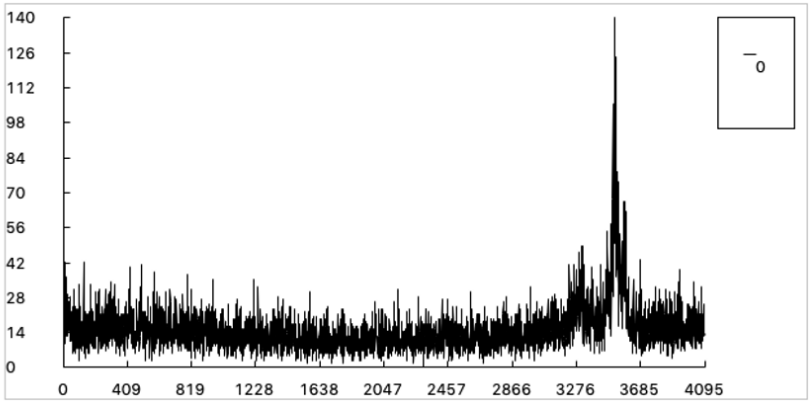


Figure: MASER Spectrum

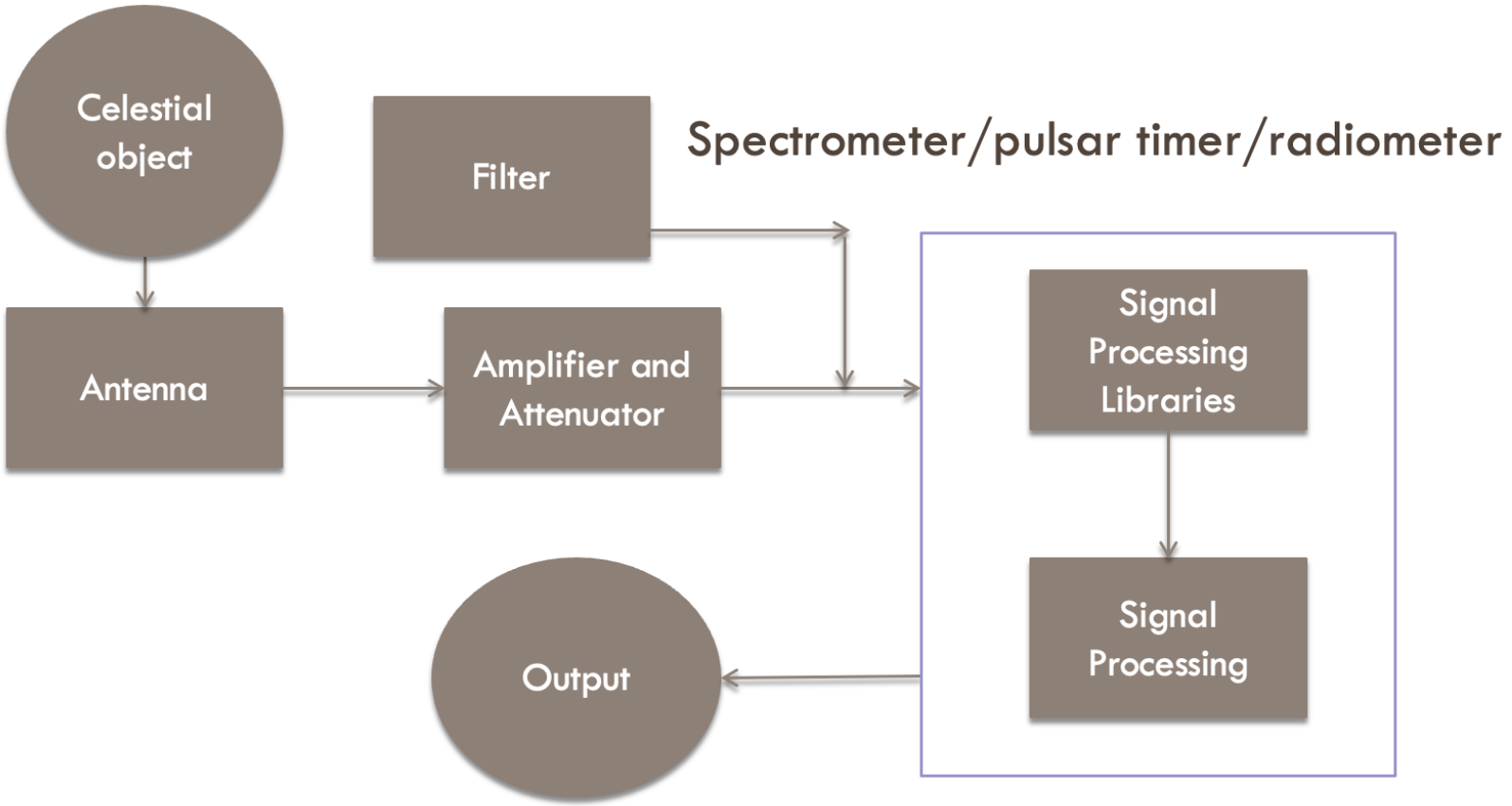


Figure: Radio Telescope System

- Deterministic Signals:
  Deterministic signals are signals that can be modeled completely as a specified function in time.

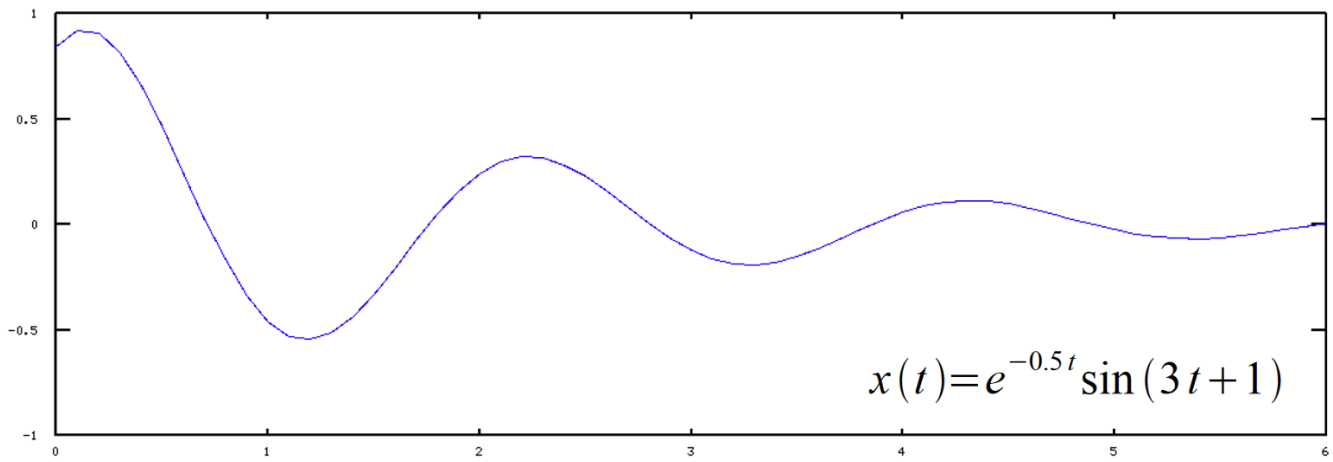


Figure: Deterministic Signal

- Random Signals:
  Random signals take on random values at any time given time.

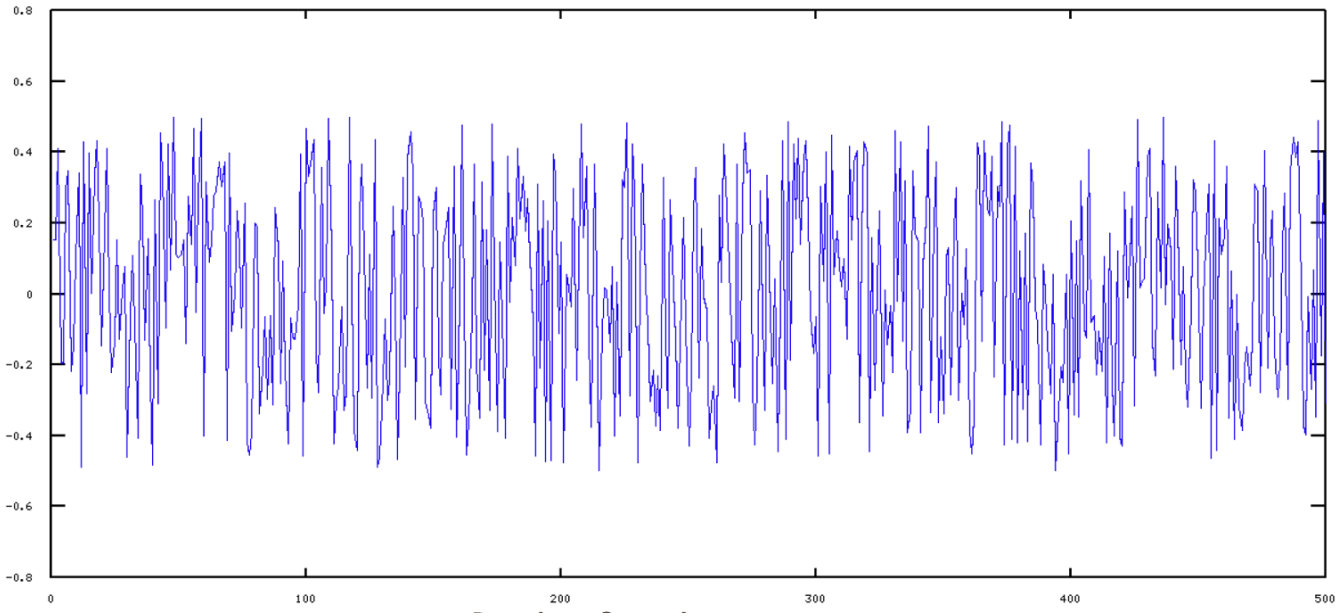


Figure: Random Signal

- Continuous-time Signal:
  A Continuous-time Signal has a value specified for all points in time.

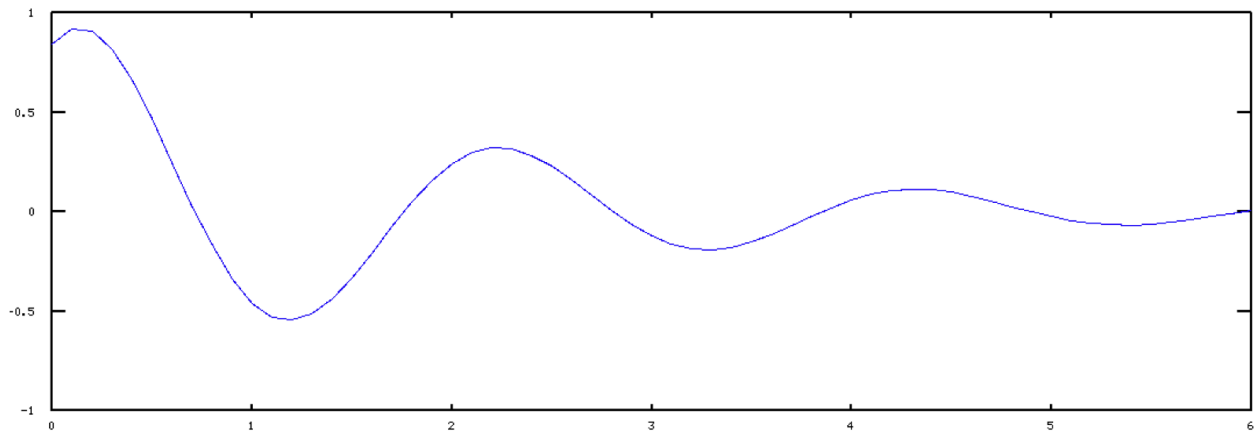


Figure: Continuous-time Signal

- Discrete-time Signal:
  A Discrete-time Signal has a value specified only at certain (discrete) points in time.

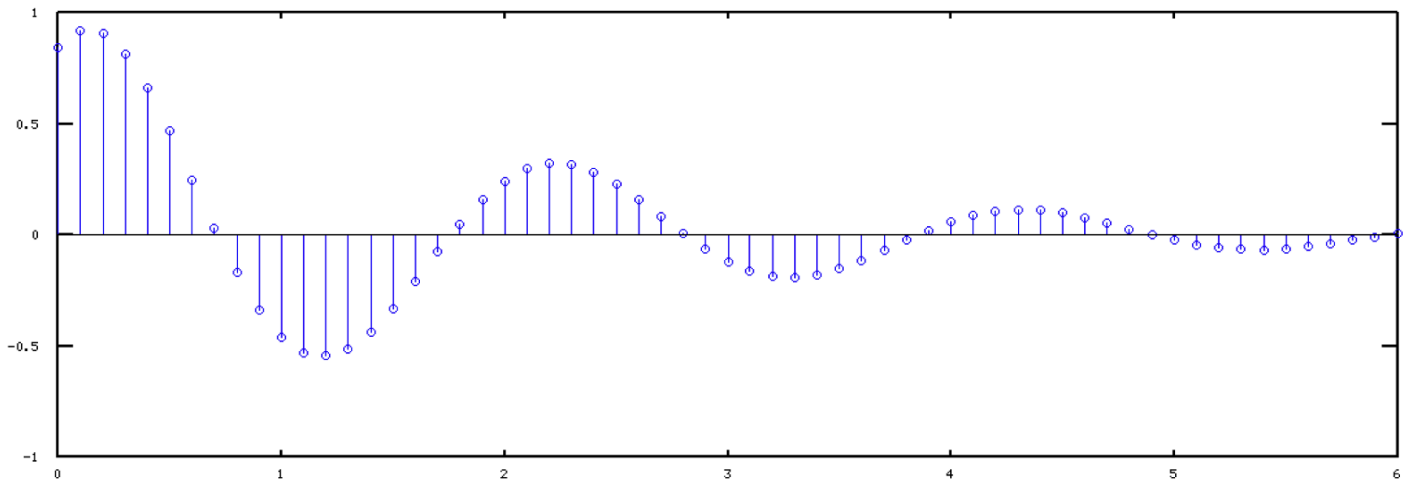


Figure: Discrete-time Signal

- Analog and Digital Signals:

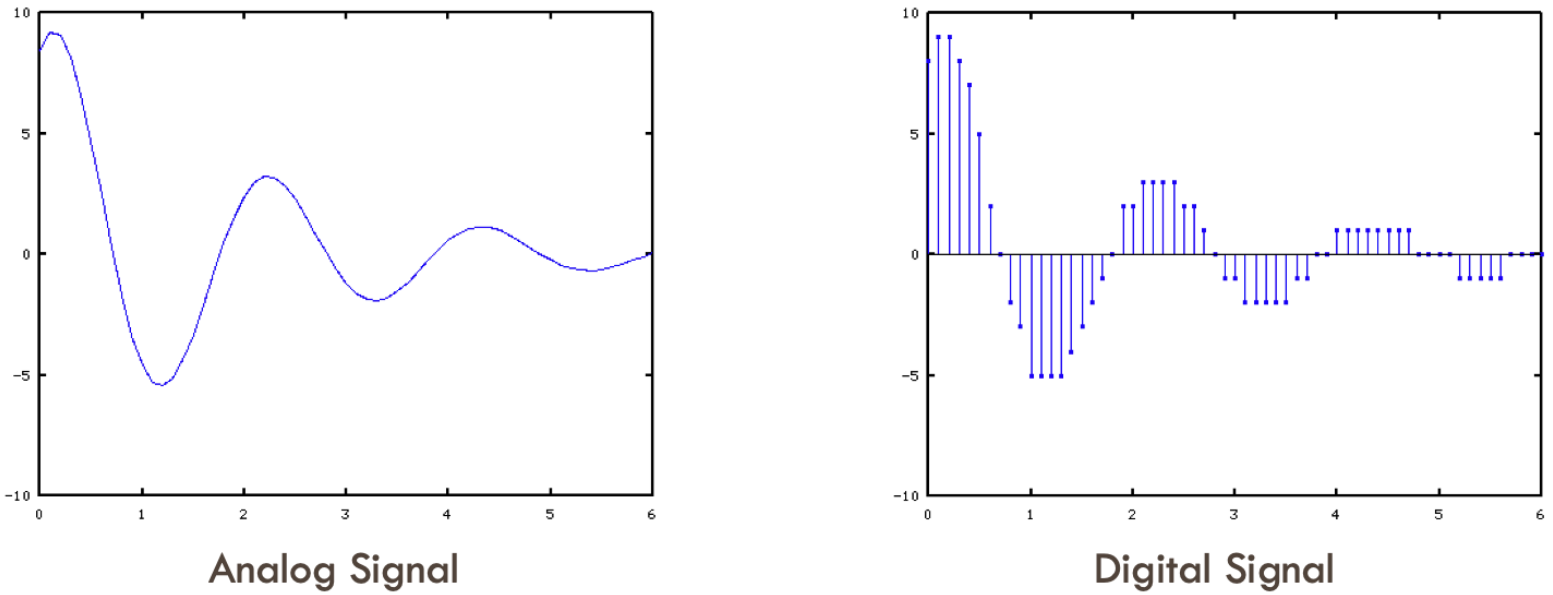


Figure: Analog and Digital Signals

- The Fourier Transform:

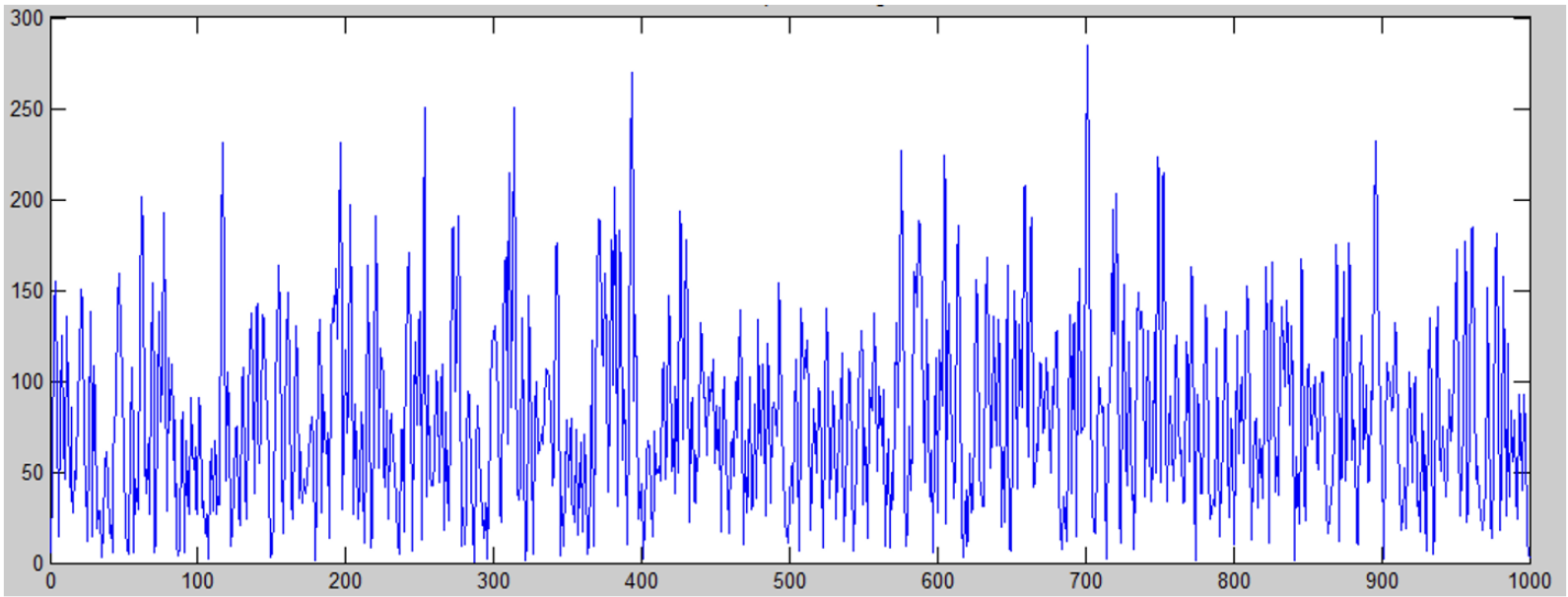


Figure: The Fourier Transform

- The Fourier Transform:

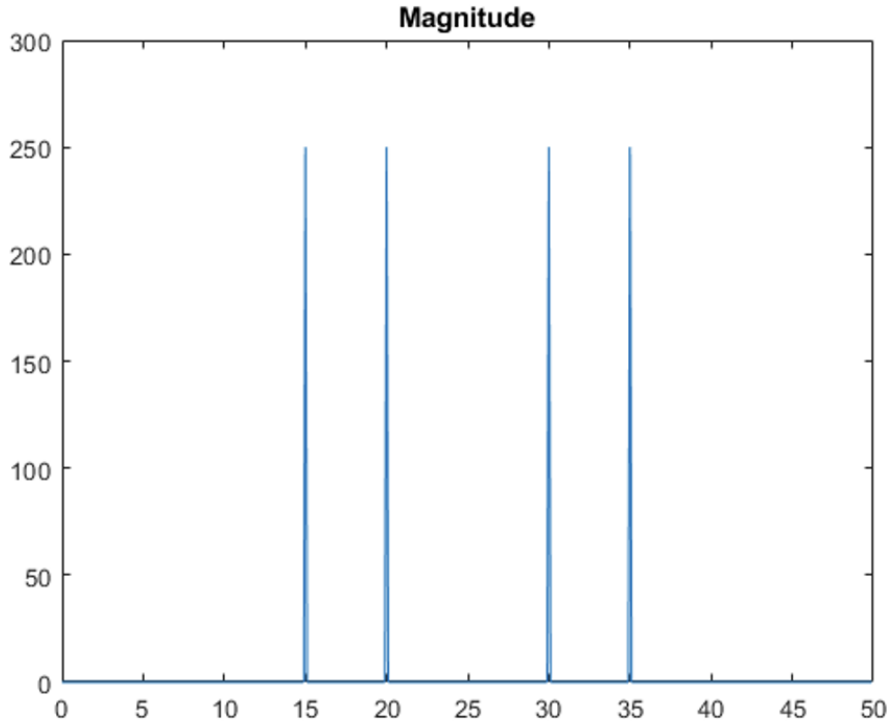


Figure: Fourier Transformed Signal

- The Fast Fourier Transform (FFT):

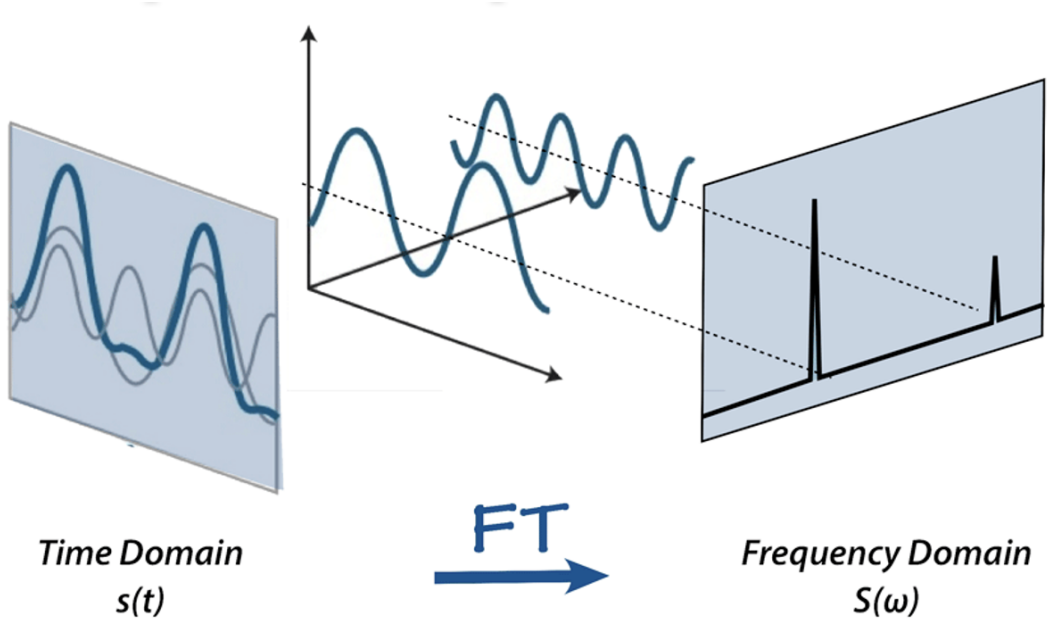
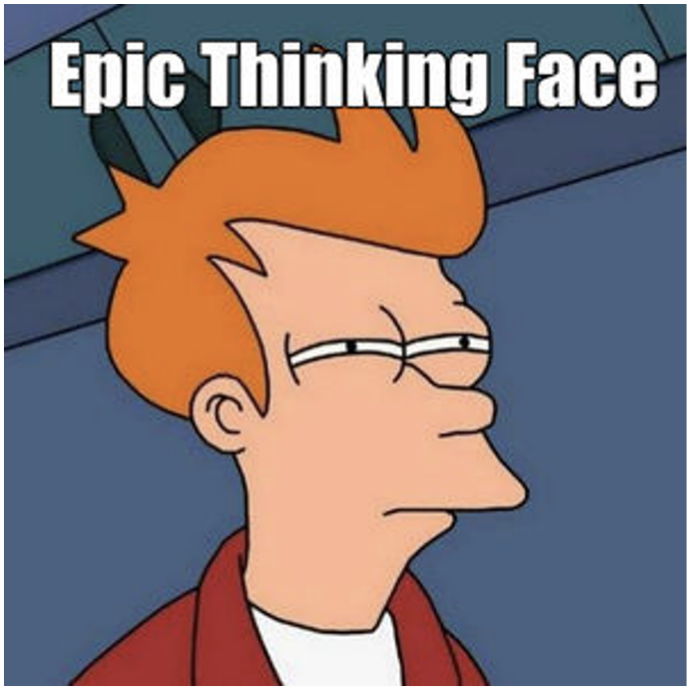
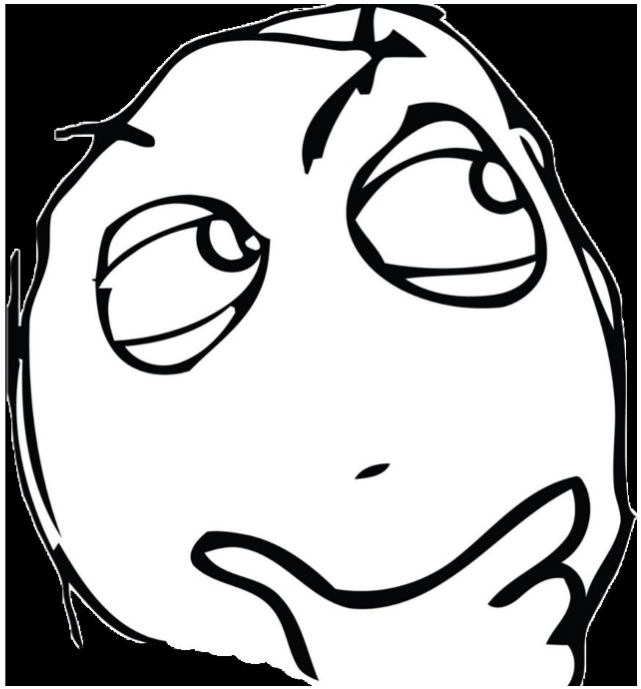


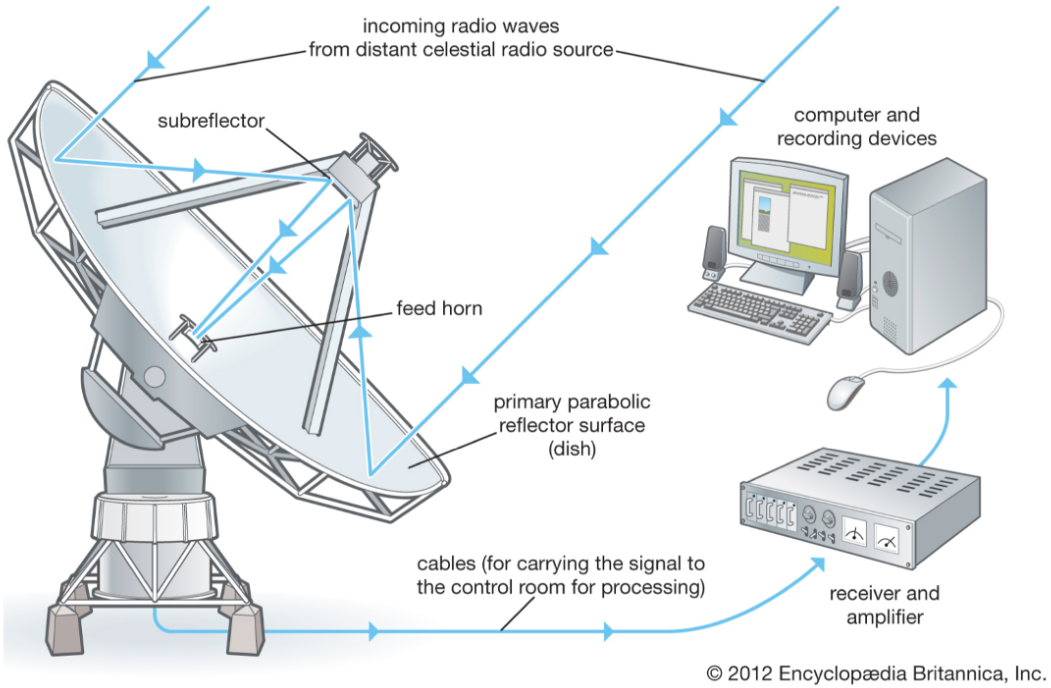
Figure: The Fast Fourier Transform (FFT)

- Where is this leading?





- Where is this leading?



Questions