MMWAVE RADAR
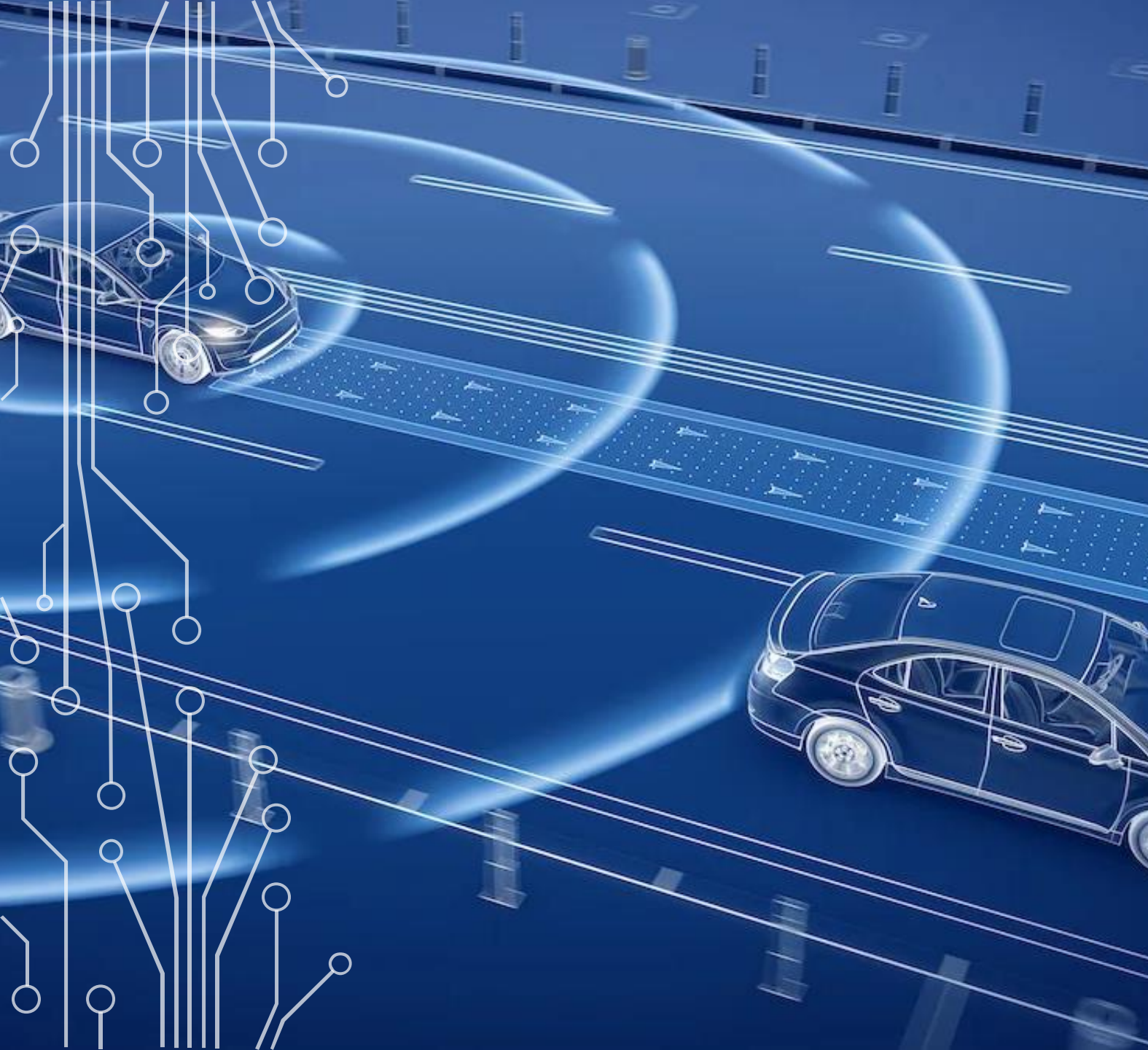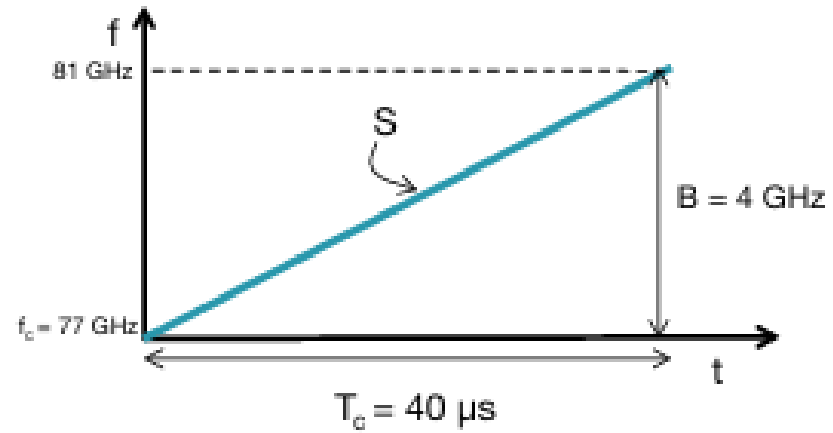
BY REID CREWS

OVERVIEW

- What is mmWave Radar

- How does mmWave Radar Detect Range

- Applications
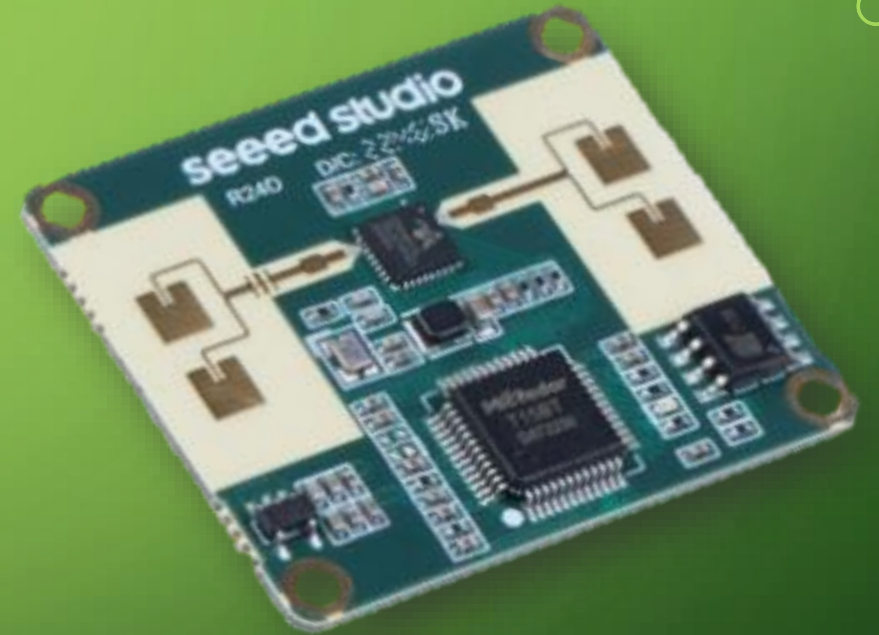
WHAT IS MMWAVE RADAR

- Radar using short-wavelength electromagnetic waves

- Radar can find range, velocity, and angle of the target

- FMCW (frequency-modulated continuous wave)
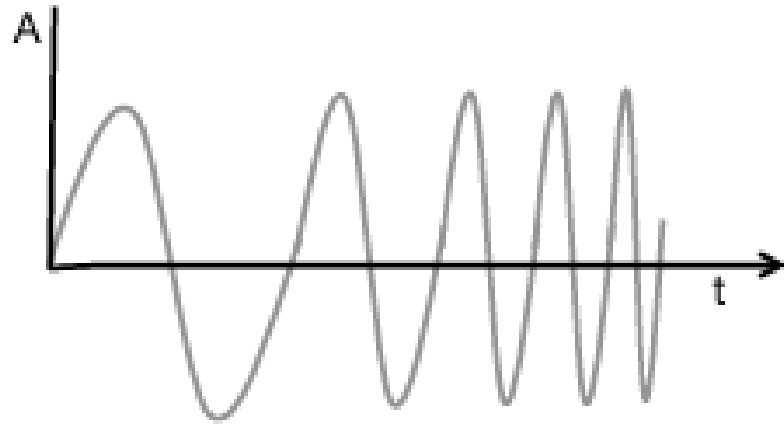
HOW DO THEY WORK

- Signal for FMCW is a chirp
  - Frequency increases linearly with time
  - Frequency vs Time plot represent a chirp
 - Slope of chirp is the rate a chirp ramps up

GENERATE SIGNAL
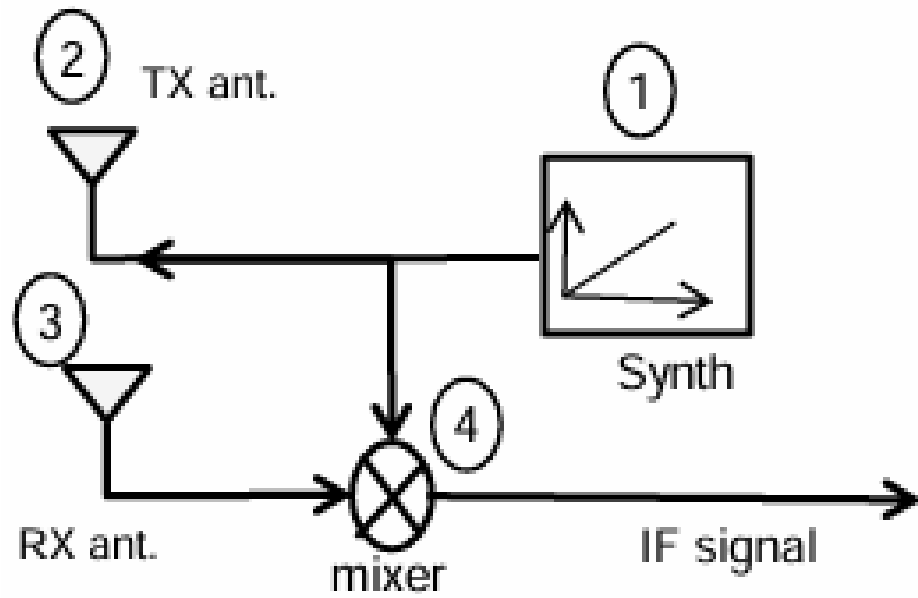
- Generate a chirp by a synthesizer

- TX transmits the chirp signal

- RX receives the reflected chirp signal from the target

- RX and TX are 'mixed' to create an intermediate frequency (IF) signal

MIXER

- Takes the TX and RX sinusoid signals

- Outputs a sinusoid with this parameters

  - Instantaneous frequency equal to difference of the TX and RX signals

  - Phase equal to difference of the phases of the TX and RX signals

$$x_1 = \sin(\omega_1 t + \phi_1)$$
$$x_2 = \sin(\omega_2 t + \phi_2)$$

$$x_{out} = \sin[(\omega_1 - \omega_2)t + (\phi_1 - \phi_2)]$$
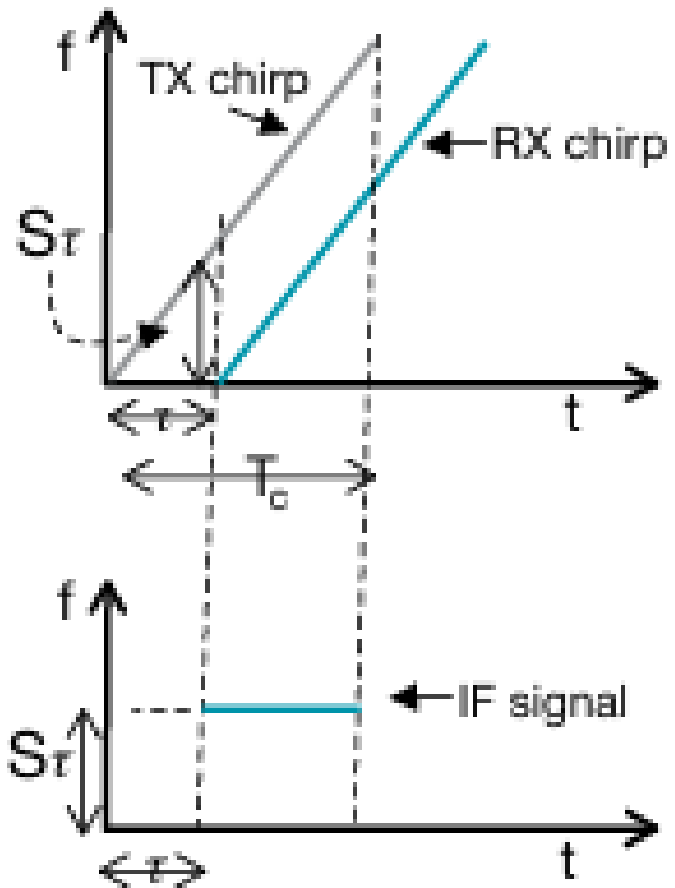
IF SIGNAL

- Plot shows the TX and RX reflected from the target
  - τ is the round-trip between radar and target
- The target produces IF signal with constant frequency tone

EQUATION

- $t = \frac{2d}{c}$, d is distance of target and c is speed of light

- $\phi_0 = 2\pi f_c \tau$, ϕ_0 is the phase difference of RX and TX

- $\phi_0 = \frac{4\pi d}{\lambda}$

- IF signal is a sine wave of equation

    - $A\sin(2\pi f_0 t + \phi_0), where\ f_0 = \frac{S2d}{c}\ and\ \phi_0 = \frac{4\pi d}{\lambda}$

    - S is slope of the chirp
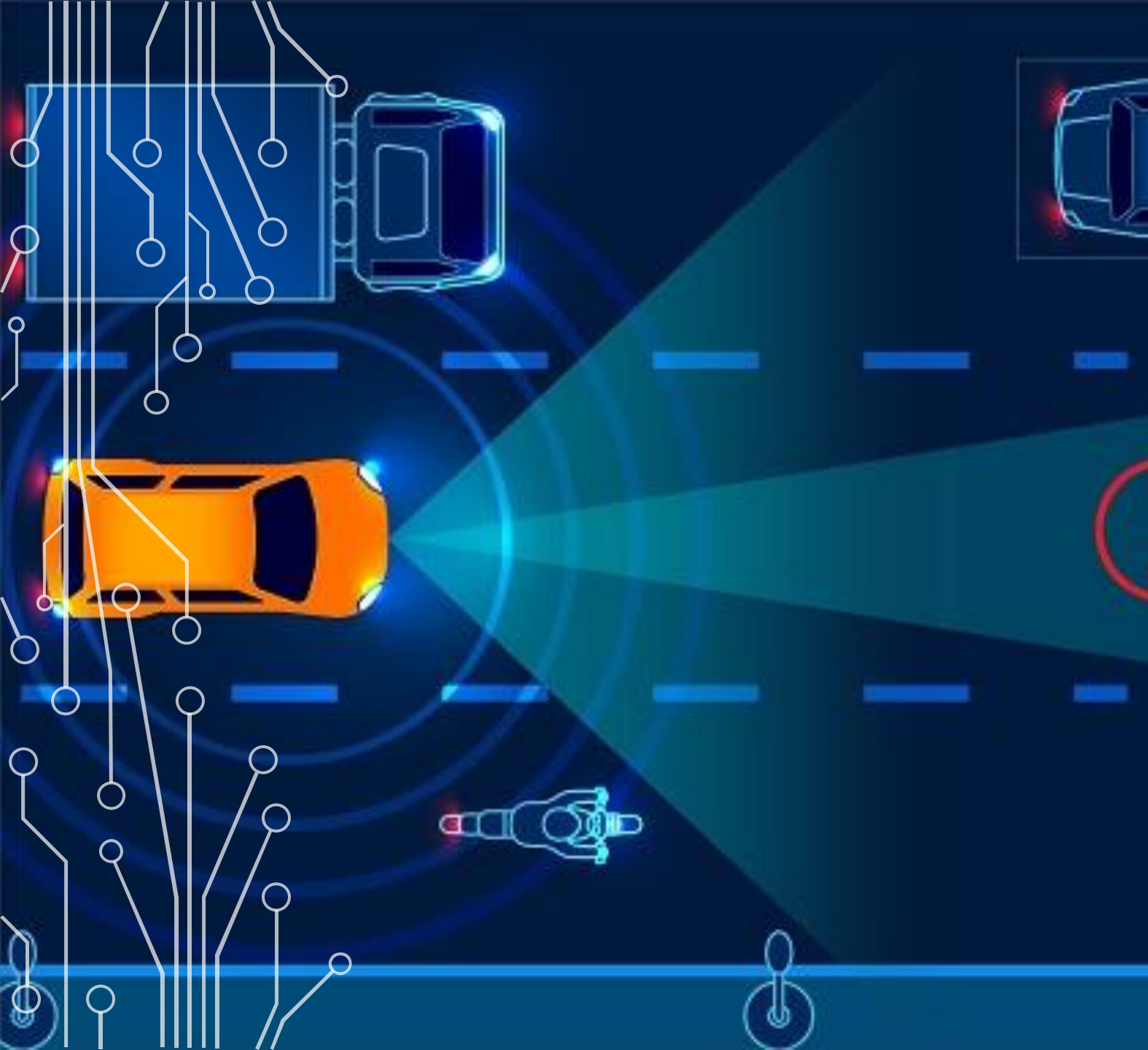
APPLICATION

- Used for Vehicle Avoidance in Blind Spots

- Used for Parking Assistance

- Used for Active Safety Systems

REFERENCE

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