Introduction to Traffic Radar
Technology Driven Radar
For The Transportation Industry

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DISCUSSION QUESTIONS

How does your technology operate under extremely high and low volume situations?

How does your technology work around occlusion issues?
Transmission and Reception

- Radar is an acronym that stands for “Radio Detection and Ranging.”
- Radar has multiple uses
  - What types of traffic radar are available?
  - Which option is the best solution for specific traffic needs?

Radar system consists of three parts:
1. Transmitter
2. Receiver
3. Digital Signal Processor (DSP)

“Radar Waves”
Or
“Radar Signal”
Transmission and Reception

The higher the frequency of the wave, the faster the oscillation occurs.

Some radar devices operate at 24.125 GHz - waves that transmit between a peak, a valley, and back to a peak 24,125,000,000 times a second.

The more power that is transmitted, the further the radar will be able to accurately detect targets. There are, however, regulations which limit the amount of power that can be transmitted for certain frequencies.
Once transmitted energy has left the radar device, it will reflect off of vehicles. Those reflected waves are then received back to the originating radar device via the receive antenna.
After the signals have been received by the antenna, they are processed by a central processing unit inside the radar device called the DSP or Digital Signal Processor.

This processor runs specially designed algorithms that look for vehicle detections in the received signals.
Applications of Radar

- Doppler Shift
  - Can be used for speed measurements

- Vehicle Detection
- Pulse Radar Ranging
- FMCW - Frequency Modulated Continuous-Wave
  - Used in Traffic Radar

\[
\text{Doppler Shift} = \frac{2 \times \text{Velocity}}{\text{Wavelength}}
\]
Bandwidth and Resolution

The range of FMCW frequencies, or the difference between the highest frequency and the lowest, is known as the bandwidth. Bandwidth is a key component when using radar with **Traffic**. The amount of Frequency/bandwidth is key to RESOLUTION.

Resolution = \( \frac{\text{Speed of Light} \times 10^6 \text{ miles per second}}{2 \times \text{Bandwidth}} \)

5X Resolution

Same Resolution
LOW RESOLUTION VS. HIGH RESOLUTION

45 MHz
low resolution

245 MHz
high resolution
Radar Used In Traffic…

Single-Beam Side-fire Radar

Applications – Use
- Freeway ITS sensor
- Mid-block ITS sensor

Capabilities
- Presence detection of moving vehicles
- Detects direction of travel
- Lane discrimination moving vehicles
- Vehicle length measurements

Low Resolution Radar

Single-beam Forward-fire Radar – Non ETA Based

Applications – Use
- Detection on approach to stop bar

Capabilities
- Presence detection of moving vehicles
- Detects direction of travel
- Accurate per vehicle speed measurements
- Long-range point detection
Radar Used In Traffic…

Single-beam Forward-fire Radar – ETA Based

Applications – Use
- Detection on approach to stop bar

Capabilities
- Presence detection of moving vehicles
- Detects direction of travel
- Accurate per vehicle speed measurements
- Vehicle tracking
- Criteria-based detection and SafeArrival technology
DILEMMA ZONE DETECTION

Vehicle Speed
+ Vehicle Distance
+ Stop Bar Location
= ETA

Dilemma Zone = 2.5 to 5.5 Seconds
EFFICIENCY IMPROVEMENTS

Minimizes unused green time
Gap out as opposed to Max Out
Queue Detection/Reduction Improvements
Increased Safety
ADAPTIVE/DYNAMIC
DILEMMA ZONE DETECTION
Multiple Radar

Some traffic radar devices have a design that utilizes multiple transmitters and receivers within the same device. These devices will have additional capabilities that single radar devices will not have.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Other Names</th>
<th>Examples</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radar Design</td>
<td>Multiple Radar</td>
<td>■ Dual Radar</td>
<td>Device can be used for side-fire per vehicle speed measurements and/or forward-fire lane discrimination</td>
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<td>■ Matrix of 16 radars</td>
<td>16 radars is a suitable number for providing coverage and tracking on an approach at the stop bar.</td>
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Radar Used In Traffic...

**Dual-beam Side-fire Radar**

**Applications – Use**
- Freeway ITS & Planning sensor
- Mid-block ITS & Planning sensor

**Capabilities**
- Presence detection of moving vehicles
- Presence detection of stopped vehicles
- Detects direction of travel
- Lane discrimination moving vehicles
- Lane discrimination stopped vehicles
- Vehicle length measurement
- Accurate per vehicle speed measurements
- Accurate traffic statistics enabled by high resolution and vehicle based detection

High Resolution Radar
Radar Used In Traffic…

Multi-Beam Corner Radar

Applications – Use
• Stop bar detection

Capabilities
• Presence detection of moving vehicles
• Locked detection of stopped vehicles
• Detects direction of travel
• Lane discrimination moving vehicles
• Lane discrimination stopped vehicles
• Vehicle tracking
• Detection area coverage at stop bar

Low Resolution Radar
Radar Used In Traffic...

Matrix of Corner Radar

Applications – Use
• Stop bar detection

Capabilities
• Presence detection of moving vehicles
• Presence detection of stopped vehicles
• Detects direction of travel
• Lane discrimination moving vehicles
• Lane discrimination stopped vehicles
• Vehicle tracking
• Detection area coverage at stop bar
• User defined shape and locations of detection zones.

True Presence
Repurposed RADAR

Designed
Engineered
Manufactured

For Non-Traffic Industry, Repurposed for Traffic
Traffic Radar

✓ Designed
✓ Engineered
✓ Manufactured

For the Traffic Industry
TRAFFIC ENGINEERED RADAR ADVANCEMENTS

BUILT FOR TRAFFIC
from the ground up

MULTIPLE LANE DETECTION
Multiple antennas

EASIER TO CONFIGURE
Set and forget