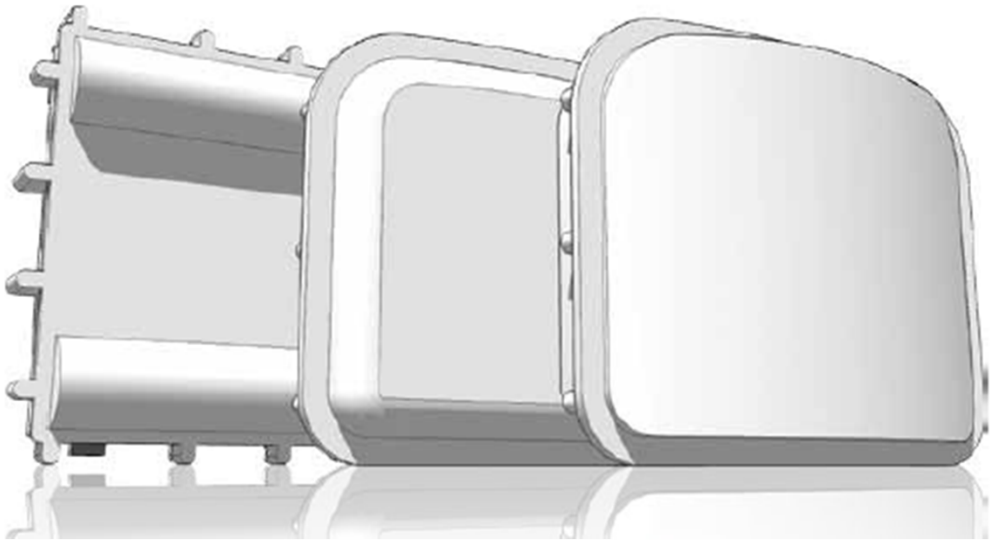
Wavetronix SmartSensors



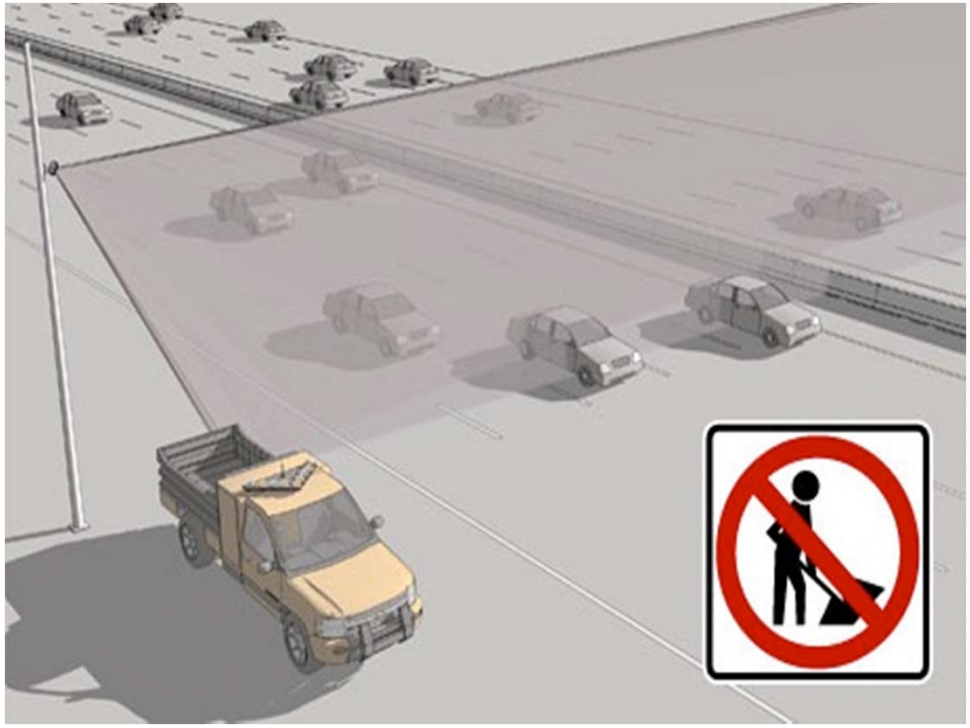
WAVETRONIX™

Tim Janes
Advanced Traffic Products
tim@advancedtraffic.com
www.advancedtraffic.com
www.wavetronix.com
425 347-6208
503 936-1765

Why use these sensors?

Non-Intrusive Installation

SmartSensors install **above the ground** without affecting traffic flow. Since the sensors install at roadside, they do not require lane closures common with in-road detectors, and this, in turn, reduces the risk of injury or death to the workers installing the sensors. Additionally, SmartSensor is easier to maintain than in-road detectors, and can quickly be replaced or reconfigured to accommodate roadway changes.



All Weather, All Light Performance

Regardless of weather or lighting conditions, SmartSensor products continue to detect vehicles in their field of view. That's because the length of radar's electromagnetic wave is much larger than the wavelength of light, so radar can propagate through rain, snow, fog and even dust storms without becoming distorted.

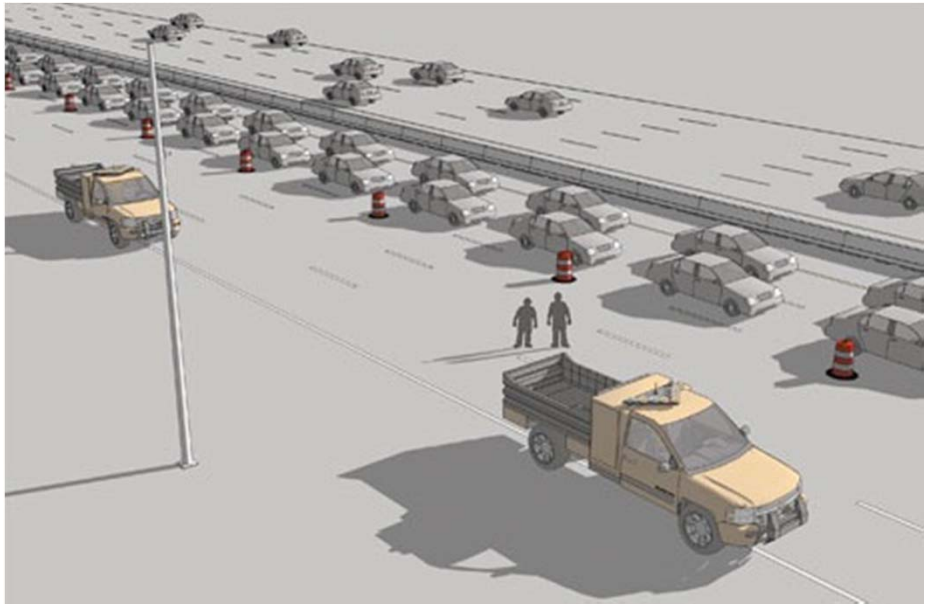
Light. Radar-based sensors are active, meaning they transmit as well as receive a signal. Since SmartSensors transmit their own signal, they are not dependent on external sources in the same way that video is dependent on light. In other words, video detections are affected by too much light in the form of glare; too little sunlight; or inadequate street lighting; but these conditions will not affect radar.

Fog. In heavy fog, SmartSensor HD's 24 GHz radar signal retains 99 percent of its original transmission strength over 100 feet. Light, on the other hand, can be attenuated in heavy fog so that it loses 41 percent of its power every ten feet. At that rate, light has diminished to less than one percent of its original transmission in less than 100 feet!

Wind. Since SmartSensor measurements are primarily range-based, the change in range to targets during windy conditions is nominal. During a wind storm, the distance between the radar sensor and the traffic on the roadway typically changes by 2 or 3 feet at the most. This amount of range change is typically not enough to cause vehicles to be falsely detected in adjacent lanes or zones. Slight changes in angle-based detectors during windy conditions can cause objects to show up in very different locations.

In-Road Detectors

In-road detectors require saw-cuts or core-drilled holes that can weaken the road surface. Lanes must be closed, so traffic flow is disrupted and workers are placed in greater danger. And if an in-road device fails, or if the roadway changes, the devices must be dug up, making them very difficult to maintain.



Graphical User Interface

All Wavetronix SmartSensors feature a similar, user-friendly graphic interface for quick and easy sensor configurations. The interface's intuitive design includes point-and-click operations that can be learned very quickly. Real-time graphic vehicle representations greatly simplify the configuration process, and they allow users to remotely monitor current traffic conditions. The GUI software runs on various Windows platforms, including Windows Mobile so that in-field configurations can be performed using a handheld computer.

Auto-Configuration

Proper installation and configuration are essential for accurate performance from radar sensors, and SmartSensor installs and configures more quickly and more precisely than competitive devices. SmartSensor is well known for its auto-configuration capability. This industry-leading, patented process automatically determines lane positions by observing traffic flow, making SmartSensor the quickest and easiest sensor to set up. It also ensures the setup will be consistent from location to location, even with different installers.

Accuracy

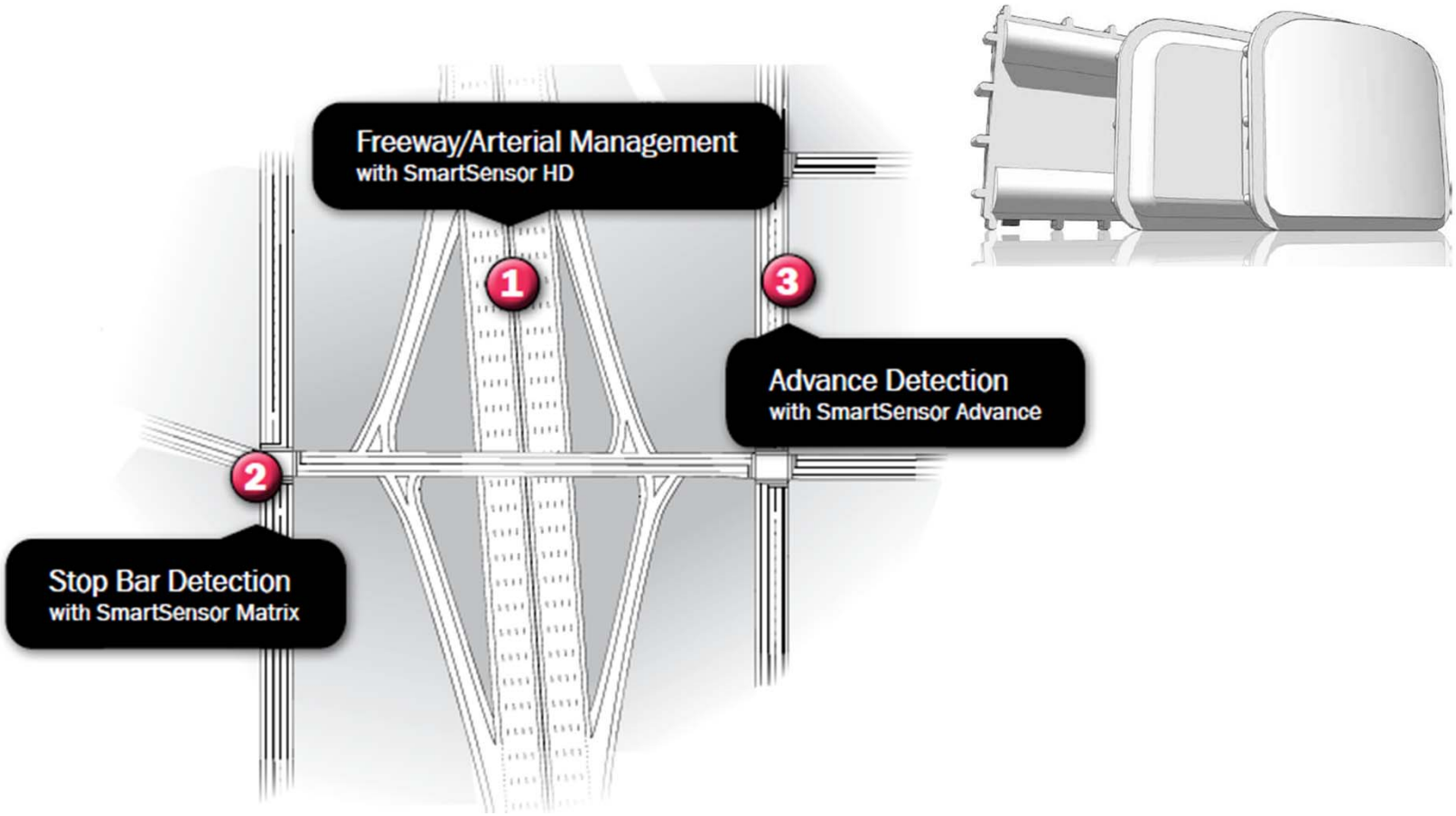
- FHWA Technical Advisory Committee March 31, 2010. Accuracy within @ 3% depending on category. Minnesota Department of Transportation.
- Texas Transportation Institute
- ODOT tests

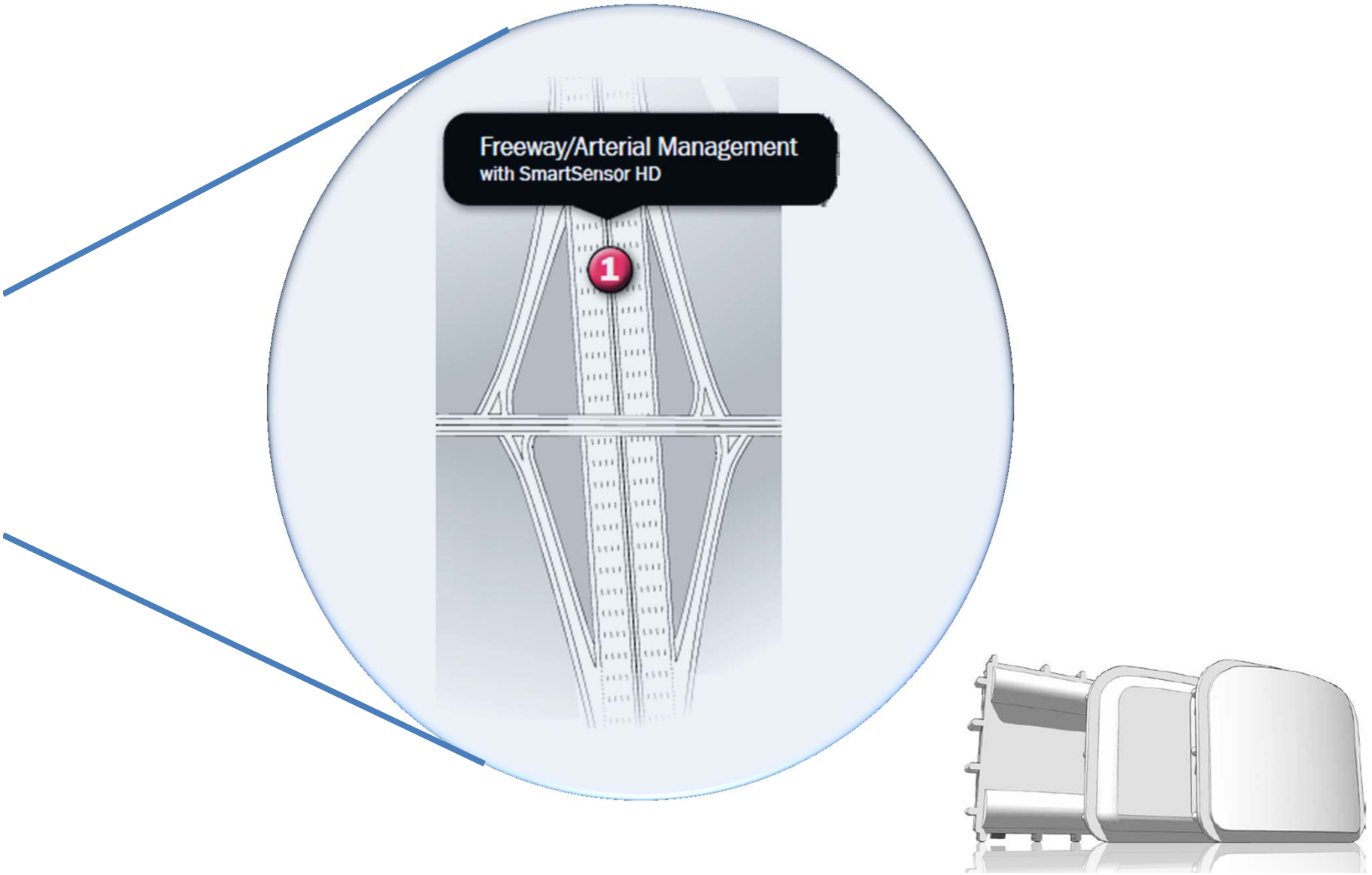
- Do your own and compare!

How Many Training Hours has Tim had?

- @ 50 hours
- @100 hours
- @ 150 hours
- @ 200 hours
- @ 250 hours
- @ 300 hours
- @ 350 hours

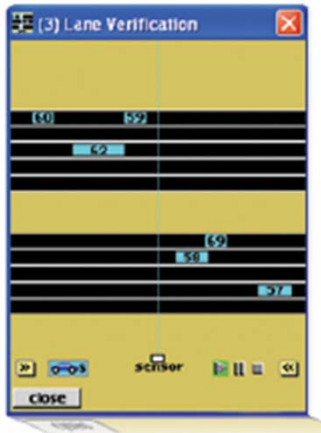
Smart Sensor Applications

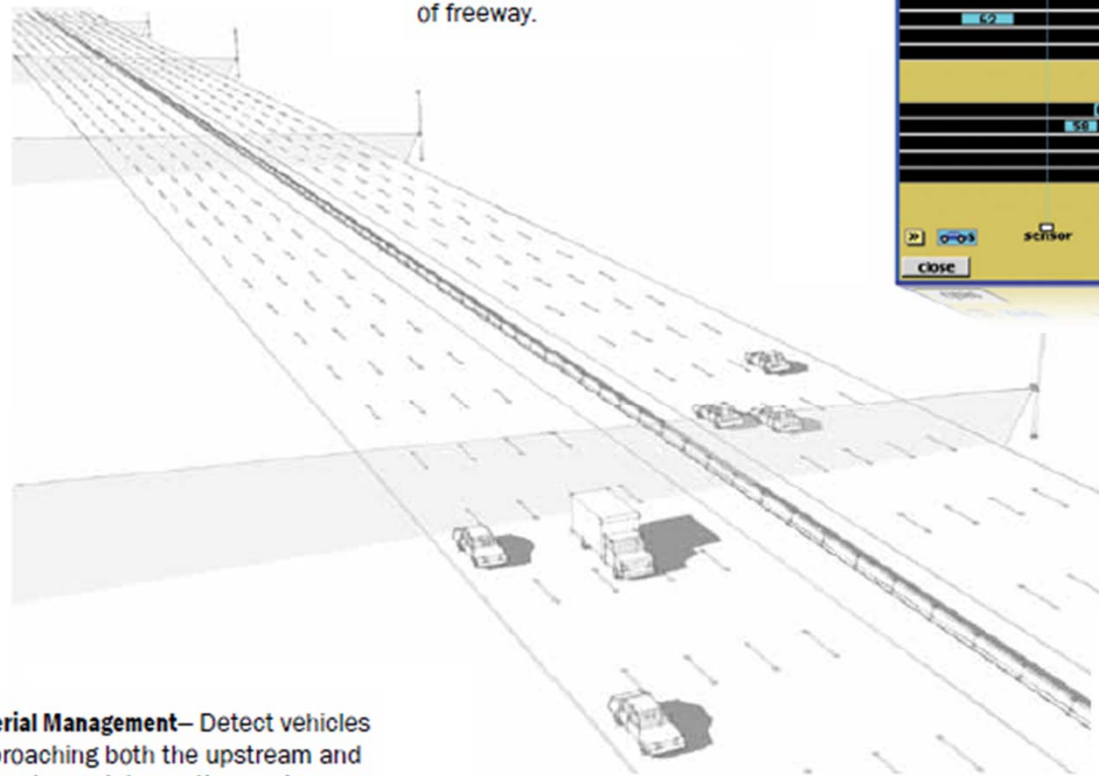



Freeway/Arterial Management
with SmartSensor HD
1

Roadway/Arterial Management

Freeway– Monitor a full range of traffic dynamics along any stretch of freeway.





Arterial Management– Detect vehicles approaching both the upstream and downstream intersections using one sensor.

SmartSensor HD

- **HD Digital Wave Radar**

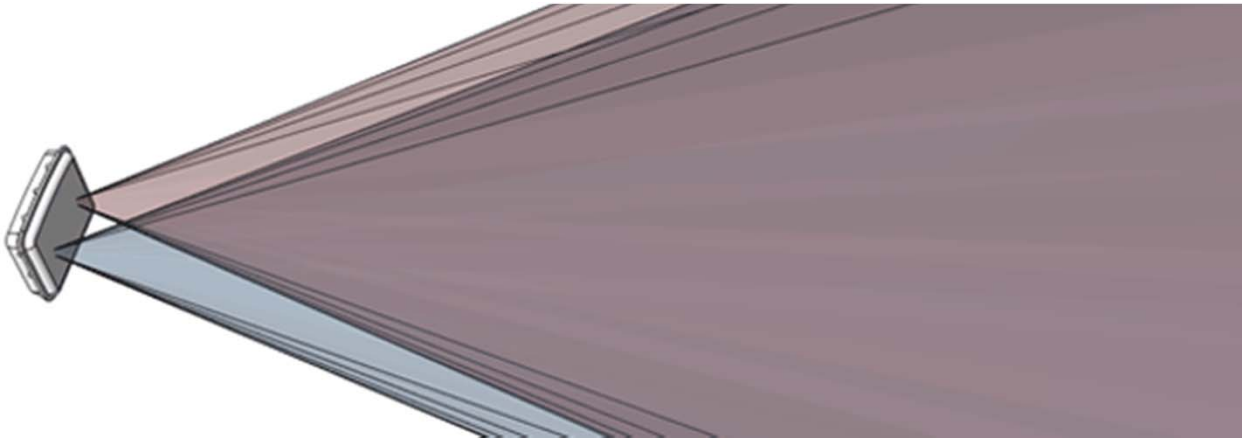
- Digital Wave Radar is Wavetronix' patented process for digitally generating a radar signal. For proper and stable operation, frequency modulated continuous wave (FMCW) radars must transmit a stable and preferably linear frequency sweep. Any nonlinearities of the sweep can reduce range resolution. Further, changes in the df/dt sweep slope due to temperature drift may reduce the accuracy of ranges measured, and shifts in the center frequency due to temperature changes can push the transmission signal out of the FCC allocated band.
- HD Digital Wave Radar digitally synthesizes the radar transmit signal such that at all times it is derived to be some numerical multiple of a fixed low crystal-controlled reference frequency.

- **Vehicle-based Detection**
- Accurate Vehicle detection means that each individual vehicle is detected and its speed, duration, length and lane assignment is precisely measured.
- SmartSensor HD detects vehicles and then assigns them to the lane closest to them. As a result, even lane changing vehicles are accurately detected. This is called vehicle-based detection, and it's possible because of SmartSensor HD's high resolution radar. In contrast, zone based detectors like loops or low resolution radar are lane-based detectors and will detect anything that passes through the lane. In this case, it is likely that the lane changer will be counted twice, once in each lane.

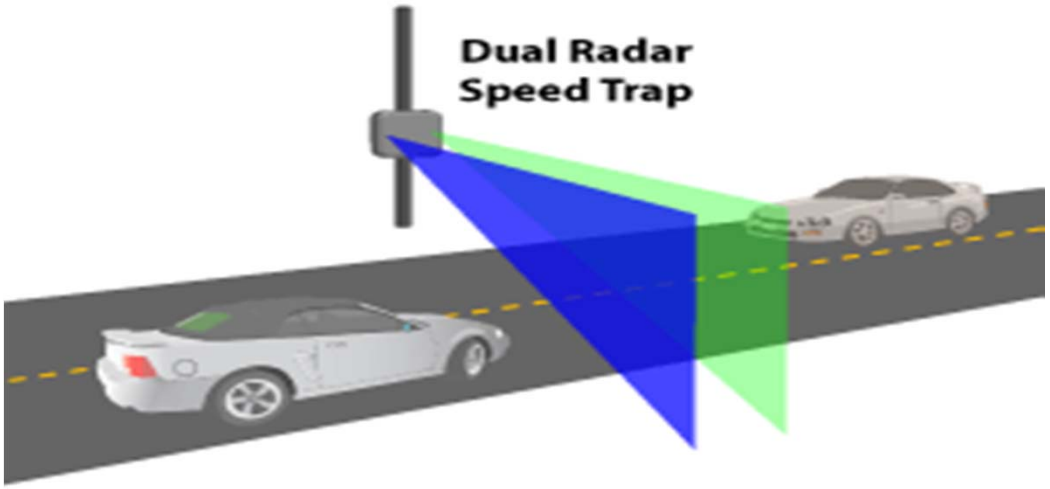
- With true high definition radar, Wavetronix has been able to develop a radical concept—multiple radars contained in one device. SmartSensor HD consists of multiple radars; two receive antennas positioned side-by-side with enough space between to create two separate, high definition beams.
- SmartSensor HD's dual radar technology allows it to detect direction of travel, which is very important for reversible lanes. With two beams, HD determines the order in which a vehicle passes through the two beams, thus allowing it to determine in which direction the vehicle is traveling without any input from the user.
- By measuring the time it takes for a vehicle to pass between the two antennas to within a fraction of a millisecond, SmartSensor HD provides a highly accurate measurement that is then used to calculate each individual vehicle's speed.

Dual Radar Detection

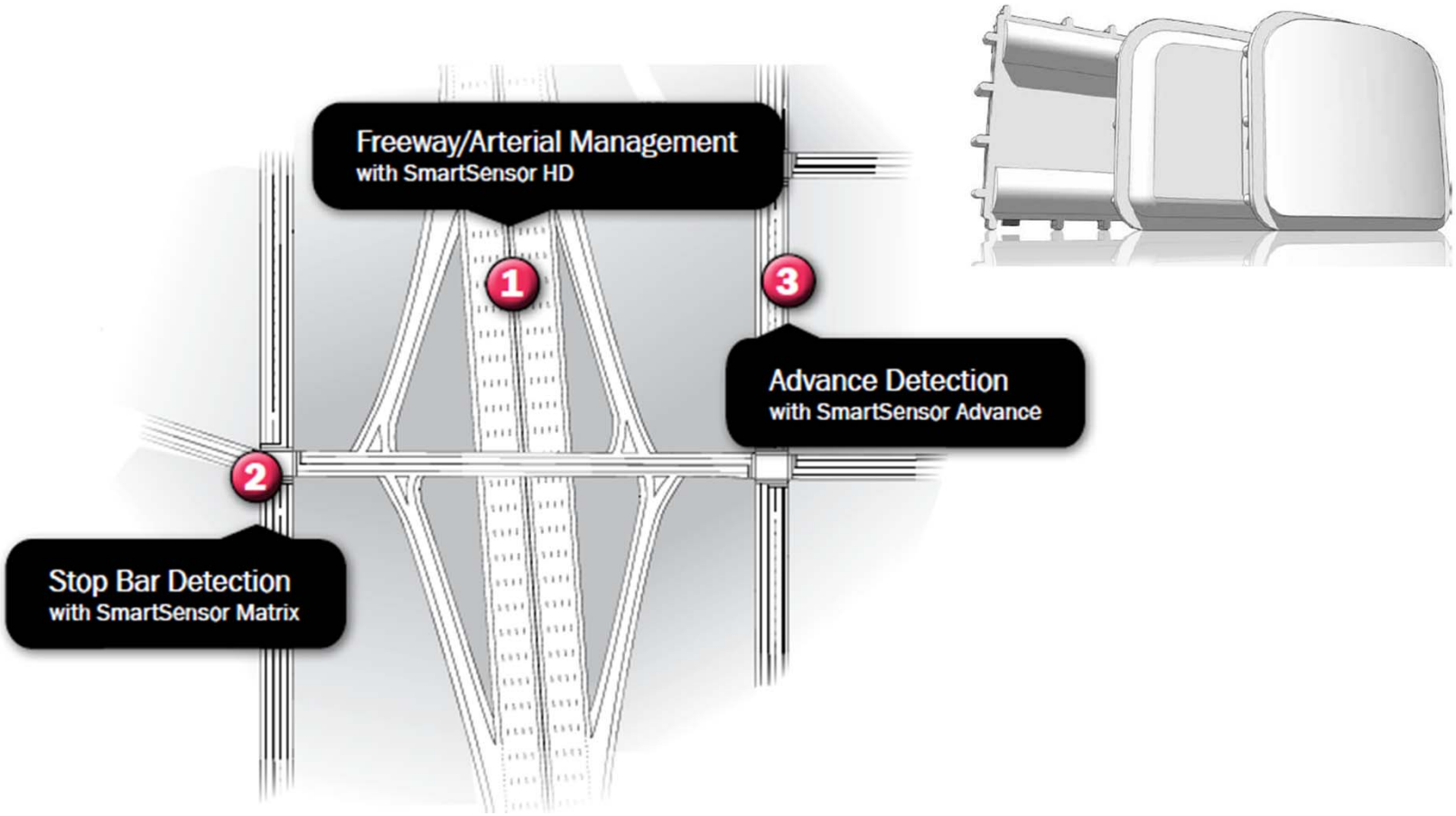
250 ft. range

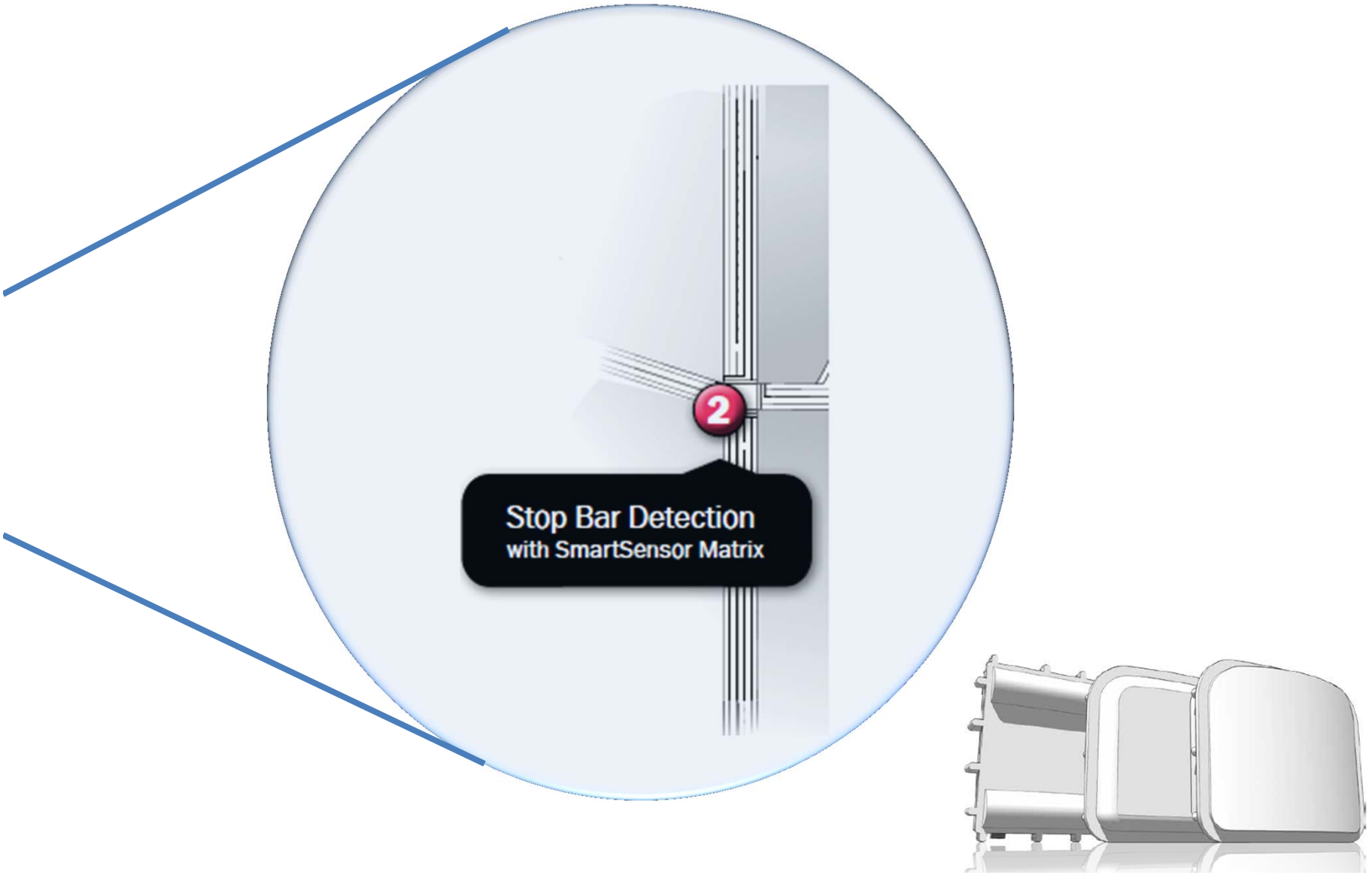


What's The *Real* Difference?

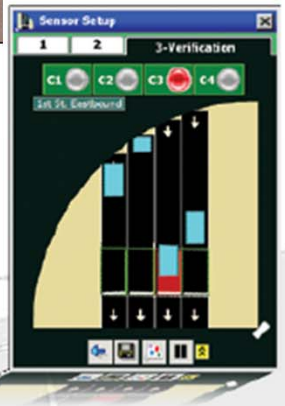


Smart Sensor Applications




2
Stop Bar Detection
with SmartSensor Matrix

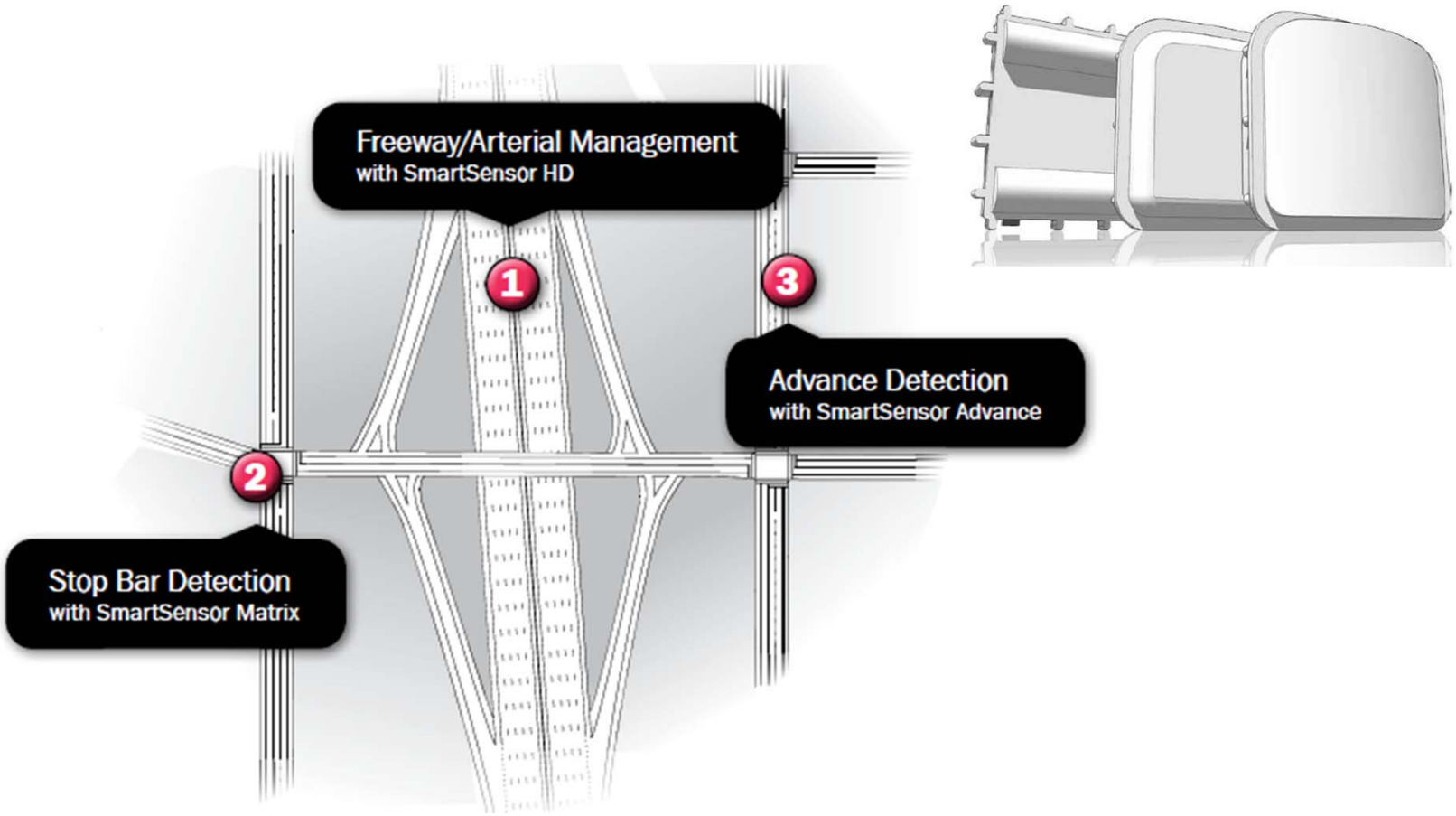
Stop Bar Detection



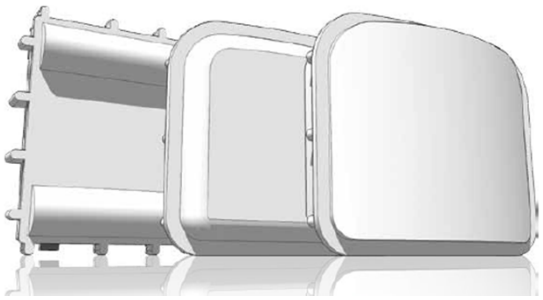
Track vehicles in individual lanes and detect true presence at the stop bar, regardless of environmental conditions.

SMART SENSOR iQ MATRIX

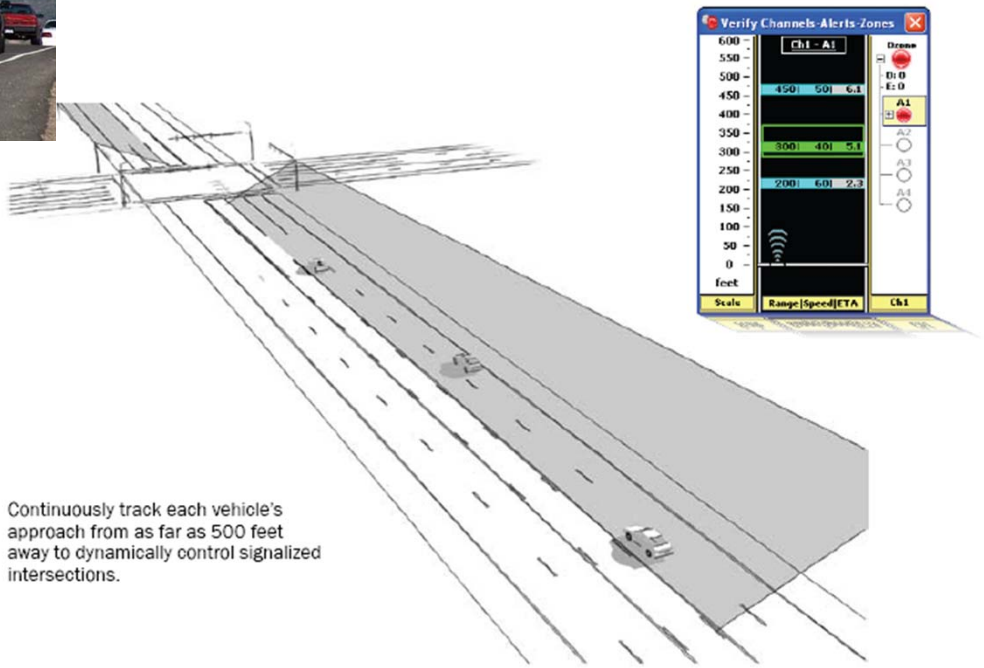
Smart Sensor Applications




3
Advance Detection
with SmartSensor Advance



Advance Detection



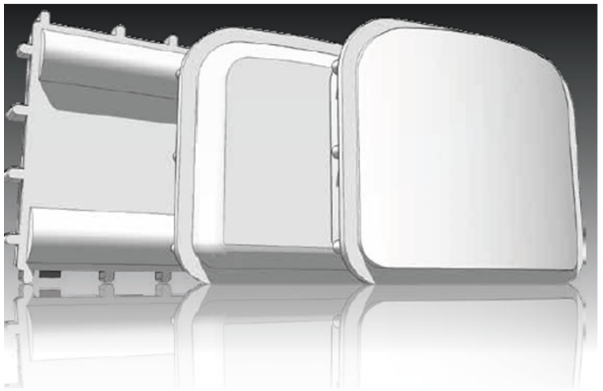
Continuously track each vehicle's approach from as far as 500 feet away to dynamically control signalized intersections.

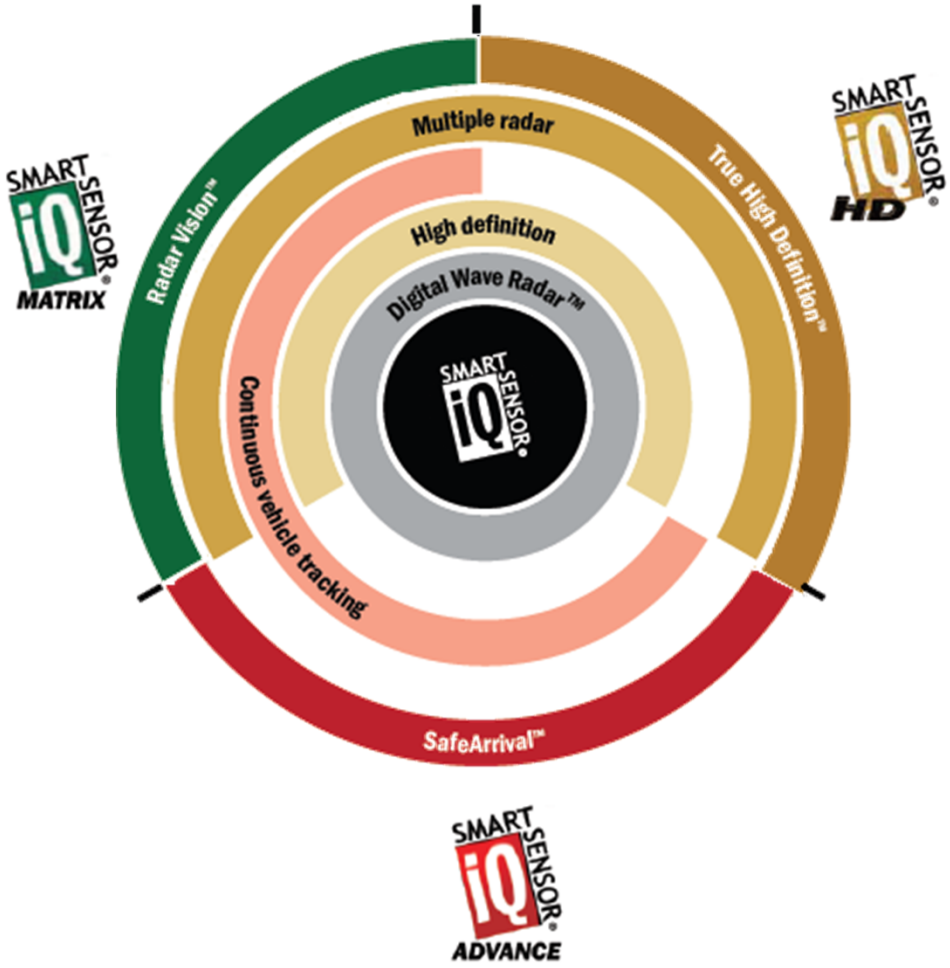
Advance Detector 82nd & Airport Way Portland

In-House Design

- Unsurpassed Accuracy
- Proven testing both internally and externally
- Created and manufactured by us.
- Designed specifically for traffic detection applications.

Core Technologies





Core Technologies

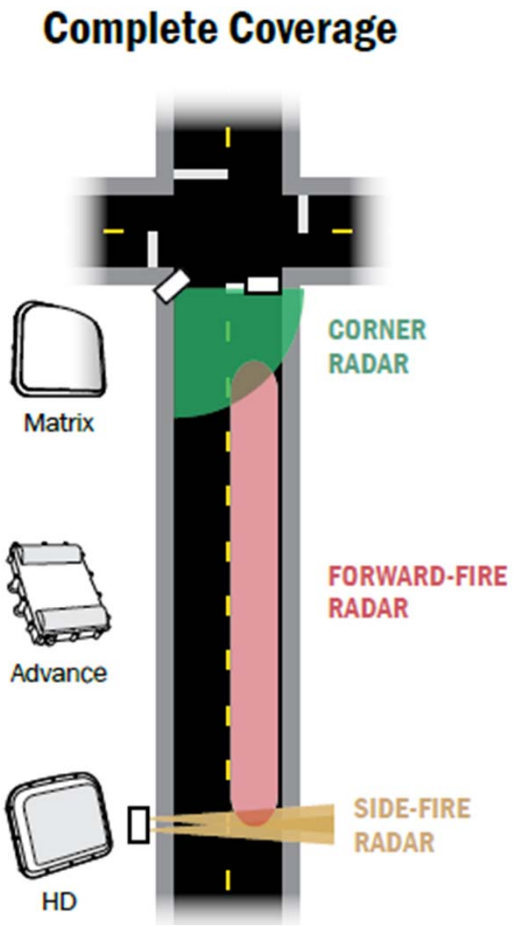
SmartSensor Matrix is built on the same tested and proven technologies found in SmartSensor HD and SmartSensor Advance. The inner rings represent shared technologies; outer rings represent unique technologies, or the ways in which core technologies have been adapted to fit each sensor's unique capabilities.

SmartSensor Technologies

Radar Vision™– SmartSensor Matrix uses a matrix of radars to create a high-contrast, two-dimensional image of an approach. It tracks distinct lanes and accurately detects presence at the stop bar without the negative effects of weather and light.

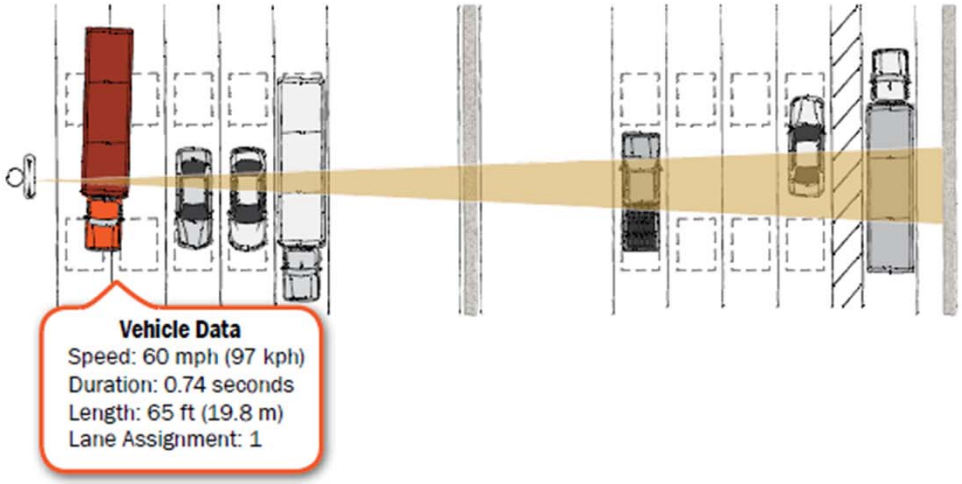
SafeArrival™– SmartSensor Advance continuously detects the estimated time of arrival of uniquely identified vehicles. It monitors each vehicle's speed and distance from the stop bar for improved intersection safety.

True High Definition™– SmartSensor HD is the first radar traffic detection device to transmit 245 MHz of bandwidth for five times greater resolution. This enables vehicle-based detection, which results in greater accuracy.

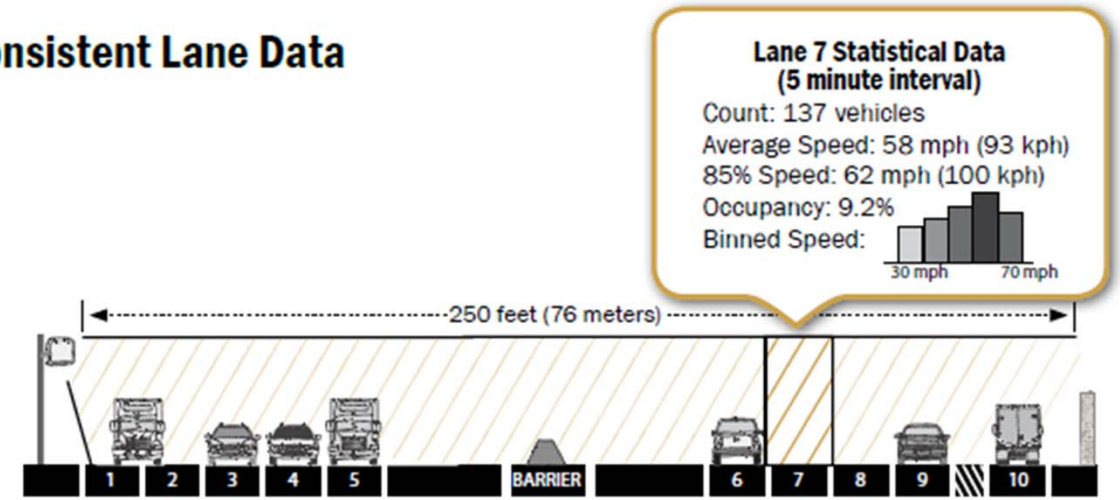


SmartSensor HD

A **Accurate Vehicle Detection**



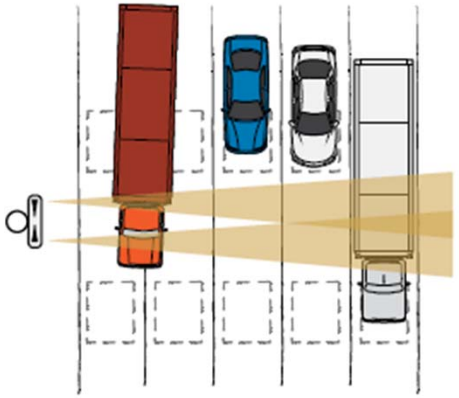
B **Consistent Lane Data**



	SmartSensor HD	SmartSensor 105
Detection Type	Vehicle based	Lane based
Per Vehicle Speed	± 5 mph	NA
Lane Speed	85%, Average, Binned	Average
Resolution/Bandwidth	2 ft (0.6 m)/245 MHz	10 ft (3 m)/45 MHz

C Dual Radar

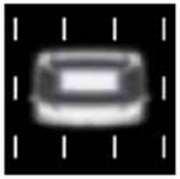
Dual Radar creates a speed trap to enhance per vehicle speed accuracy.



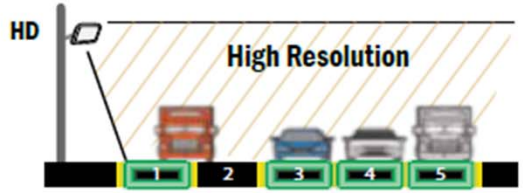
D High Definition

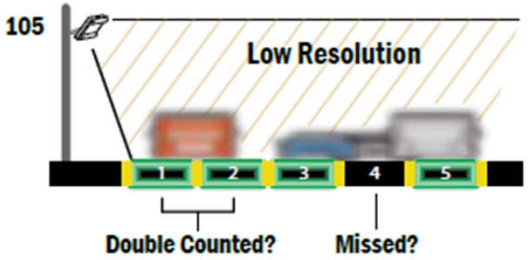
HD Digital Wave Radar™ transmits 245 MHz of bandwidth to achieve high resolution, which improves count accuracy.

High Resolution



Low Resolution





Anticipated Life Expectancy

- 2 Years
- 4 Years
- 5 years
- 8 years
- 10 years
- 12 years
- 15 years

Pre Set-Up Snake River

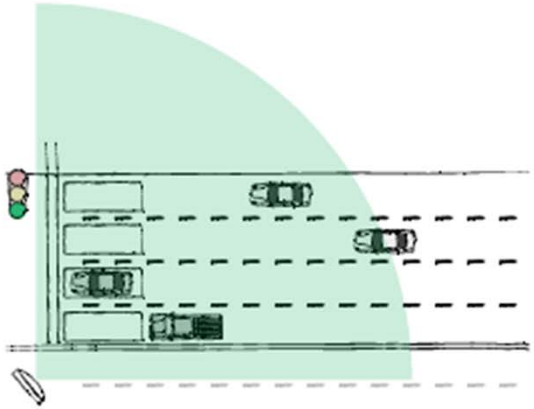
Gresham, Oregon Portable Unit
3 years ago…

Staley's Junction (Hwy 26 Oregon) Variable Speed Limit Project

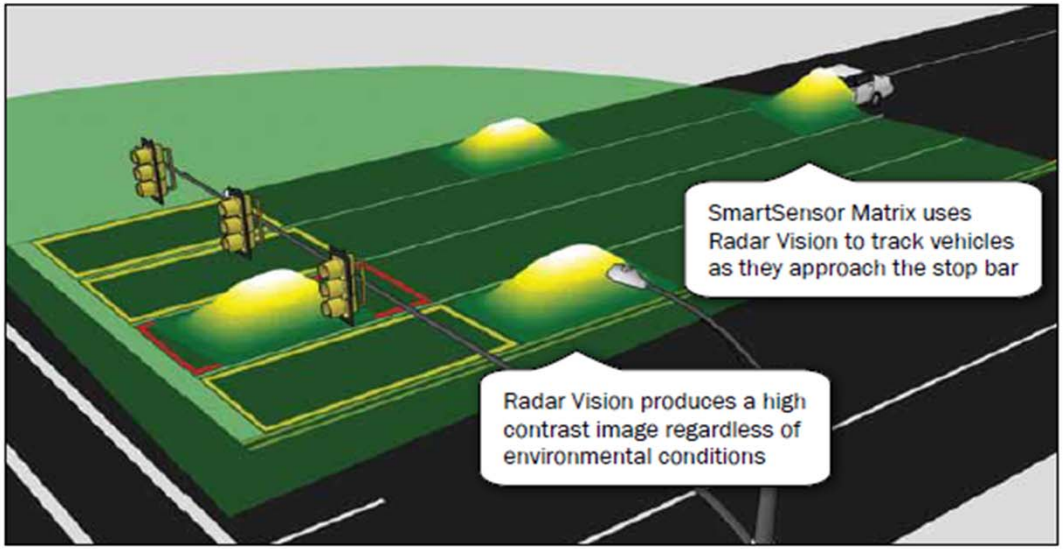
SmartSensor Matrix

A Reliable Presence Detection

SmartSensor Matrix is a corner radar with a 90° field of view. Vehicles that enter the user-defined zones within this field of view alert the controller with a presence detection.



B Radar Vision



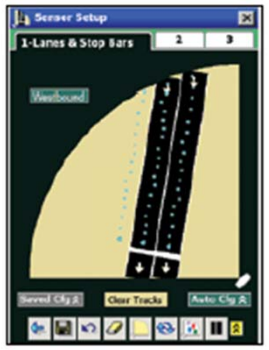
SmartSensor Matrix

View: 90°	**Lane Discrimination**
Range: 100 ft.	**True Presence**
Visualization: Two-Dimensional Image	**All Weather**
Max Zones: 8	**All Lighting Conditions**
Max Contact Closure Outputs: 4	**Simple Configuration**

C

Simple Configuration

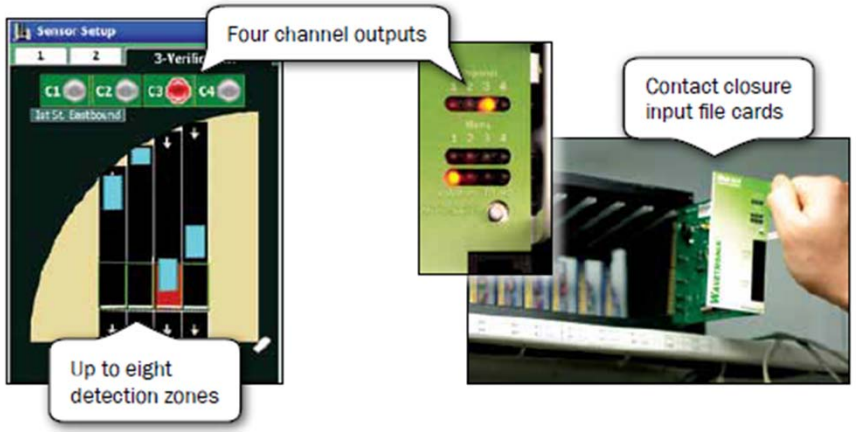
With auto-configuration, traffic visualization, and intuitive click-and-drag functionality, sensor setup is quick and easy.



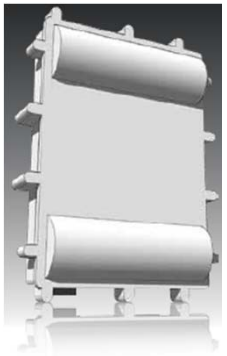
D

Controller Integration

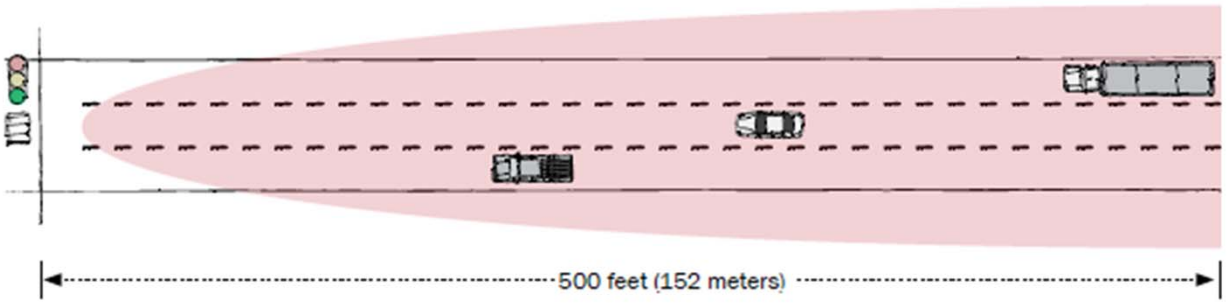
SmartSensor Matrix provides a standard interface to traffic signal controllers.



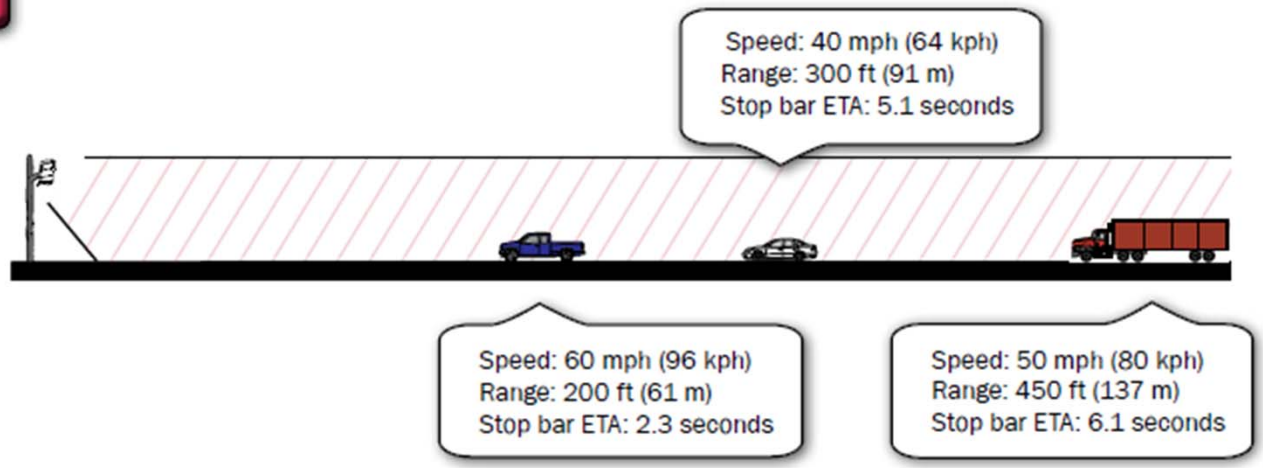
SmartSensor Advance



A Long-Range Advance Detection



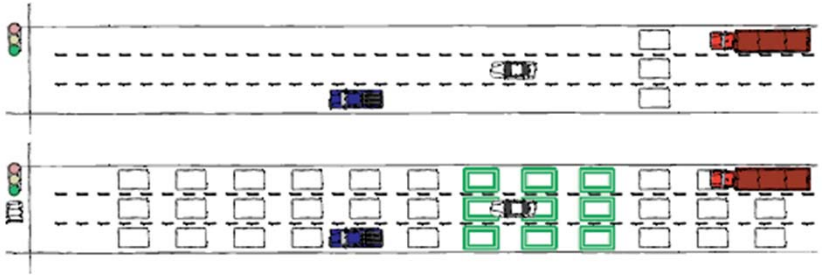
B Continuous Vehicle Tracking



	SmartSensor Advance	Loop
Field of View	Long range	Small area, discrete point
Monitoring	Continuous tracking	Single measurement
Detection	Changing range, speed, ETA and qualified count	Presence
Zones	Dynamic activation within zone limits	Fixed point
Call Placement	Based upon multiple criteria to increase effectiveness	Based upon occupancy, limited application

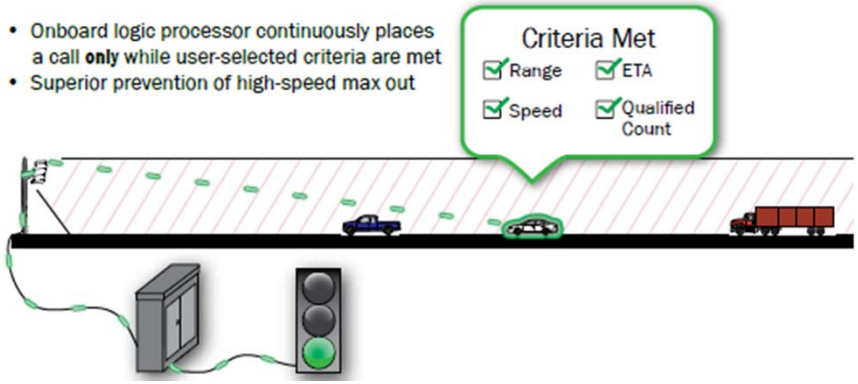
C Dynamic Zones

- Equivalent to a series of loops that are selectively activated
- Actively adjust the location of zone limits based upon ETA and speed
- Increase safety and efficiency



D Criteria-Based Signaling

- Onboard logic processor continuously places a call **only** while user-selected criteria are met
- Superior prevention of high-speed max out



What other technologies are out there

1. Loops
2. Road Tubes
3. Radio Pucks
4. Video
5. Other brand of radar (Single Beam)
6. Infra-Red LED

Vehicle Detection

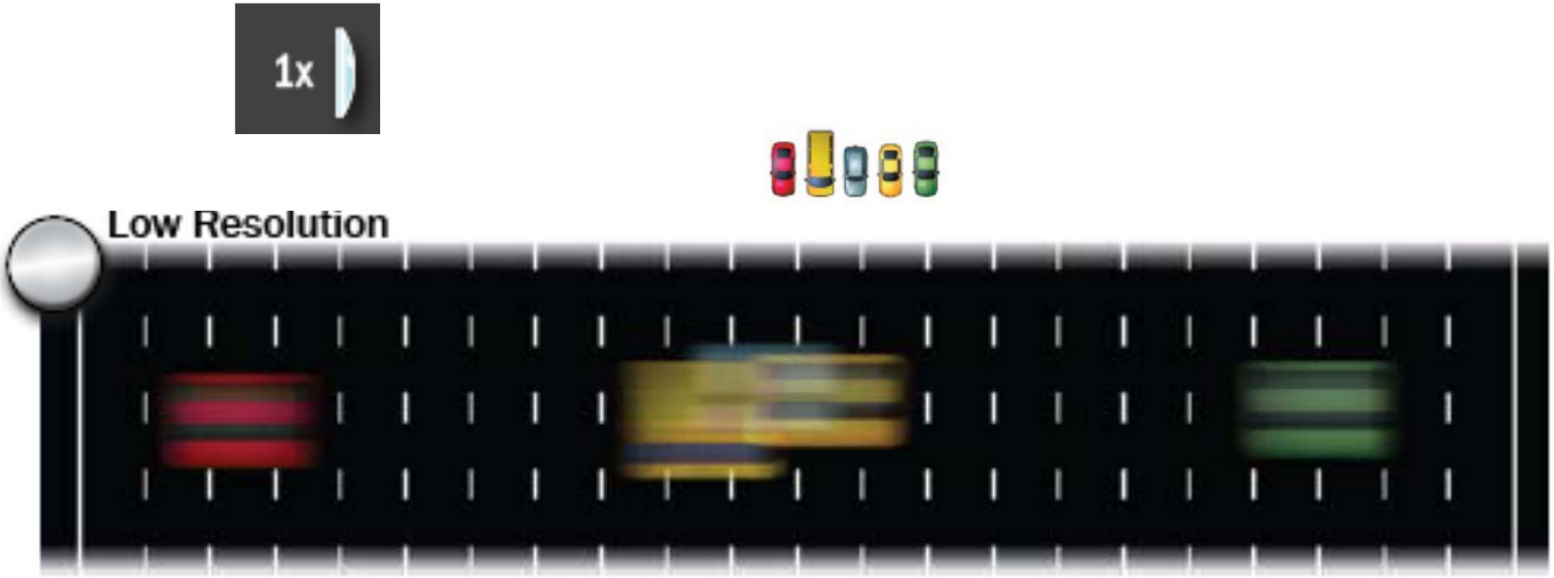
Radar as you know it has Change

Three Generations of radar have been developed

1st Generation Radar X2-X3

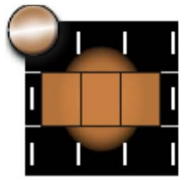
1992 – Present

This 1x lens image illustrates what first and second generation radar sees. At lower resolutions, vehicles blur across lanes and are indistinguishable.



1st Generation Radar

- Bandwidth approximately 45MHz (at 10.5GHz)
  - Provides a Zone resolution of 10 feet
  - Range Bin Size 10 feet

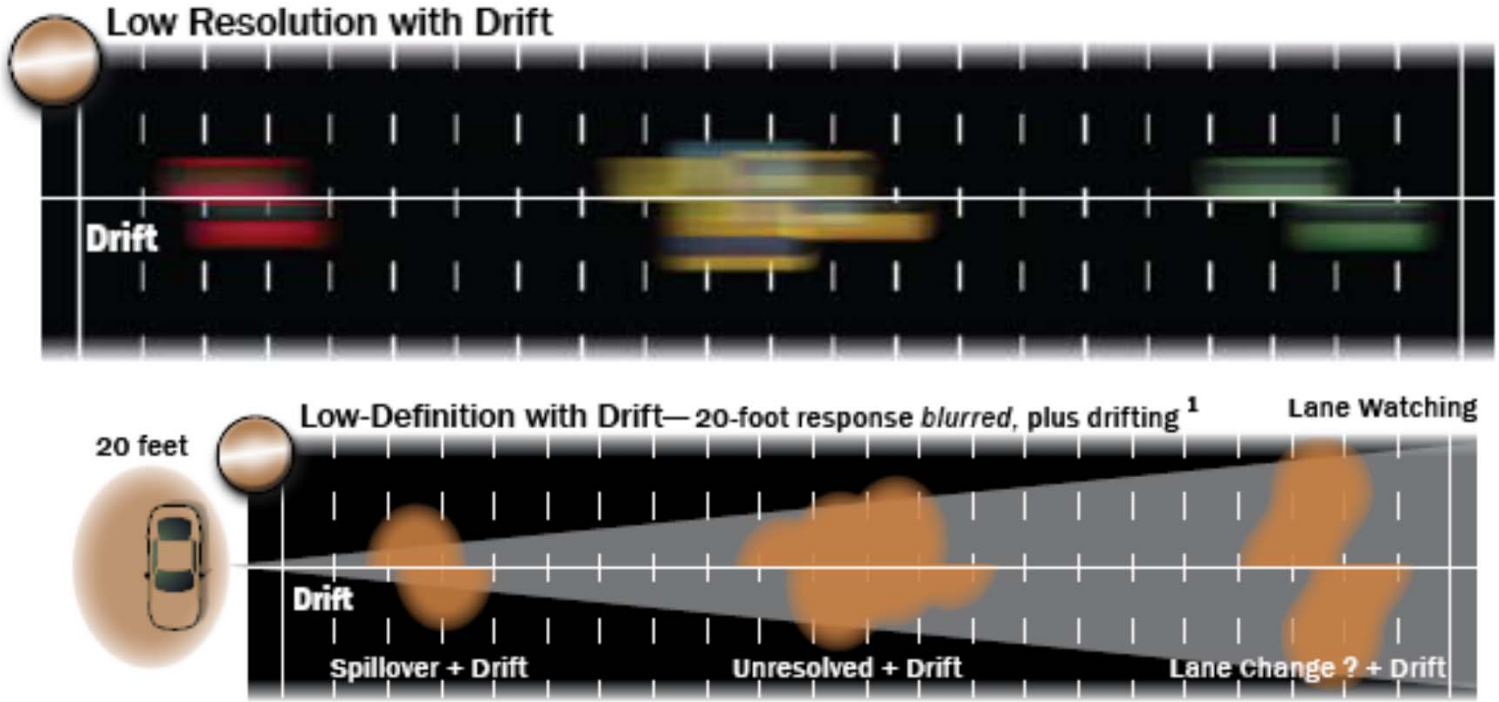


  - Range Bin size is not Zone Resolution
    - Zone Resolution is a product of Bandwidth

1st Generation Radar

In addition to low resolution you had a range stability issue with a no lock Factory set frequency

Now over time and temperature there was a shift in frequency of up to one full lane

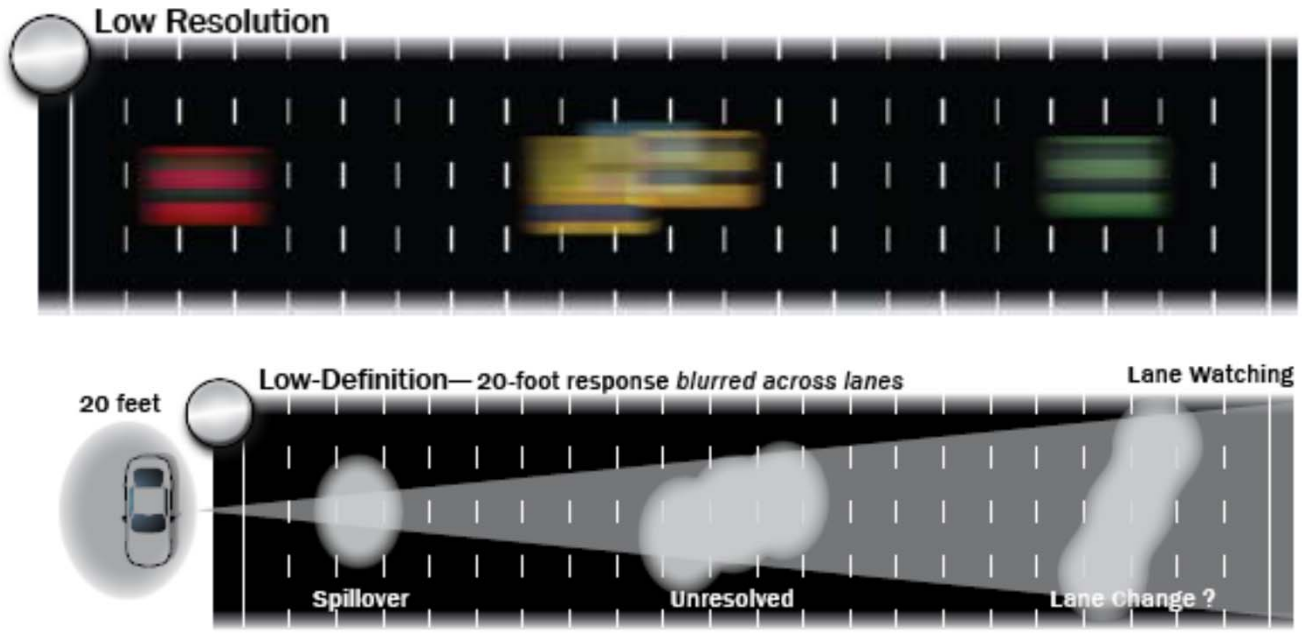


NOTE

- With the first generation (analog) radar the unit had to have equal distance between each lane in order to collect accurate data.
- It was not tolerant of variations and could require hours (if not days) of set-up to even get close.
- Temperature changes could throw it off. Snow, heat, etc.

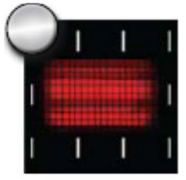
2nd Generation Radar – SS105

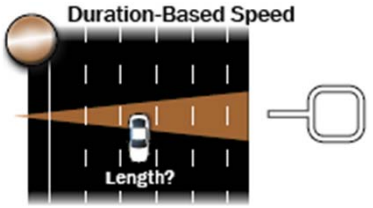
- Unlike X2-X3 – Doesn't drift
- Uses Digital Reference Fast Lock



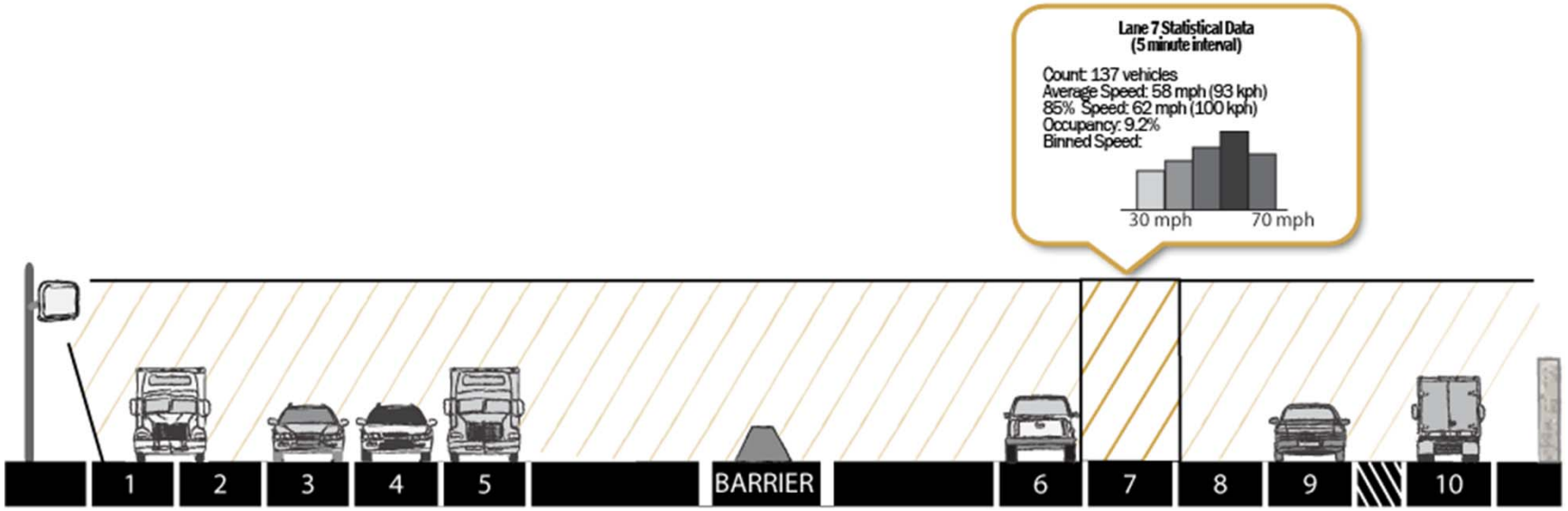
2nd Generation Radar – G4

- Resolution of 10 feet
- Improving Pixel Density per lane to 9
- Still uses Duration based Speed
  - Assumes vehicle length
  - Average lane speed changes with density of traffic
- Field of View slightly improved to 50 degrees
  - Claiming 250 feet but difficult to achieve



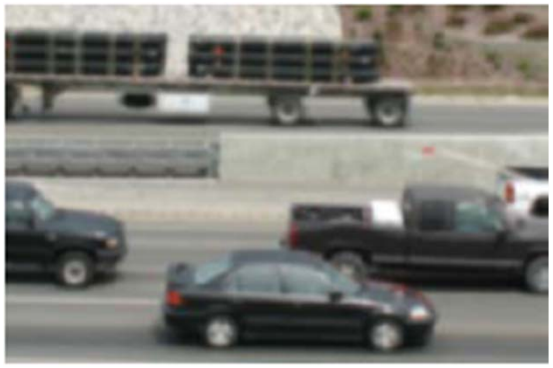


65 Degree Field of Vision
Finds the vehicles



3rd Generation Radar – SS125HD

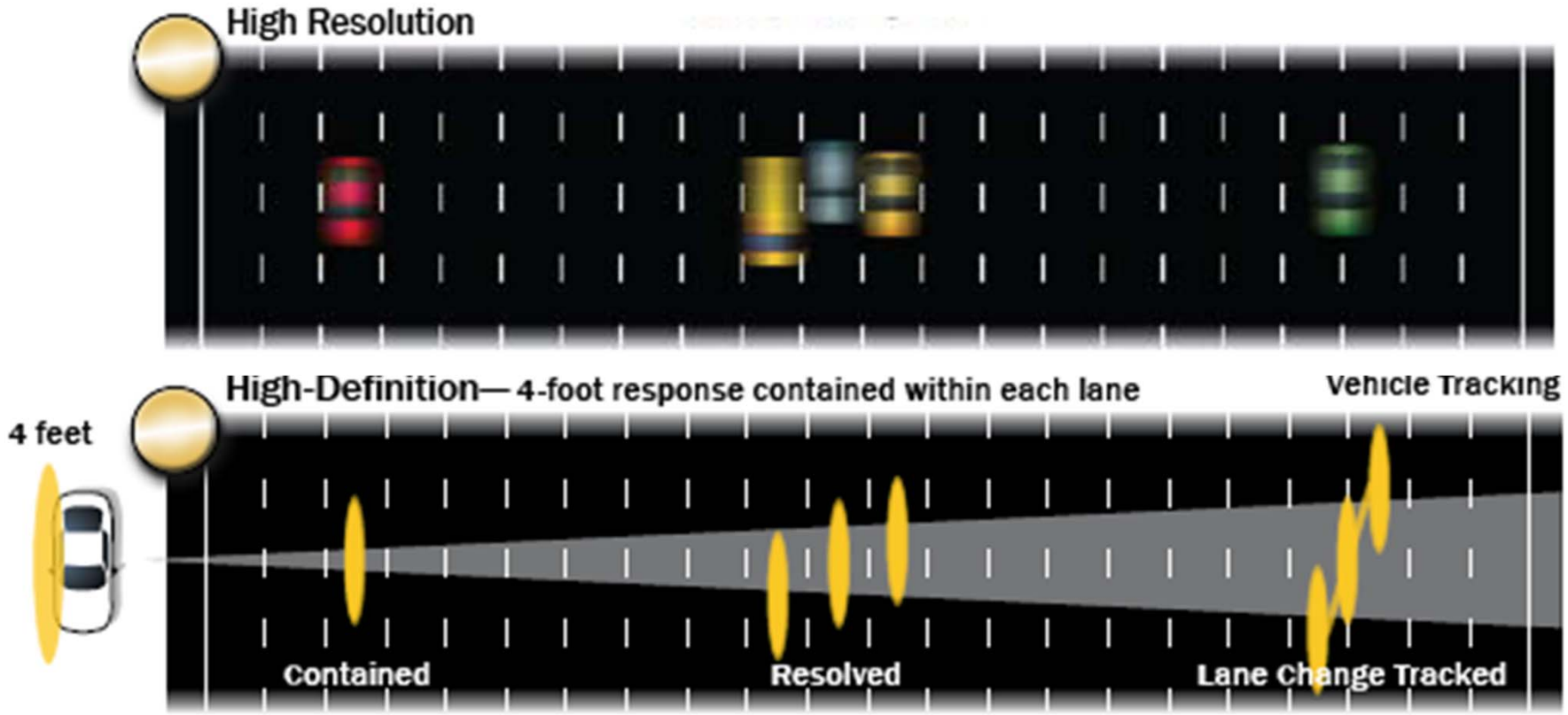
2006 - Present



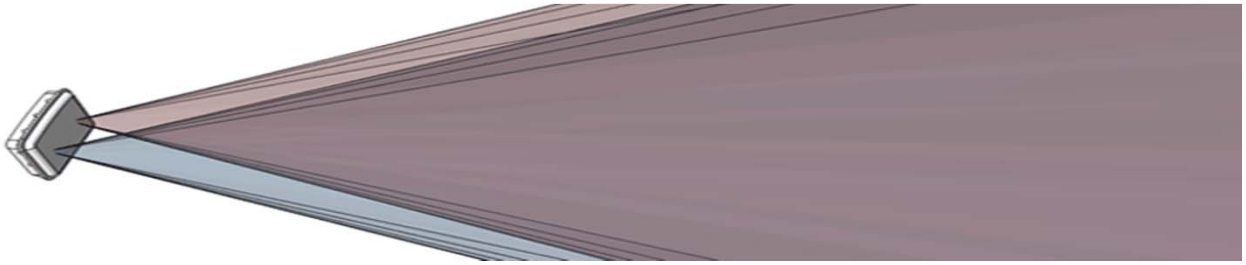
Uses Higher resolution – 240 MHz
(24.1GHz) True High Definition Vehicle Based Detection

3rd Generation Radar – SS125HD

- Unlike 1st Generation – Doesn't drift
- Uses Constant Lock Digital Synthesis



Why you would want the HD Sensor.



- **Non-Intrusive Installation**
- **Graphical User Interface**
- **Auto-Configuration**
- **All Weather, All Light Performance**
- **HD Digital Wave Radar**
- **Vehicle-based Detection**
- **Dual Radar**
- **Per Vehicle Speed**

Rural Advantages

- Non-Invasive/Non-Intrusive
- Low Power consumption
- Long Life
- Portable – 1 unit may be used for small or large roads
- Easy to set-up and configure

Rural Applications

- Counts
- Too big/too fast
- Dilemma Zone protection – High speed intersections
- Chain-Up Zones (Durango, Colorado)
- Wildlife Detection (Colorado)
- POE Detection

Get More

- www.wavetronix.com
- www.advancedtraffic.com
- Pulse Magazine

Articles, applications, information

tim@advancedtraffic.com