



# Iteris Vantage Vector®

## A Case for Speed Sensitive Radar and Video Detection

### Detection needs have changed.

The purpose of detection at traffic signals has shifted dramatically in recent years. In the past, detection was placed on an approach to simply notify the traffic signal controller that the approach was occupied to provide vehicle calls and extensions. The need to detect more than vehicles and the need for data has changed everything.

With the increase of multi-modal users, the demand for detection to understand the entire mix of traffic, including bicycles and pedestrians, has increased. Performance enhancements in detection help the controller make smarter, safer decisions. Safety applications using speed-sensitive detection include protection of vehicles caught in the decision zone and prevention of crashes due to red-light runners.

In addition, today's high performing detection sensors provide the input needed for Adaptive Control and Signal Performance Measures (SPM). It is no longer adequate to simply know that an approach is occupied. The detection system must also provide how many vehicles and where they are located on the approach.

### What detection technology can do all this?

There is no single technology capable of providing the detection that is needed at an intersection today. The speed sensitivity of radar can provide intelligent outputs for decision zones and red-light running decision-making. The vision of video detection can distinguish between vehicles, bicycles, and pedestrians at the stop bar. So, which one is the best? Both.



Decision zone detection can provide inputs to the controller to hold a phase green while vehicles are in the **decision zone**.

The Iteris Vantage Vector sensor combines both detection technologies into a single hybrid unit. The sensor includes a speed-sensitive radar with a high-resolution video detection camera to provide everything that is required of intersection detection today.

Utilizing the advanced algorithms in the radar unit, the Vantage Vector tracks all approaching vehicles, providing extremely accurate range, lane position, and speed data of each individual vehicle. The Vantage Vector radar has two modes of operation, trip-line, and lane-by-lane radar zones. These two modes allow the Vantage Vector to address both safety and data collection applications.

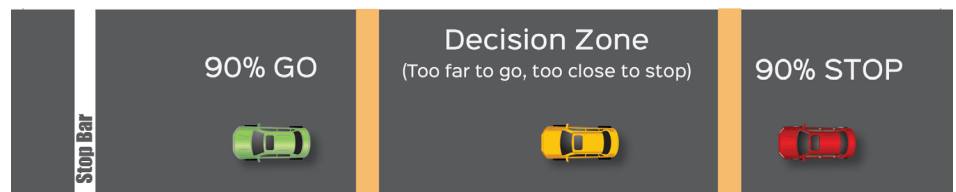
The Vantage Vector also has a fully functional video detection sensor with all the functional advantages of video detection including stop bar presence detection, bicycle discrimination, pedestrian detection, and high-quality video for traffic monitoring at a traffic management center.

## Speed-Sensitive Radar Applications

### Decision Zone Protection

A primary safety application of the Vantage Vector is the detection of vehicles in the decision zone. Speed-sensitive advance radar tracks vehicles upstream to inform the controller when vehicles are in the “decision-making” dilemma zone (**decision zone**).

On higher speed approaches, driver reaction to a signal turning yellow varies greatly. High rear-end crashes occur if the signal goes yellow at the “wrong time.” Decision zone detection can provide inputs to the controller to hold a phase green while vehicles are in the decision zone. Based on studies originally conducted in the 1970’s (1,2,3), a physical distance on the approach exists where 90% of vehicles will choose to go through the intersection at the onset of yellow. There is also a physical distance where 90% of vehicles will choose to stop at the onset of yellow. In between, there is a mix of decisions to go or stop that is often influenced by the driver’s aggressiveness.



Inconsistent decisions made to go or stop in this area can lead to an increase in rear-end crashes if the following vehicle did not make the same decision. A way to reduce rear end crashes is to make sure that the green is not terminated when vehicles are in the decision zone.

The location of the decision zone is based on the speed of the vehicle. Speed-specific zones are established for each viable approach speed. The ability to track the speed of each vehicle individually will provide the correct inputs to the controller’s timing

strategy to hold the signal green until vehicles in the dilemma zone can safely make the decision to “go” or “stop.” If they are traveling at speeds slow enough to stop, they will not trigger the detection.

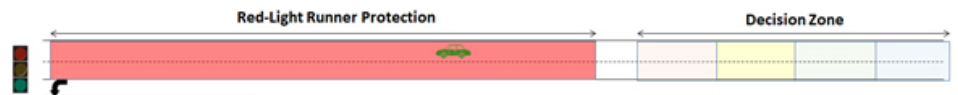
The control strategy for decision zone protection utilizes up to four separate detection zones for varying vehicle speeds including a speed-sensitive intermediate zone to ensure queue clearance and a stop bar presence zone. The speed-sensitive zones upstream on the approach are provided by the radar sensor of the Vector. The stop bar presence zone is provided by the video detection sensor of the Vector.



Combining video detection for stop bar presence with speed-sensitive trip lines within the Vector allows the user to create total coverage of the approach to ensure that high speed vehicles are detected, and the proper outputs are sent to the controller. This will reduce vehicles caught in the decision-making dilemma zone while still maintaining an efficient operation when vehicles are not in the decision zone.

### Red-Light Runner protection

Decision zone detection is designed to hold a phase green while a vehicle is within the decision speed and distance threshold. Speed sensitive detection can also be used to hold the red clearance timing to allow a vehicle that is not going to clear the intersection to safely run a red light. Some manufacturers of traffic signal controllers can delay the start of an opposing green signal with a detection input indicating that a vehicle is traveling at a speed on the approach that is not likely to stop and will not clear the intersection before the end of red clearance. Placing one or more of Vector’s speed-sensitive radar zones at a distance where it can be determined that a vehicle is not stopping will provide the necessary controller input. Vehicles going under the set speed can safely stop and will not trigger the red clearance extension.



## Video Detection Applications

### Automatic Turning Movement Counts

With the Vector video detection sensor, vehicles are tracked from the time they enter the field of view until they exit the field of view. By knowing where a vehicle leaves the field of view, the Vector can determine if the vehicle made a right or left turn or went straight after departing the stop bar. These counts are binned by turning movement or



[Watch bicycle detection video](#)



[Watch pedestrian detection video](#)

an output is available to the controller per movement per lane for high-resolution data logging for SPM. Once the movement decision has been made for a vehicle, a detector channel call is placed to the controller for the channel assigned to that movement. So, each vehicle on the approach will create a detector on/ detector off event for the appropriate channel to be tallied by the SPM tool.

### Bicycle Detection and Differentiation

As with all Iteris video cameras, there are algorithms embedded in the software to accurately detect and differentiate bicycles approaching the stop bar. The Vector has this functionality embedded within the processor and allows agencies to perform this detection simultaneously with vehicles. By providing the ability to differentiate bicycles, agencies can program the signal timing for accommodation of the slower moving bicycles to get through the intersection before the phase changes, ensuring a safer passage.

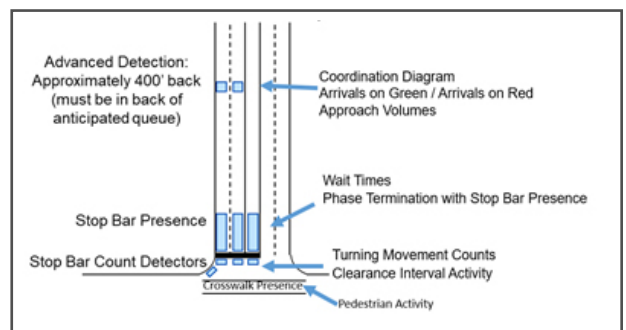
### Pedestrian Detection

Because video detection can differentiate the shape, motion, and location of objects in the field of view, the Vantage Vector can recognize when a pedestrian is in the crosswalk and send an output. This feature has been used for Connected Vehicle (CV) applications to alert turning buses to potential pedestrian conflicts. A traffic signal controller can log this detection output where it is available for use in SPM. Iteris SPM currently charts when a pedestrian was in the crosswalk against the pedestrian clearance interval to help traffic engineers understand the effectiveness of their pedestrian timing.

## Signal Performance Measures (SPM)

The optimum detector placement for SPM data collection includes detection in front of the stop bar (stop bar count detectors or Automatic Turning Movements), stop bar presence detectors, and lane-by-lane advance detectors, each on a separate channel. Knowing where vehicles are located on the approach in relation to the signal indication, allows SPM to provide insights to the operation of the intersection.

Video detection at the stop bar is ideal for SPM and data collection because not only can it recognize and output turning movements, but it can also distinguish between vehicles, bicycles, and pedestrians. The Vector's output to a high-resolution data logging enabled controller enables SPM products to visualize multi-modal use of the signal.



Although video detection is ideal at the stop bar, it may not accurately distinguish between vehicles farther upstream due to same lane occlusion caused by the angle of

the camera. For SPM, the ability to detect and output a separate channel for each lane is important in being able to count individual vehicles on the approach in relation to signal indication. Advance detection on the mainline is used by SPM to project vehicle arrivals at the intersection and determine if vehicles are arriving on green or arriving on red. This is an important metric in determining the effectiveness of coordination. The advance detection should be behind any anticipated queue. Any vehicles queued past the detection, will trigger the detection during the green and show up as an arrival on green. Lane-by-lane advance detection on the cross-street is important in SPM to determine delay and queue length metrics.

## Adaptive Control Systems

Many adaptive control systems use a detection layout similar to the requirements for SPM. Stop bar presence, stop bar count, and advance detection zones are common requirements for adaptive control algorithms. A critical requirement is lane-by-lane data at both the stop bar and in advance of the intersection. As shown earlier, the stop bar presence is provided by the video detection system. Adaptive control systems require detection on the approach prior to the anticipated end of queue (typically 400ft from the stop bar). The lane-by-lane advance radar detection in Vector provides better approach count data than either trip line radar systems or video detection systems.



## Summary

The Vector Hybrid Sensor from Iteris is truly a one-of-a-kind product that can provide the detection that is required today to improve intersection safety, enhance efficiency, and provide the data needed for traffic engineers and Adaptive Control Systems to make better operational decisions. Please visit [www.iteris.com](http://www.iteris.com) for more information on Vantage Vector and the complete line of Iteris detection systems.

### References:

- [1. Parsonson, P.S., R. W. Roseveare and J.R. Thomas, Jr. Small-Area Detection at Intersection Approaches. Traffic Engineering, Vol. 44 No. 5, 1974 pp.8-17.](#)
- [2. Zegeer, C.V. and R.C. Deen. Green Extension Systems at High-Speed Intersections. ITE Journal Vol. 48, No. 11, 1978, pp. 19-24](#)
- [3. Chang, M.S., C. J. Messer and A.J. Santiago. Timing Traffic Signal Change Intervals Based on Driver Behavior. In Transportation Research Record 1027, TRB, National Research Council, Washington, D.C. 1985, pp. 20-30.](#)