Video Detection Zone Design and Phase Extensions

Having accurate well calibrated vehicle detection is a fundamental requirement for optimal signal operations. The primary function of vehicle detection at traffic signals is to let the traffic signal controller know that there are vehicles present within the detection zone; the controller will then use this information to extend or gap out movements with actuated phases based on the extension time programed for each phase. Malfunctioning detection is one of the leading causes of higher delays, frequent stops, and can even result in a decrease in safety.

In the past, loop-based detection and early video detection would create a detection zone roughly 40' in length starting at the stop-bar. More modern systems, such as the Gridsmart System, are capable of creating significantly larger zones with 80-120 foot zones being common in most installations. The FHWA Signal timing Manual provides guidance on the relationship between the length of vehicle detection zones and the programed extension time, where the maximum allowable headway between vehicles should be limited to 3-4 seconds; this ensures that there is an equable distribution of green time between all movements and increases the capacity by terminating a phase before the density drops to inefficient levels. For example, a 40 foot zone on a 25 mile per hour approach with a 3 second maximum allowable headway (MAH) results in the following extension timer calculation:

$$\textit{Extension} = \textit{MAH}^{[Seconds]} - ((\textit{Vehicle Length}^{[Feet]} + \textit{Zone Length}^{[Feet]})/(\textit{Speed}^{[MPH]} * 1.466))$$

$$\sim 1.5 \text{ seconds} = 3 \text{ seconds} - ((20 \text{ feet} + 40 \text{ feet})/(25 \text{ MPH} * 1.466))$$

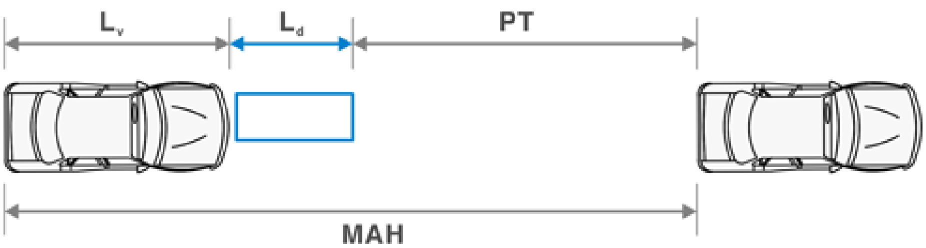

Figure 5-4 FHWA Signal Timing Manual
Lv: Length of Vehicle
Ld: Length of Detector
PT: Passage Time = Extension
MAH: Maximum Allowable Headway

This extension equation can be rearranged to find a zone length based on an extension time:

$$\textit{Zone Length}^{[Feet]} = ((\textit{Speed}^{[MPH]} * 1.466) * (\textit{MAH}^{[Seconds]} - \textit{Extension})) - \textit{Vehicle Length}^{[Feet]}$$

For the most optimal operations the detection zone length would be calibrated so that an extension would not be required, however not having an extension can lead to potential issues if vehicles are not detected correctly or if the detector has any delay. As such it is recommended that the detection zone length be calibrated so that there is a 1 second extension, proving a balance between optimal operations and some buffer for equipment imperfections. At speeds below 60 miles per hour the zone length$^{[feet]}$ for a 1 second extension roughly approximates to 2.5 times the speed$^{[MPH]}$, with negligible error.

Detector zone width and position perpendicular to the approach is largely dependent on the skew of the camera from the centerline of the approach. One camera per approach installations commonly have little to no skew and as such the detection zones are roughly placed within 1-2 feet of the edges of the lane. Single point installations will have varying skews depending on the intersection geometry and detector placement needs to be calibrated so that only the desired traffic is actuating the zone; typically, as the skew increases the zone width will decrease to limit the number of false calls from adjacent traffic.

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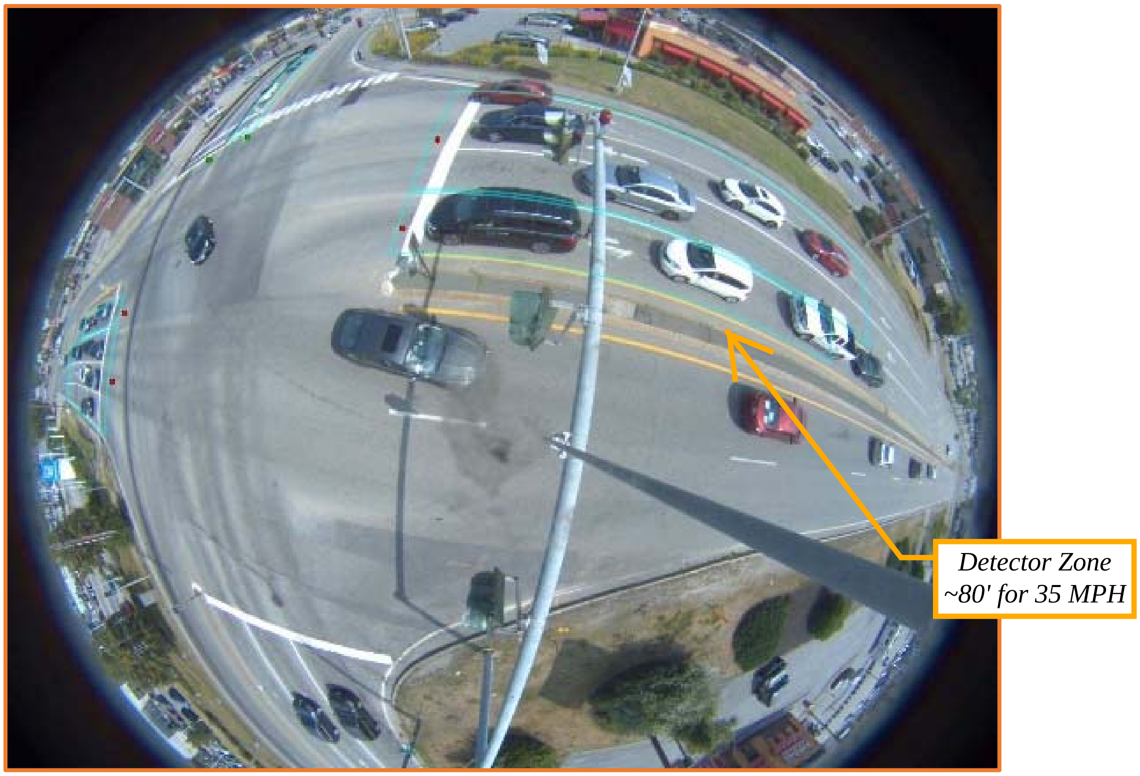
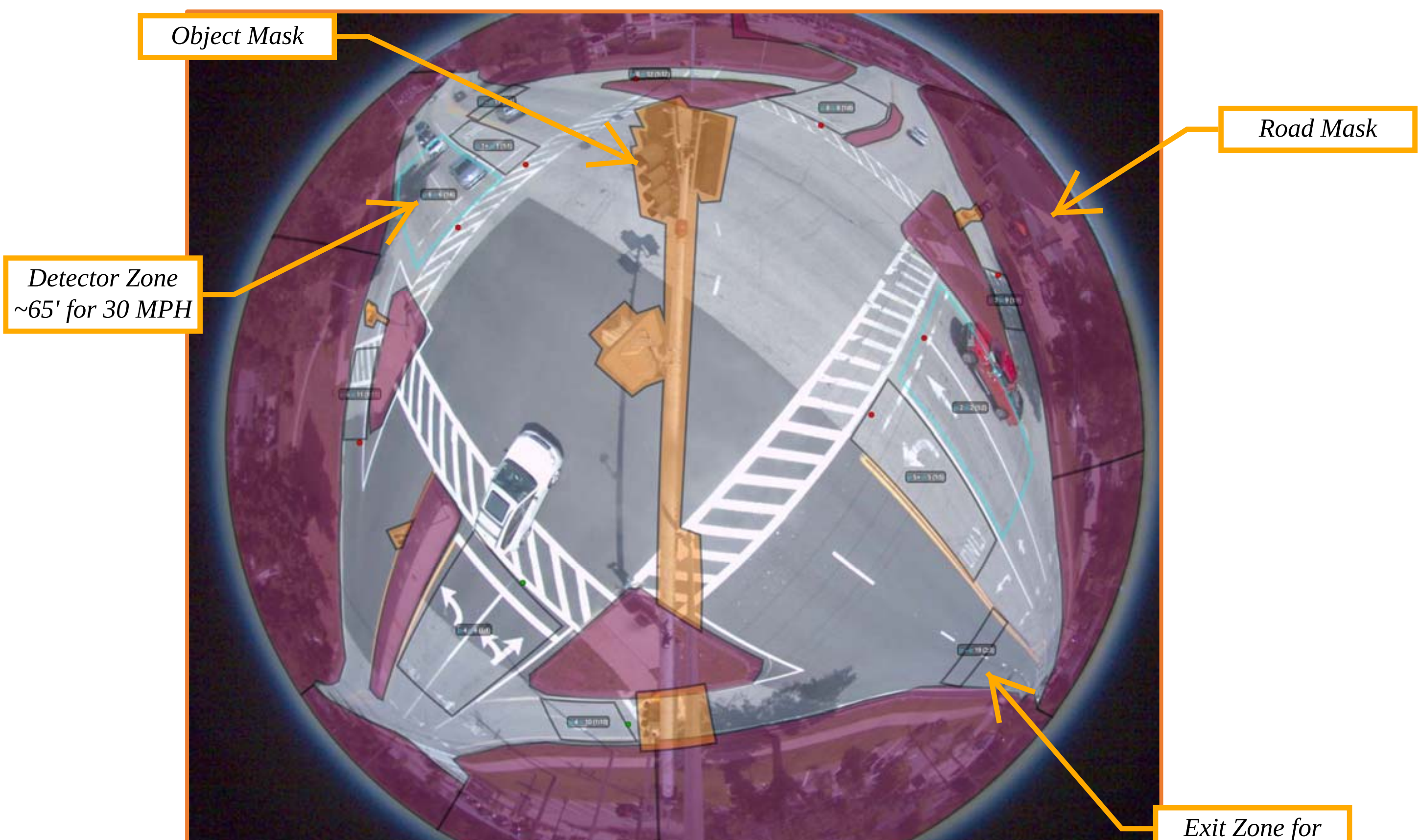


Example Zone Design for Gridsmart Detection System
Maine Mall Rd at Gorham Rd, South Portland ME



Example Zone Design for Gridsmart Detection System
Central Ave at Glenwood Ave, Dover NH

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