



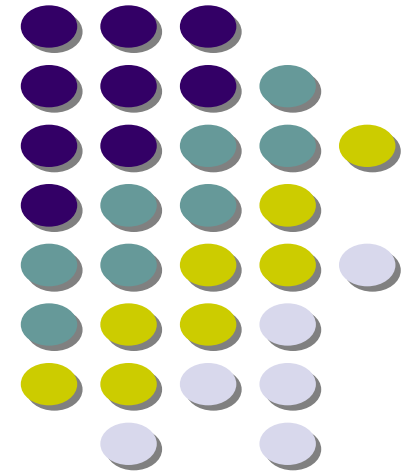
ConSysTec

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Continued Development of an Assured Green Period Concept to Support Red-Light Violation Warning Applications in Connected Vehicles

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Agenda

- Background
 - Challenges with Red-Light Violation Warning applications
 - Inconsistencies in Yellow Change Intervals
 - Issues convey traffic signal timing information through SPAT
- Assured Green Period (AGP) Concept
 - Purpose of AGP
 - Computation of AGP
- Deployment of AGP
 - Potential Integration with Controller
 - Use Cases
 - Triggering AGP
- AGP Documentation



Red-Light Violation Warning (RLVW) Challenges

- Purpose of signal change intervals
 - Yellow → right-of-way is about to occur
 - Red Clearance → clear intersection before releasing conflicting movement to enter intersection
- MUTCD Requirements
 - Yellow Change interval is a **mandatory, fixed** interval before the onset of red
 - Red Clearance interval is an **optional** (but fixed if provided) interval after the onset of red



Inconsistent Yellow Change Laws Nationwide

- State regulations concerning yellow change intervals
 - Permissive Yellow – vehicle allowed maintains right-of-way as long as it enter intersection before onset of red
 - Restrictive Yellow – vehicle must be clear of intersection before onset of red
- Some RLVW applications would trigger if vehicle is projected to still be inside intersection at onset of red

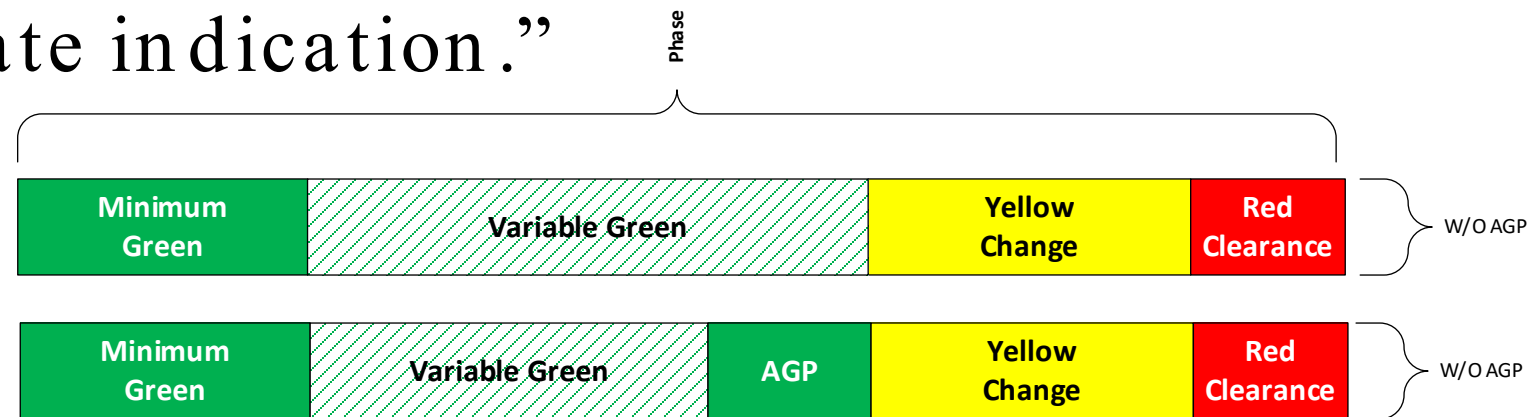


Traffic Signal Information Convey through SPAT

- SPAT = Signal Phase and Timing Messages
- Conveys to CV
 - Current movement state of the traffic signal
 - Minimum end time until the end of the current state
 - Maximum time until the end of the current signal state
 - Next movement state at the intersections
- For fixed intervals (e.g. YC), $\min \text{EndTime} = \max \text{EndTime}$
 - Vehicle knows with certainty when signals state will end
- Under actuated control, duration of greens interval can have a high level of uncertainty

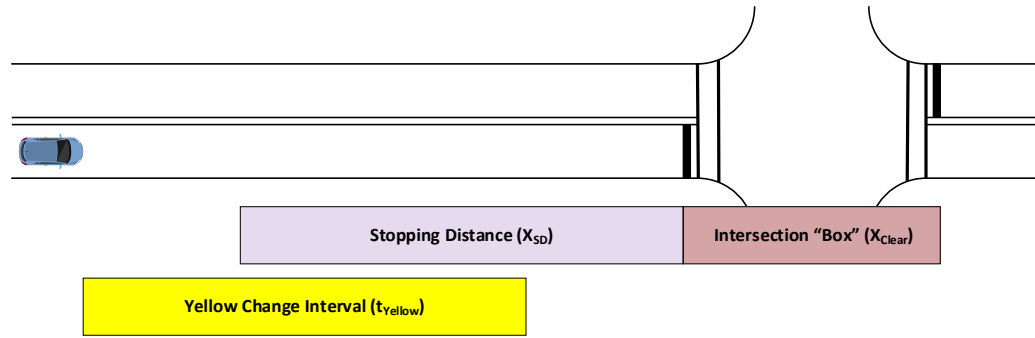
Assured Green Period (AGP) Concept

- Originally proposed as part of the *Connected Intersection Projects* between ITE, SAE, and AASHT
- “...the portion of [the] green interval for the through movements that, when combined with the duration of the yellow change interval, decreases the likelihood that a [connected] vehicle will be in the intersection during a red signal state indication.”

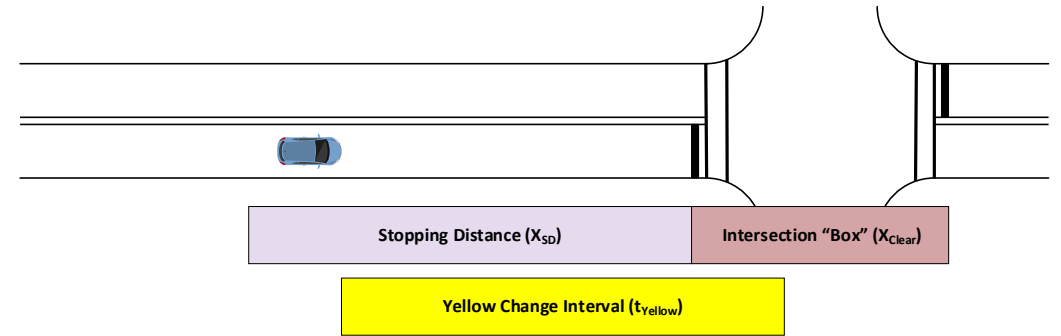




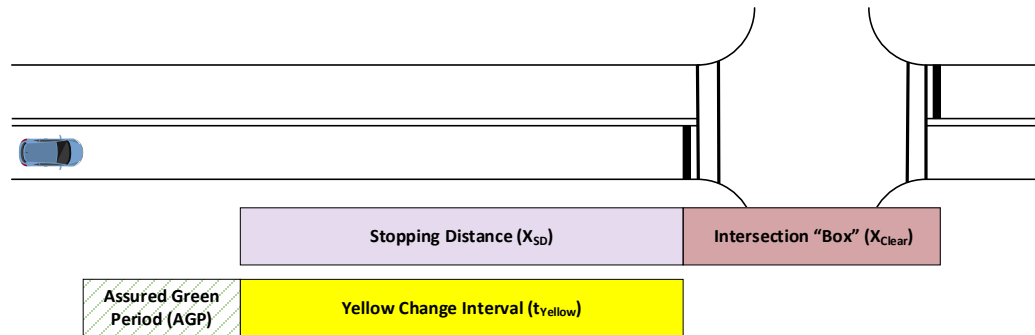
AGP Concept



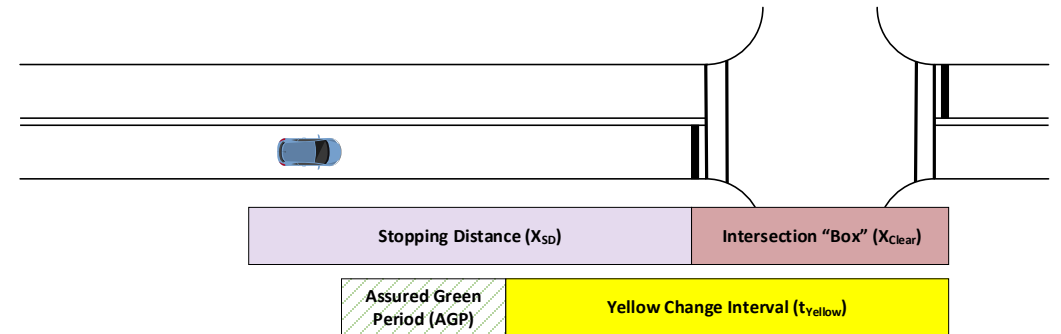
A) CV Receives Sufficient Notification that the CV can Stop Before Onset of Red



CV Receives Insufficient Notification that it can Clear Intersection Before Onset of Red



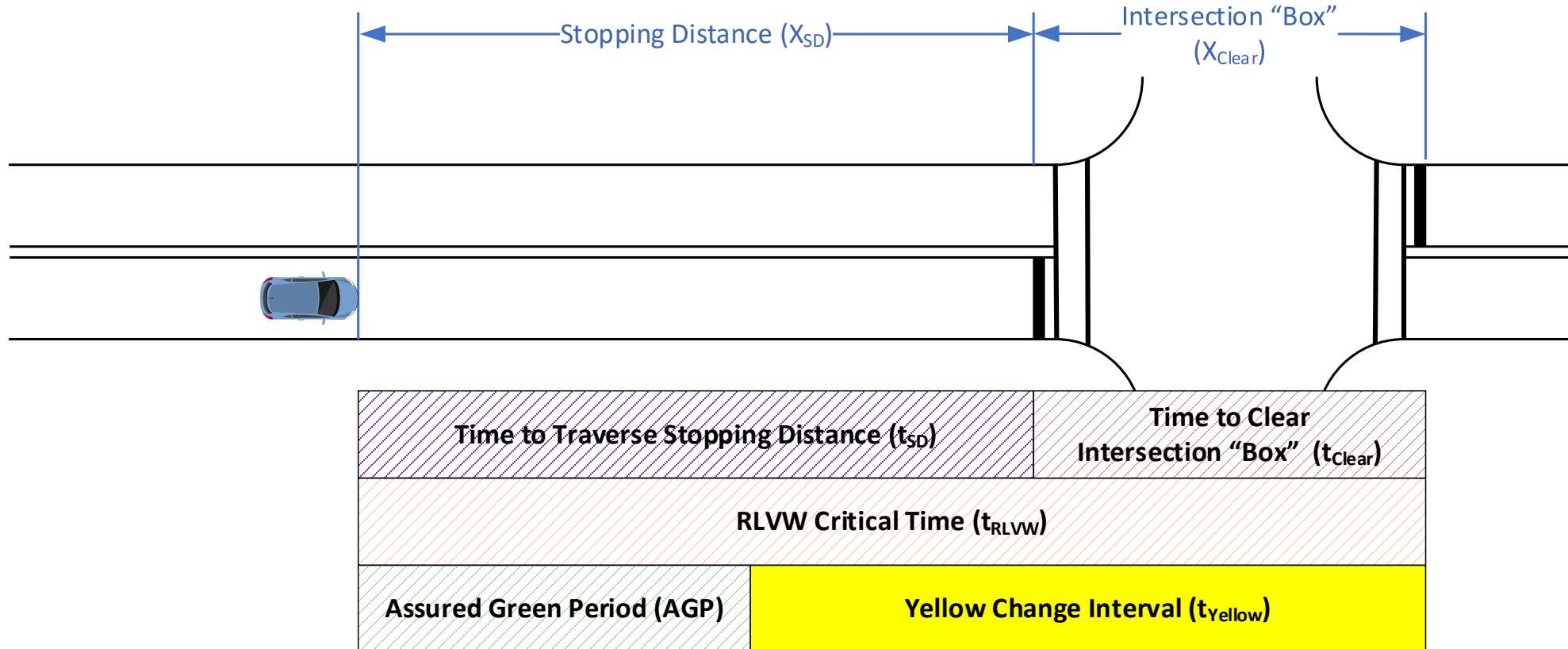
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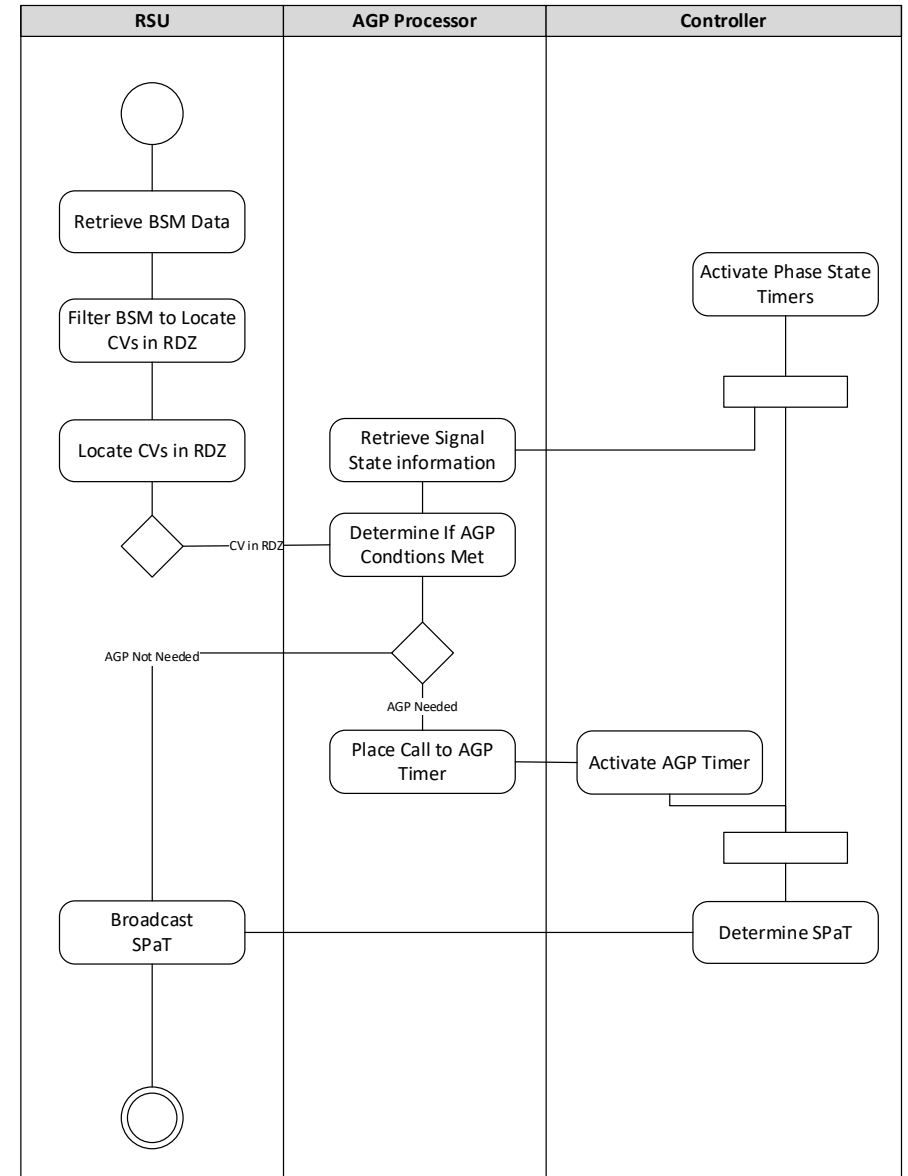
Determining the Duration of the AGP





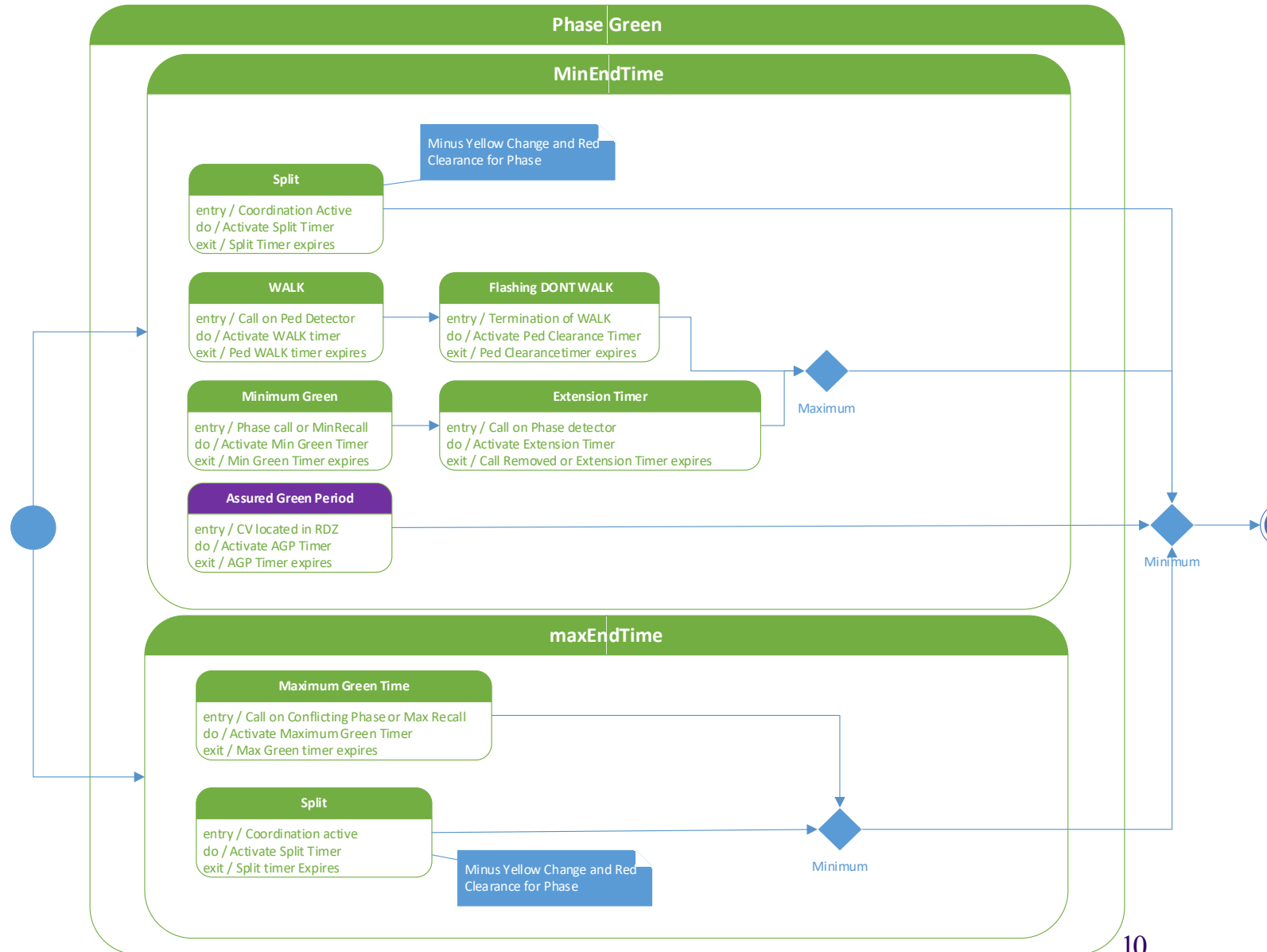
Application of AGP

- Integrated application in traffic signal controller
- Uses RSU to help identify vehicle in position to receive AGP assistance
- AGP applied only when needed





AGP Implemented as Additional Timer



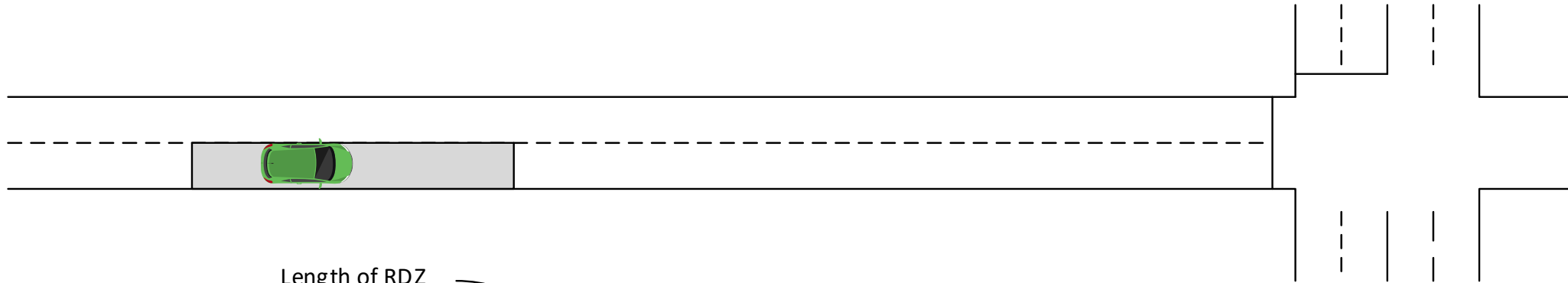


Use Cases

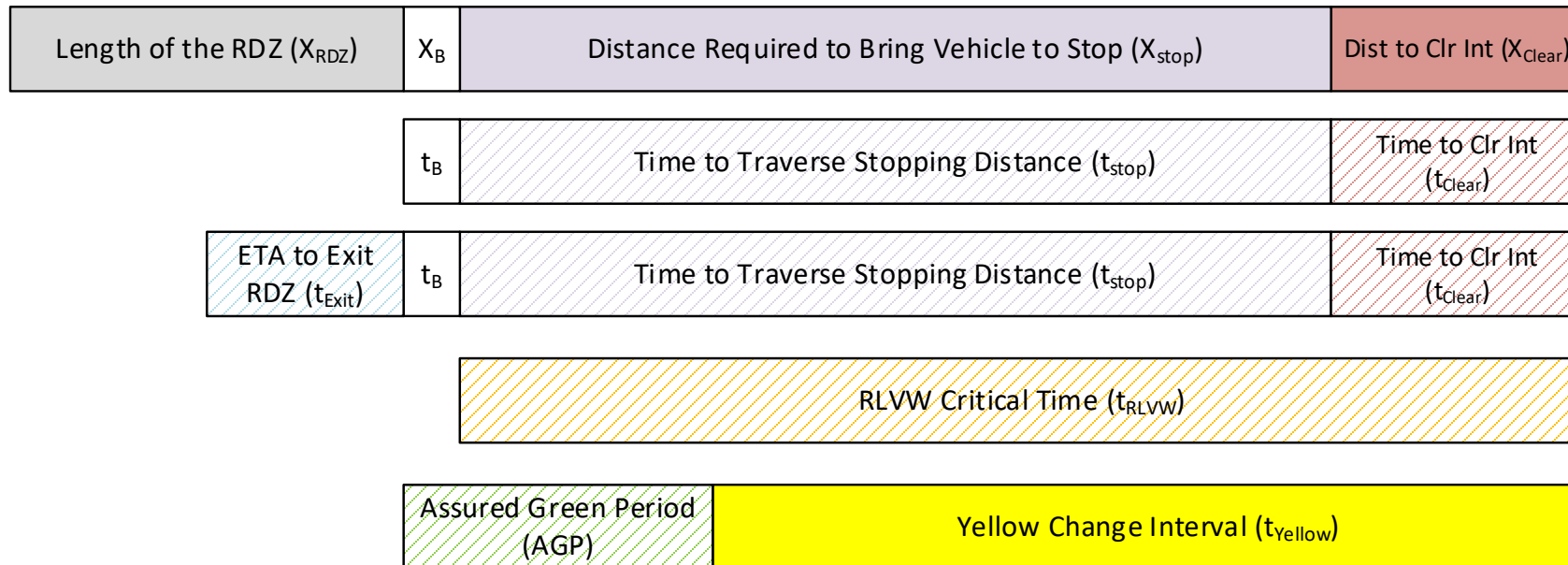
- AGP not needed in all situation and all circumstance
 - Pretimed control where interval are fixed
 - Extension Time with advance detection are sufficient to allow vehicle to cover stopping distance
- AGP may be beneficial under the following conditions:
 - Semi-Actuated control where main street has no detection
 - Rest-in-Green (extremely low volume conditions)
 - Advance detection where short extensions are used



RLVW Detection Zone



Length of RDZ Buffer (X_B)





Connected Transportation Interoperability (CTI) Standards Development

- CTI 4501. CI Implementation Guide v2.0
- J3305. Assured Green Period to Support Red Light Violation Warning
- J3258. V2X Infrastructure Support for GNSS Corrections
- J3238/1. Testing & Validation of SPaT information broadcast
- J3238/2. Testing & Assessment of MAP using RTCM information broadcast
- J2945/B. Recommended Practices for Signalized Intersection Applications
- J3295. Cooperative Perception Services Concept of Operations
- J5001. Onboard Unit Standard for Connected Vehicles

Completed 1st ballot or about to start ballot

Publication: early half 2025



J3305. Assured Green Period to Support Red Light Violation Warning

- Informational report produced for SAE
- Provides detailed background information on AGP
- Includes guidance for practitioners on how to deploy AGP
- Under ballot as part of the ITE/SAE Connected Transportation Interoperability Connected Intersections (CTI/CI) projects



Thank You!

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