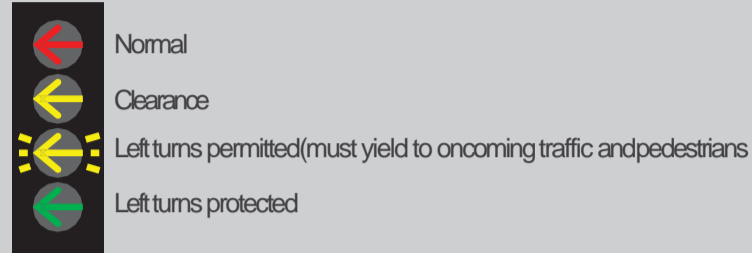


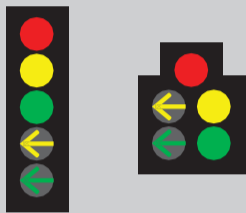
## Flashing Yellow Arrows 101

Q. What are Flashing Yellow Arrow (FYA) indications?

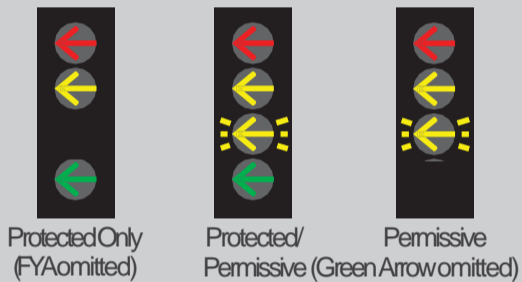
A. FYA indications are type of signal indication designed for left turns. They provide traffic engineers with greater operational flexibility.



Q. Why don't we just use the old 5-section protected/permissive display?

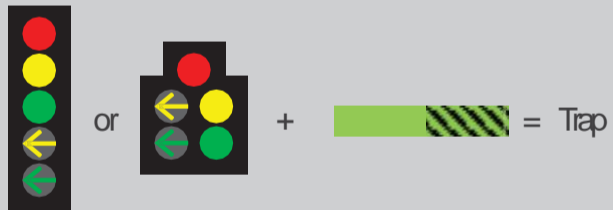


A. FYA indications can handle all left turn phasing modes;



and can provide lead/lag protected/permissive phasing without causing a yellow ball trap.

- Yellow Ball Trap Ingredients
  - Permissive Left turns with shared signal indication
  - Oncoming phase with extended green (e.g. due to opposing lagging left turn phase)



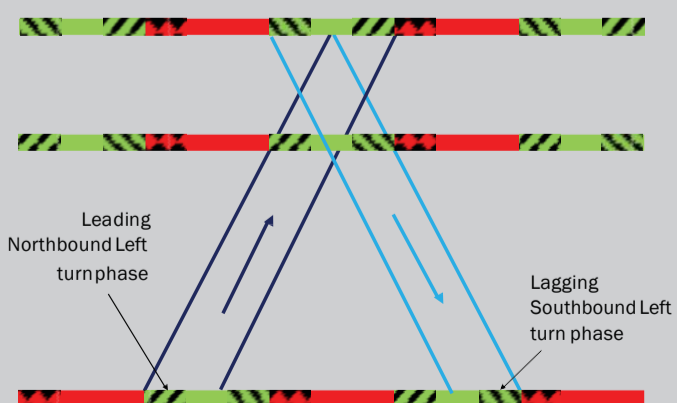
Q. What is lead/lag phasing?

A. Lead/lag phasing is the name given to the signal timing strategy of starting with a left turn phase and the adjacent through phase in one direction, and ending with the opposing through and left turn phases.



Q. Why do we need lead/lag phasing?

A. Lead/lag phasing helps traffic engineers to provide optimal two-way progression along a corridor.



## System Need

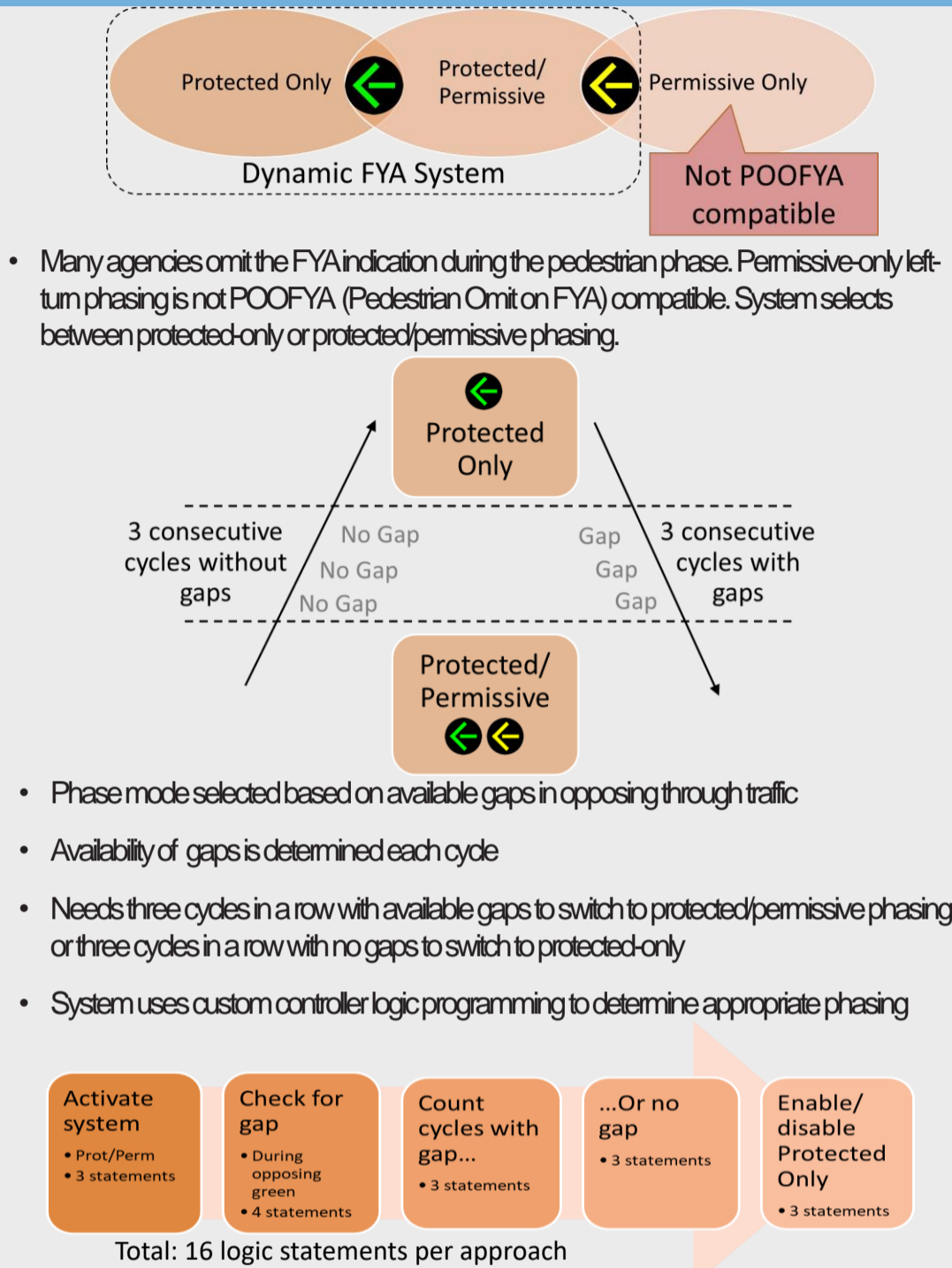
### Dynamic Phase Mode Selection:

- FYA allows the operator to select protected-only, protected/permissive, permissive-only left turn phasing for each movement and vary operations throughout the day
- Current state of practice is to collect turning movement counts and use these to develop a time of day schedule to vary phase mode (e.g. protected-only, protected/permissive, or permissive only)
- Static approach and does not change based on real-time conditions
- Time of day operation can be inefficient
- Costly to collect data and decisions can be out of date by the time signals are retimed
- Isolated, Free signals are not retimed often and local controller clock drift makes time of day operation impractical

### Dynamic Delay of FYA:

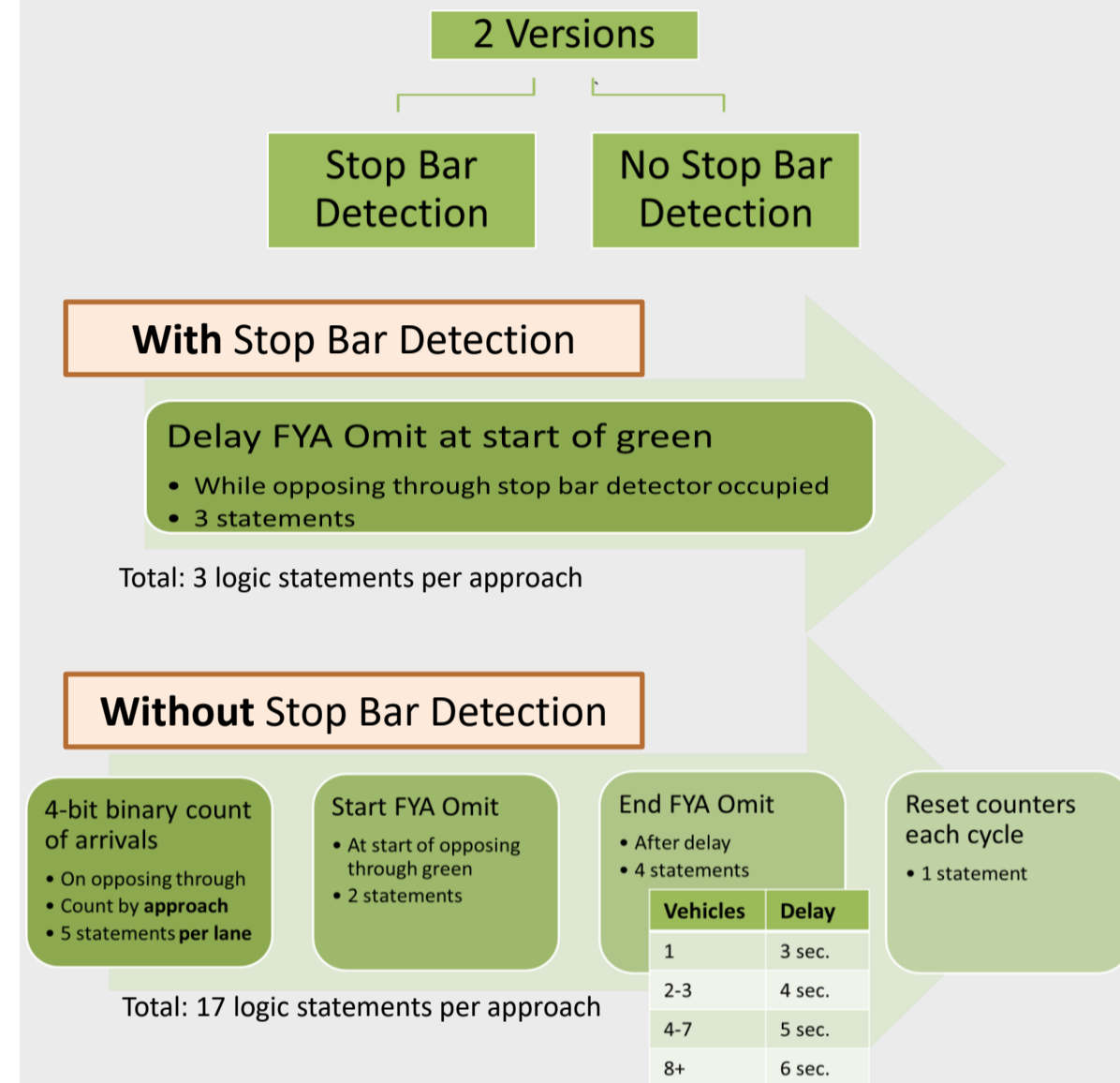
- Signal controller software allows the operator the option to delay the start of the FYA phase for a short period of time to give the oncoming through traffic a chance to establish their priority in the intersection
- Delaying the FYA indication enhances safety by limiting the ability of left-turning driver to "jump" when the FYA indications come up and try to beat oncoming traffic
- Setting in controllers to delay the FYA indication is global by approach and applies to all timing plans at all times of the day, which leads to inefficient operations during off peak periods by unnecessarily holding left-turning vehicles back when there are no opposing vehicles

## System Design – Phase Mode Selection



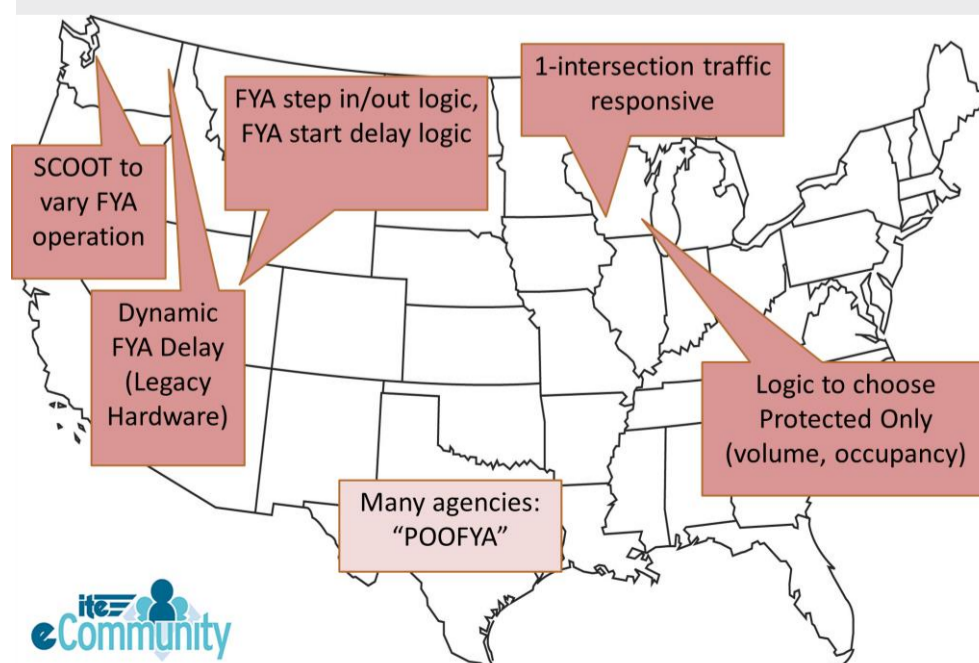
## System Design – Delay of FYA

- Allows opposing through traffic to establish right-of-way in intersection
- User-defined max delay (6 seconds)
- Guaranteed FYA Min Green time (5 seconds)



## Literature Search

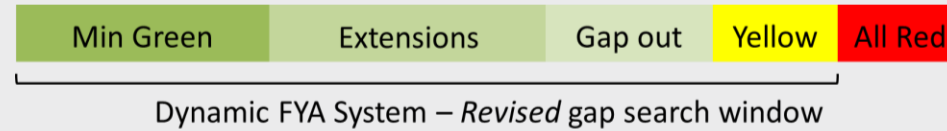
- WisDOT: Testing Contracs Traffic Responsive (TRP) to dynamically change phasing move
- City of Richland, Washington: Northwest Signal Voyage equipment with Min and Max delay settings to delay start of FYA
- City of Bellevue, Washington: SCOOT software to vary phase mode based on traffic volumes
- City of Boulder, Colorado: Controller logic and fixed TOD schedules to vary phase mode
- UDOT: Signal controller logic to make phasing mode selection on shoulders of a.m. and p.m. peak periods based on available gaps. Dynamically determines time to switch to protected-only. Logic to vary delay of FYA at locations where opposing left-turns limit sight distance.



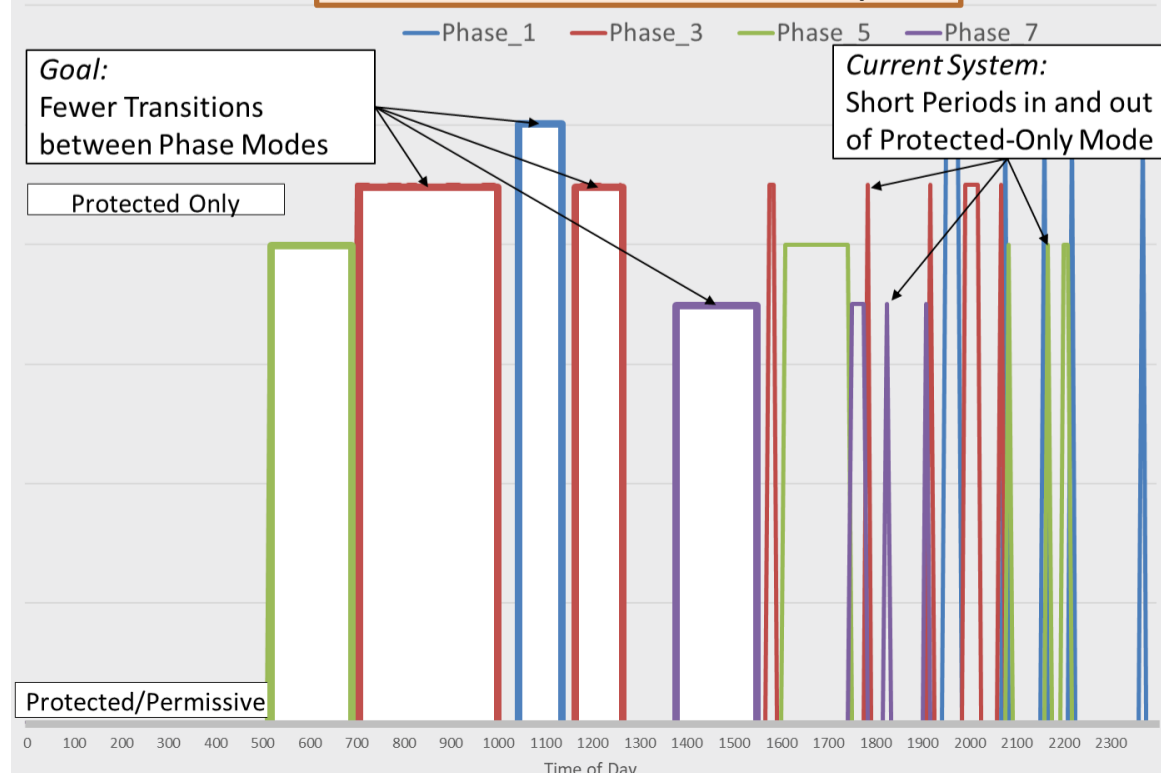
## Bench Testing and Field Implementation

### Bench Test:

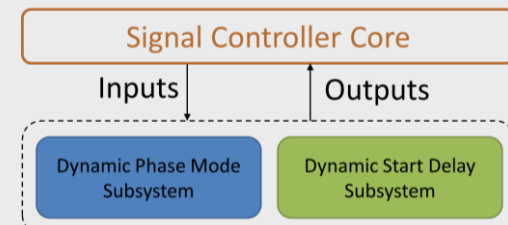
- Revised logic to handle EVP calls appropriately
- Revised logic to make phase mode changes only during all-red interval
- Shortened acceptable gap time to improve performance for side streets and Free



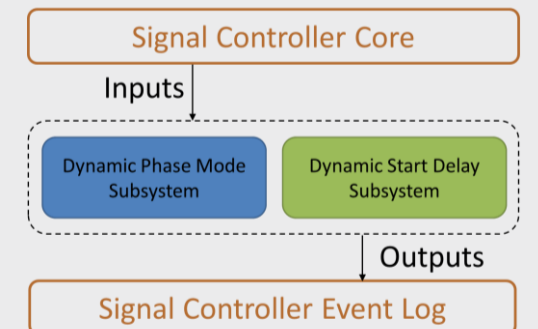
### Phase Mode Decision Output



### Live Operation



### Test Mode



### Delay Mode Decision Output

