Optimizing The Operations of Closely Spaced Traffic Signals

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Closely Spaced Signals - The Challenges

• According to many sources, minimum traffic signal spacing should be 1/4 mile, with 1/2 mile spacing being preferable

• However, this isn’t always possible in urban areas

• Our usual analysis techniques do not properly assess the interaction impacts of signals

• Working with closely spaced signals requires additional techniques, such as simulation
Case 1: Summit, NJ

- Intersections of Broad St & Ashwood Av, Morris Av & Ashwood Av
Case 1: Summit, NJ

- Both Broad Street and Morris Avenue are heavily traveled County Roads
- To the east of Ashwood, traffic from a freeway is fed in one direction onto each road (Eastbound from Morris Avenue, Westbound from Broad Street)
- This leads to high turning movements between Morris Avenue and Broad Street
- Ashwood is a heavily traveled cut-through from an interstate in the morning peak
- Two signals originally worked from one controller, using a common two-phase timing plan
- There is only 130 feet of storage on Ashwood Avenue between Broad Street and Morris Avenue
- Lack of storage on Ashwood Avenue led to queue spillback and congestion on both County Routes
Case 1: Summit, NJ

- Union County engaged us to replace the signal installations
- Used Synchro to devise a timing plan that minimized queuing between intersections:
  - Cycle length - 70 sec. in PM, 60 sec. Otherwise
  - Added arrow at one intersection to help flush it
  - Optimal offsets were found, and they were not intuitive
- No more than 6 cars queued per lane, according to Synchro and SimTraffic simulation
- Real life observations confirmed this to be the case
- No spillback impacts on County Roads
Case 1: Summit, NJ

Weekday Evening Peak With Improvement, approx. 5:30 p.m.

Notice that Simulation appears to match reality, and that queue spillback is avoided (light is about to change for queue shown)
Case 1: Summit, NJ

- New configuration caused a number of pull-through collisions - about 1 per week for the three months following installation.
- Essentially Ashwood Avenue traffic at Morris Avenue were reacting to the green light at Broad Street and proceeding.
- Field investigations revealed that although Morris Avenue heads were in a driver’s cone of vision, the Broad Street heads were “front and center”
- We rotated all arms 90-degrees (only option due to time of pole used)
  - Pull-through collision rate fell to 1 per 3 weeks
- Added cut-off louvers to greens and arrows, and dropped one head to 15 feet clearance.
  - No pull-through collisions since (more than a year later)
Case 1: Summit, NJ

Original

Fix 1

Fix 2
Case 2: West Milford, NJ

- Intersections of Union Valley Road & Ridge Road, Union Valley Road & Marshall Hill Road
Case 2: West Milford, NJ

- Union Valley Road is a County Road that makes a right turn at Marshall Hill Road.
- Left Turns operate in protected mode only at this intersection.
- Union Valley Road and Ridge Road is also signalized, and it is approximately 300 feet from Union Valley Road and Marshall Hill Road.
- Both signals are controlled by one controller, with a common timing plan.
- Queuing blocks signals most of the time.
- According to simulation, actual delay is 40% higher than HCS would indicate.
Case 2: West Milford, NJ

- Used Synchro to develop a coordination plan that required minimal left turn storage.
- Essentially, when the heavy traffic platoon is released at one intersection, it would have green arrow when it arrives at next intersection
- Delays expected to be cut in half with new timing plan, and queues are not expected to exceed storage.
- All movements Level of Service C or better
- Will be implemented later this year.
Case 3: Westfield, NJ

- Intersection of East Broad Street & Mountain Avenue/Central Avenue
Case 3: Westfield, NJ

- Both East Broad Street and Central Avenue/Mountain Avenue are heavily traveled County Roads
- Central Avenue and Mountain Avenue are off-set by approximately 200 feet along East Broad Street in downtown Westfield
- Presently unsignalized, and highly congested
- Only right turns permitted from Central Avenue/Mountain Avenue
- Satisfied nearly every MUTCD warrant, including Pedestrian Volume warrant
- Only 300 feet from existing traffic signal
- Police Traffic Directors used at least half the time
Case 3: Westfield, NJ

- Due to angle of roadways, left turns onto Central and Mountain have resulted in significant pedestrian conflicts. This resulted in a need to make left turns protected only
- In signal design, did not allow left turns from Central and Mountain (as existing case).
- Kept pedestrian crossings on the outside of intersection
- Run left turns from East Broad, right turns from Mountain/Central and pedestrians concurrently
- Put in a clean-out phase for left turns
- Set up signal timing based on storage capacity of left turns between intersection, and storage capacity of East Broad Street
- Everything found to operate at Level of Service C or better, based on simulation
- To be implemented in the Fall.
Case 3: Westfield, NJ
Lessons Learned - Operations

• Optimizing the operations of closely spaced signals is essentially an exercise in queue length minimization.

• SYNCHRO makes this easy, since queue lengths are calculated based on traffic volumes, signal timings, offsets, and phase orders.

• Left arrows within the short section should be used where possible for clearing out area between intersections.

• Shorter cycle lengths are better, since queue lengths tend to be shorter for short cycle lengths. (60-80 seconds appears to be best)
Lessons Learned - Safety

• Just because a signal installation complies with MUTCD, it is not free from potential problems between intersections

• “Pull-Through” is a major traffic safety concern for closely spaced signals. The following techniques can minimize the risk of this:
  – use 8” lenses between intersections instead of 12” lenses
  – use backplates on the outside approaches
  – place heads as low and as directly in front of stop bar as possible on the outside approaches (far side right pole placement helps)
  – use cut-off louvers or optically programmed heads between intersections
Conclusion

• Closely spaced traffic signals create traffic problems that are a bit more complex and difficult for conventional HCS analysis to properly analyze.

• However, with traffic simulation and progression analysis programs (SYNCHRO or similar programs), it is possible to analyze and optimize closely spaced intersections.

• It is often possible to get closely spaced signals functioning efficiently, despite the lack of storage.

• Attention must be paid to what happens “between” the closely spaced signals.

• Attention must also be paid to traffic signal layout and the potential for pull-through effects.