2.5 Traffic Flow between Intersections Assuming Structured Platoons

A time-space diagram (TSD) can be used to represent vehicle flow on an arterial between signalized intersections. The TSD shows the trajectory of vehicles traveling along the arterial using both the time and distance domains. Figure 1 shows a well-structured platoon of six vehicles traveling through two signalized intersections at constant speed and with uniform headways, arriving during green at both intersections. The vehicles experience no delay.

Figure 1 also shows several aspects of the signal control system.
- The cycle length is the sum of the green, yellow, and red intervals for one phase.
- The offset at the second signalized intersection is the difference between the start of green at the first intersection relative to the start of green for the second intersection.
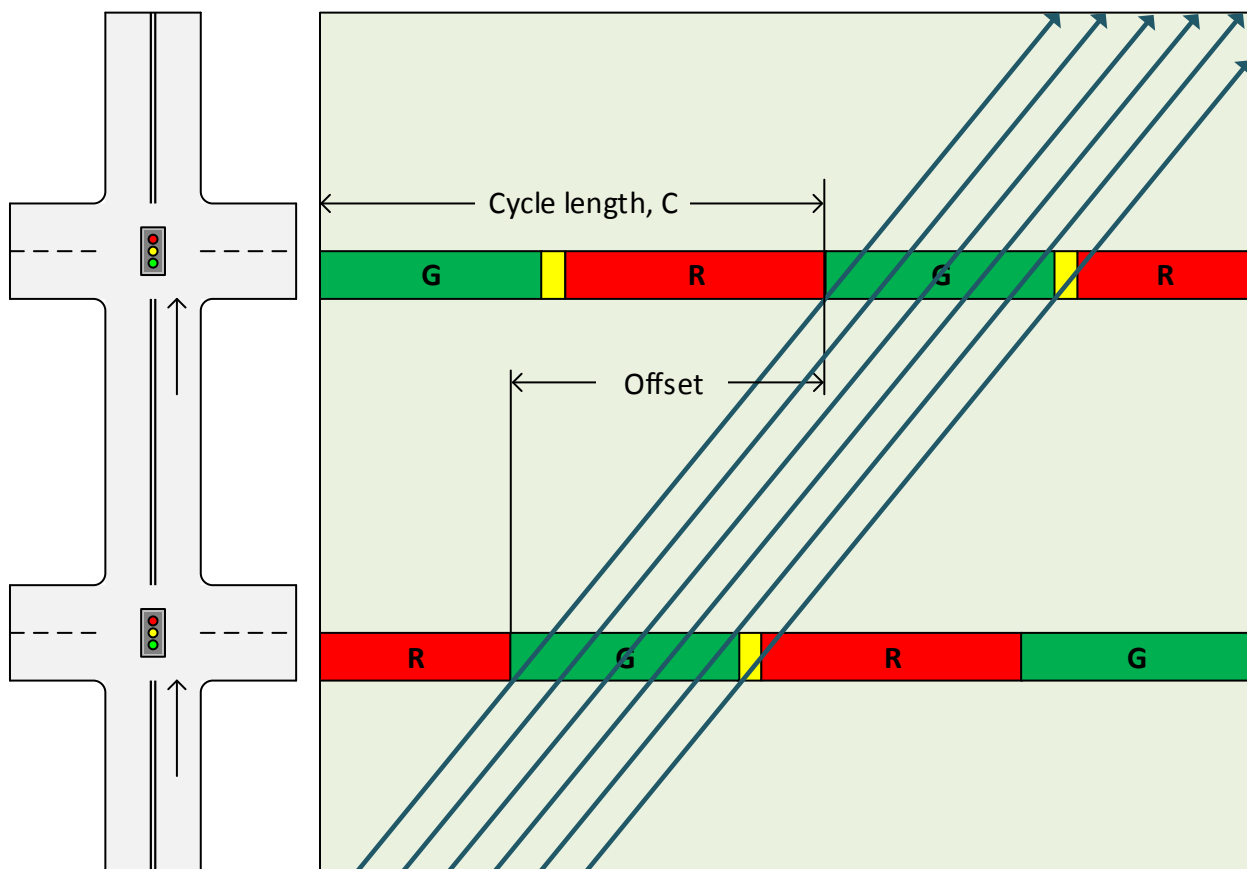

Figure 1 Time space diagram

A simplified version of this same TSD is shown in Figure 2. Here the displayed green (G), yellow (Y), and red (R) intervals are replaced by the effective green (g) and effective red periods (r). Also, only the first and last vehicles in the platoon are shown. In both figures, the platoon is assumed to be well-structured as all vehicles travel at the same speed with uniform headways between each vehicle pair. In addition, Figure 2 shows the bandwidth, defined to be the maximum time duration of the platoon that can be served with the green band provided along the arterial.
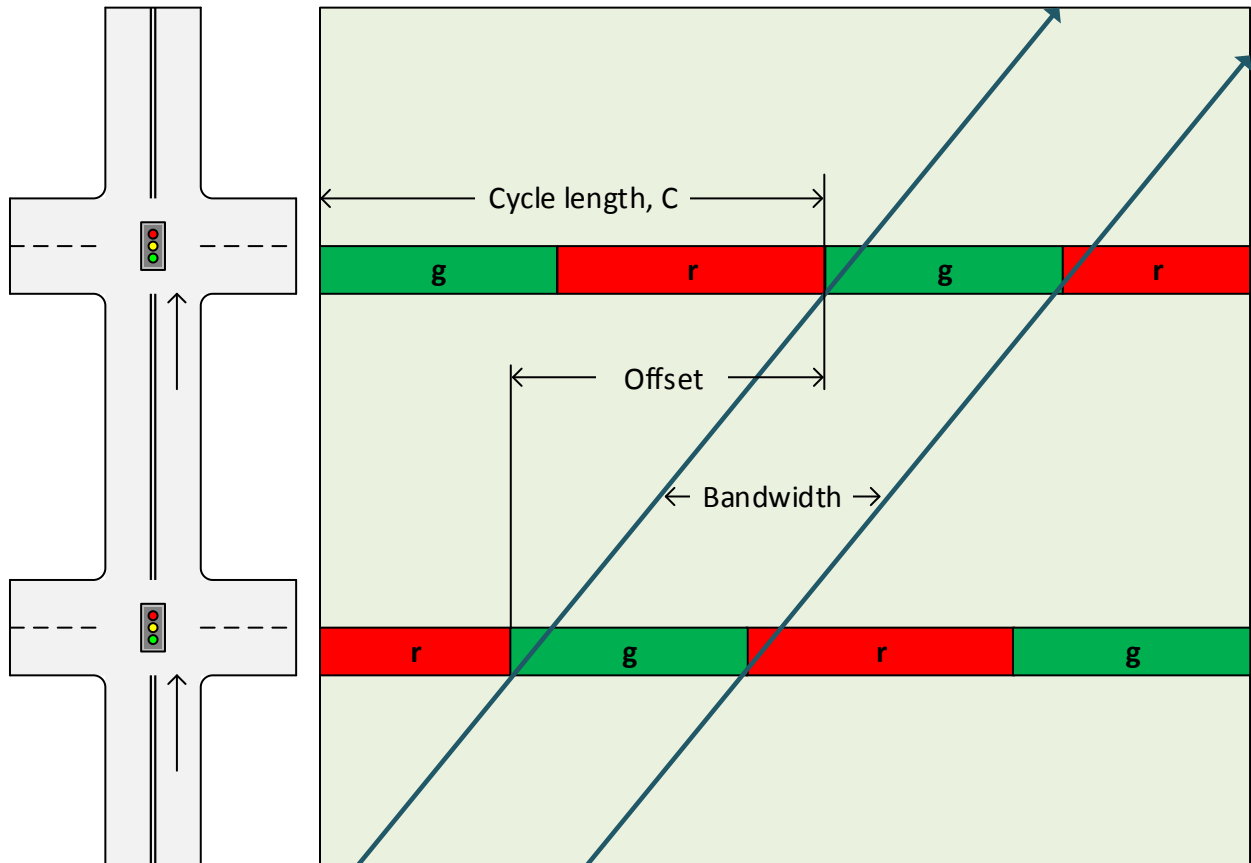

Figure 2 Time space diagram

Figure 3 shows the case where all vehicles arrive at the second intersection during the red interval.
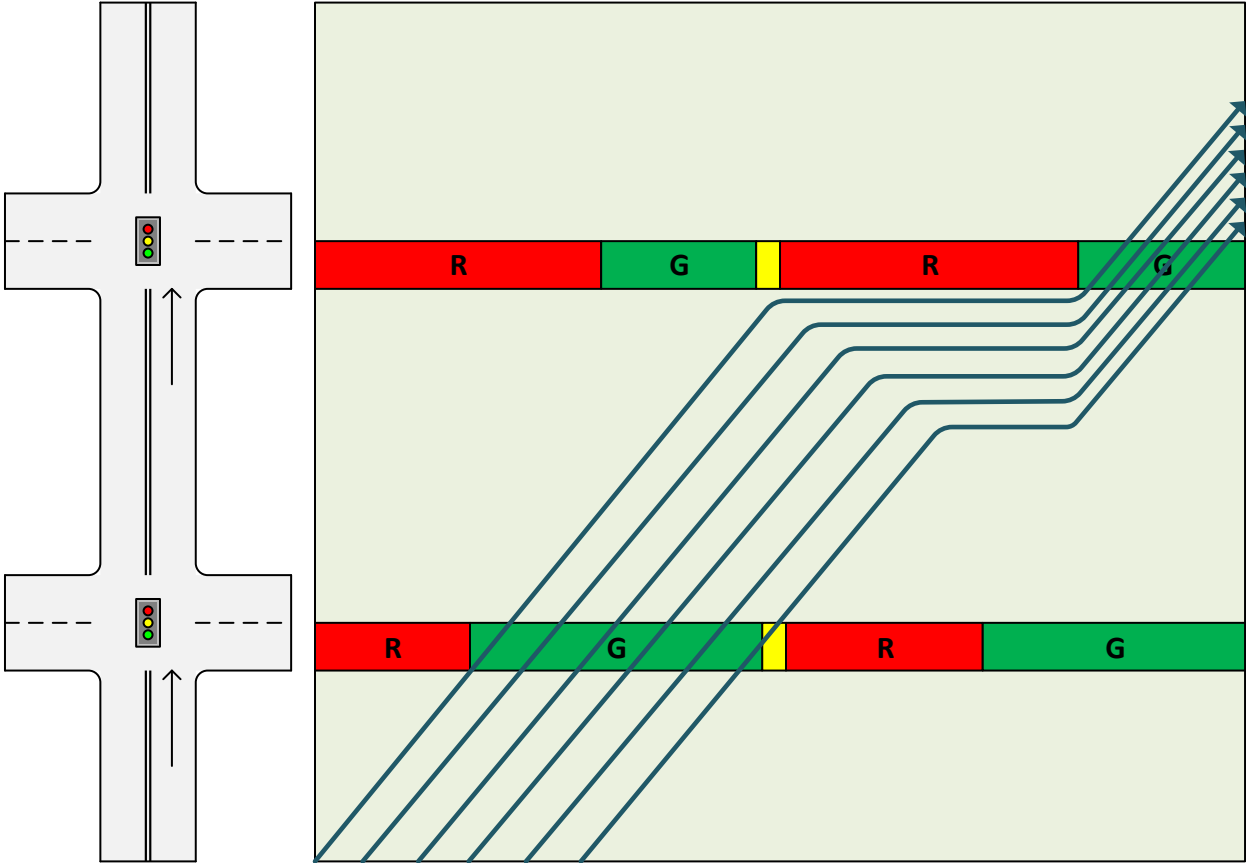

Figure 3 Time space diagram, arrivals on red at downstream intersection

Figure 4 shows the same case, this time with an inverted QAP shown with a dashed line. The queue grows during red during the arrival of the six vehicles, it remains steady after the sixth vehicle arrives, and begins to clear after the beginning of green. The shaded area shown in light red is the total delay experienced by these vehicles.
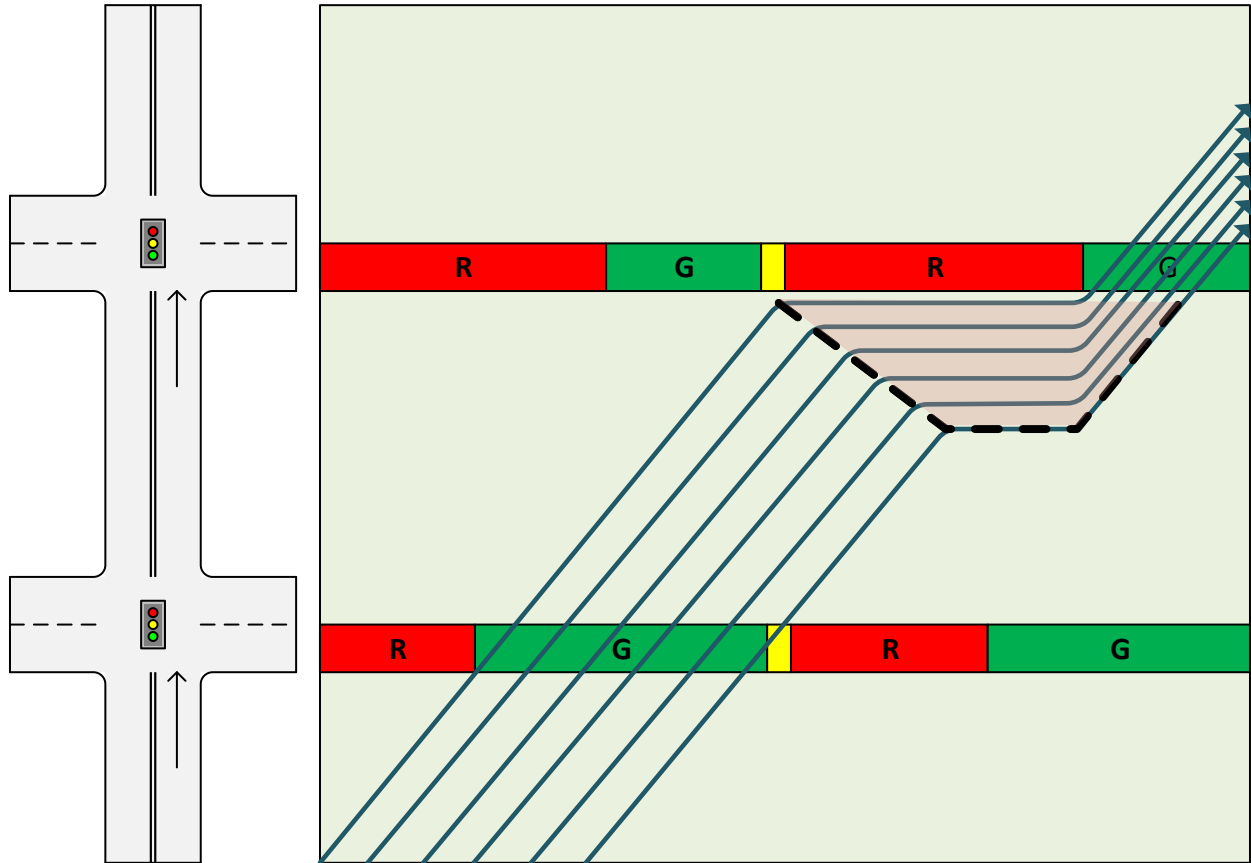

Figure 4 Time space diagram, arrivals on red at downstream intersection, queue accumulation polygon

Activity C01: Intersection Spacing, Offset, and Vehicle Speed (Time-Space Diagrams)

Purpose
The purpose of this assignment is to construct a spreadsheet tool that you can use to study the effect of changing intersection spacing, speed, offsets, cycle length, and splits on the quality of progression through the intersections of your system.

Requirements
1. A time-space diagram in an Excel workbook showing trajectories for the front and back of two platoons, one traveling in one direction and another in the opposite direction through your system of four intersections. See the example below that shows a time-space diagram for two intersections over a period of nearly two cycles.
2. Input data that control the four platoon trajectories and the red and green signal display lines over two cycles in the time-space diagram.
3. A cycle length of 100 sec and an effective green time of 50 sec.
4. A platoon duration of 30 sec.
5. An offset of zero for the first (reference) intersection in your system.
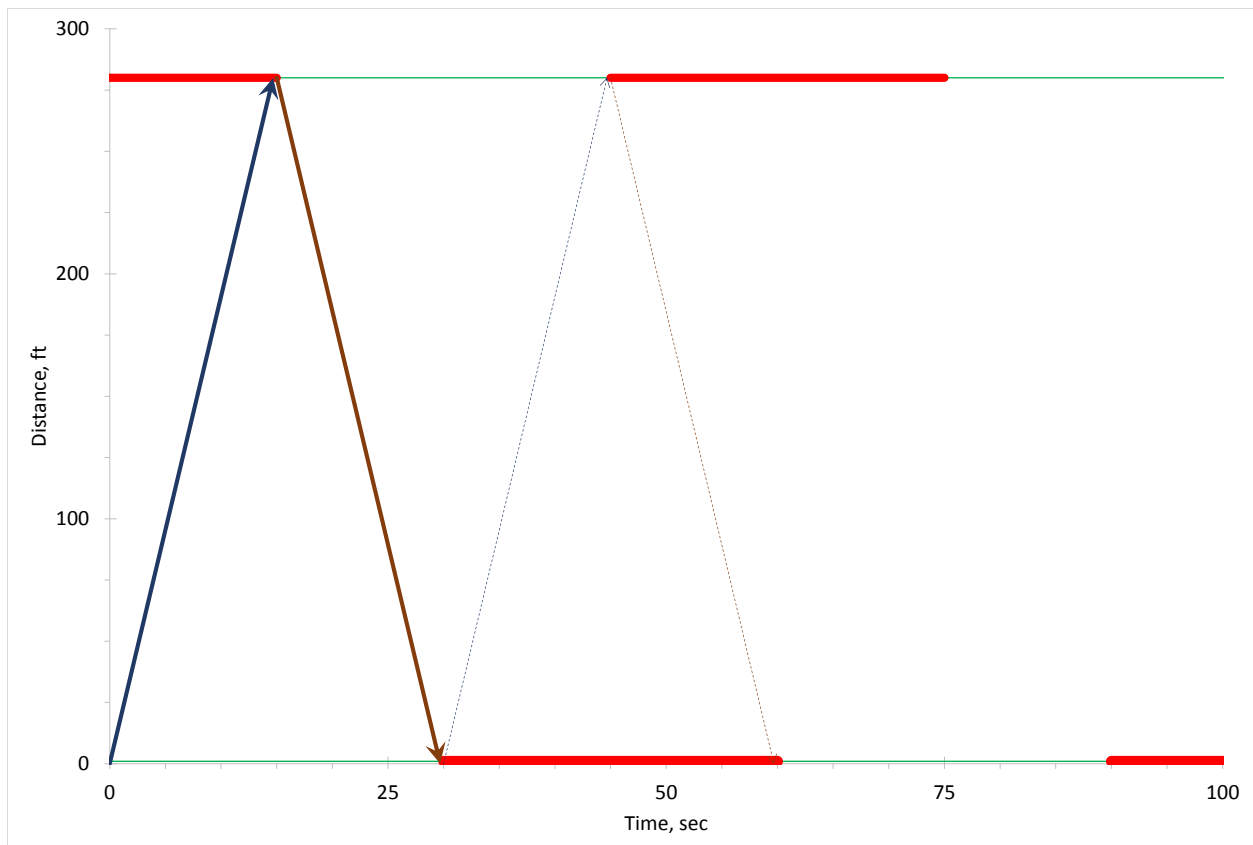
Tasks

1. Measure the distance between your intersections using Google Earth or a similar tool.
2. Construct the input data space that satisfies requirement 2.
3. Add the time-space diagram including:
   - The horizontal lines representing the intersections,
   - The green and red display lines for each intersection, and
   - The leading edge of the up platoon, the trailing edge of the up platoon, and the leading and trailing edges of the down platoon.

(Note: The trajectory lines should respond to any change in the intersection spacing and vehicle speed. The signal display lines should respond to any change in the intersection spacing, the cycle length, the splits, and the offset.)

4. Compute the travel time between each intersection pair to be used as initial values for the offsets, assuming the speed limit in each segment is a good representation of the travel speed.
5. Determine the best offsets to achieve progression for the "up direction" only.

Deliverable

Excel workbook with time-space diagram as per the requirements listed above.