The MUTCD prescribes that the timing at a traffic signal must relate to traffic flow, and that data from engineering studies shall be used to determine the proper phasing and timing for a signal. This raises several questions that will be addressed here. The first question is “What data do we need to time a signal?” The answer is that we need to know the following things about each traffic movement to be accommodated:

1. The demand traffic volume (vph), generally adjusted to reflect the peak 15 minute period;

2. The saturation flow rate (vphg), either measured or estimated; and

3. The lost time per cycle.

These items were all defined in Session 2.

**A Simple Example**

Consider the traffic volumes (vph) and number of lanes for the intersection shown below:

This intersection will be used to illustrate the principles to be set forth in the current session, and in several subsequent sessions. To make the computations easier to follow, the traffic volumes are assumed to be adjusted to reflect the peak 15 minute flow within the hour. No turning movements are included to complicate the process.

To complete the data requirements, the two additional assumptions shown at the right must be made.

**ASSUMPTIONS**

- \( L = 4 \) sec
- \( s = 1800 \) vphgpl
We must first compute the saturation flow rate for each of the approaches. As shown on the drawing, each north-south approach has one lane and each east-west approach has 2 lanes.

**The Flow Ratio**

Now a new term: The *flow ratio* is defined as the ratio of the volume to the saturation flow rate for each approach. This term is usually denoted by the symbol \( y \) in the literature. For each approach, \( y = \frac{v}{s} \). This is a very important term because it indicates what proportion of the total effective green time is required to accommodate the movement within its capacity. Let’s compute the flow ratio the northbound movement:

\[
y = \frac{500}{1800} = 0.277.
\]

This means that at least 27.7% of the effective green time must be given to the northbound movement, otherwise the volume will exceed the capacity. There will be no problem if more time is allocated, in fact we probably want to allocate more time to ensure that the movement operates somewhat below its capacity.

Each movement must have its flow ratio computed in this manner. The results of this step are shown in the box at the right.

**The Critical Flow Ratio**

If we add the flow ratios for all of the movements together, we will get a value much greater than 100%. This would mean that more than 100% of the effective green time would be required to give each movement its own exclusive phase. We will talk more about signal phasing decisions in Session 7, but for now, the only sensible choice would be to create a phase in which the NB and SB traffic moves simultaneously, followed by a similar phase for the EB and WB traffic. We can do this because there are no geometric complications or left turning movements to accommodate.

So, we now have to add up the flow ratios for the critical movements on each phase. The critical movement is the one that has the highest flow ratio. It is easy to see that the southbound and westbound movements are critical and that together, they require 81.9% of the effective green time. This means that we have a viable signal operation, with 18.1% of the time available for something other than effective green time.

Note that the sum of the critical flow ratios for all phases is generally denoted in the literature as \( Y \).