Demonstration of Experiments Relating to Isolated Intersections (Labs 2 through 5)

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Lab Titles and Goals

Laboratory 2. Effect of Detector and Timing Parameters on the Operation of the Cross Street of an Isolated Intersection

- **Goal:** Develop a detector design (length of the detection zone) and timing design (Minimum Green time and Vehicle Extension time parameters) for a cross street at an isolated intersection.

Laboratory 3. Developing Timing Plans for Efficient Intersection Operations During Moderate Traffic Volume Conditions

- **Goal:** Develop a timing plan for a signalized intersection with moderate traffic volumes.

Laboratory 4. Impact of Detector and Timing Parameters on Arterial Street Operations at an Isolated Intersection

- **Goal:** Develop a detector design (location of detection zone) and timing design (Minimum Green time and Vehicle Extension time, as well as volume-density parameters) for the arterial street approach of an isolated intersection using advance detection.

Laboratory 5. Selecting Left Turn Phasing for Various Traffic Volume Conditions

- **Goal:** Determine the appropriate left turn phasing for a given volume condition.

Structure of Laboratory

- Introduction
- Terms
- Experiments
- Closure: Summary of Key Points Learned

Introduction

Terms

Experiments

Closure: Summary of Key Points Learned

Structure of Laboratory

1.1 Purpose

How and when should a green indication terminate at a signalized intersection? There are a number of factors that affect the termination of green including the desired efficiency of traffic signal operation, the quality of service provided to motorists, and the safety of motorists traveling through the intersection.

1.2 Goals and Learning Objectives

The goal of Laboratory 2 is to develop a detector design (length of the detection zone) and timing design (Minimum Green and Vehicle Extension time parameters) for a cross street at an isolated intersection.

1.3 Organization and Time Allocation

Laboratory 2 is divided into nine sections, including this introduction. The eight sections that follow and the approximate time allocated to each section are listed in Table 1.

Table 1 Laboratory sections and approximate completion times

Section	Title	Approximate Time (min)
1	Introduction	5

Introduction

Terms

Experiments

Closure: Summary of Key Points Learned

Structure of Laboratory

2. TERMS

Standard definitions for traffic signal terminology are provided by the National Electrical Manufacturers Association (NEMA) [9] and by the National Transportation Communications for ITS Protocol (NTCIP) 1202 document, "Object Definitions for Actuated Traffic Signal Controller Units" [2]. Definitions are also provided in the Federal Highway Administration's *Traffic Signal Timing Manual* [5]. The definitions presented here are adapted from these sources.

Actuated Signal Control: A type of signal control in which the timing of each phase is at least partially controlled by detector actuations.

Actuation: The operation of any type of detector.

Call: An actuation of a phase by vehicle detection or by an internal signal controller setting (a "recall"). A phase that is not called will be skipped.

Gap Out: A method of terminating a phase resulting when the Passage Timer expires.

Introduction

Terms

Experiments

Closure: Summary of Key Points Learned

Structure of Laboratory

3. EXPERIMENT #1: HOW A TRAFFIC PHASE TIMES

3.1 Learning Objective

- Be able to describe the two primary methods for the termination of a traffic phase at an isolated intersection.

3.2 Overview

The purpose of this experiment is to observe the timing of a traffic phase and the method by which the phase terminates. You will observe the SB approach (phase 4) of the intersection of State Highway 8 and Line Street. This approach (Line Street) has two lanes, a left turn lane and a through/right turn lane. State Highway 8 is the major street and serves as a primary east-west route through the city. It also serves as the major access to a university. See Figure 1. You will monitor traffic on the through/right turn lane of this approach.

3.3 Questions to Consider

As you begin this experiment, consider the following questions. You will come back to these questions once you have completed the experiment.

- Why does the phase terminate for each of the two cases that you observe?
- What is the process followed by the Minimum Green timer from the beginning of the green indication, until the timer expires?
- What is the process followed by the Vehicle Extension timer from the beginning of the green indication, until the timer expires?

Introduction

Terms

Experiments

Closure: Summary of Key Points Learned

Structure of Laboratory

9. CLOSURE: SUMMARY OF KEY POINTS LEARNED

In this laboratory, you looked at the factors that should be considered when the Minimum Green time and the Vehicle Extension time parameters are set, for a given length of the detection zone. It should be pointed out that we've only considered stop bar detection, and other detection zone configurations will result in different results.

You saw in Experiment #1 how a phase times, and two common ways in which a phase is terminated: (1) the Minimum Green and Vehicle Extension timers both expire, resulting in a "gap out," and (2) the Maximum Green timer expires, resulting in a "max out."

You saw in Experiment #2 that the detection zone itself can provide some extension of the green as vehicles arrive at the intersection and enter the zone. A longer zone provides more of this extension capability.

Structure of Experiments

- Learning objectives
- Overview
- Questions to consider
- List of steps
- Running the experiment
- Discussion

Learning objectives

Overview

Questions to consider

List of steps

Running the experiment

Discussion

Structure of Experiments

3.1 Learning Objective

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3.3 Questions to Consider

As you begin this experiment, consider the following questions. You will come back to these questions once you have completed the experiment.

- Why does the phase terminate for each of the two cases that you observe?
- What is the process followed by the Minimum Green timer from the beginning of the green indication, until the timer expires?
- What is the process followed by the Vehicle Extension timer from the beginning of the green indication, until the timer expires?
- What is the process followed by the Maximum Green timer from the beginning of the green indication, until the timer expires?
- What are the two conditions that separately cause the termination of the green indication?

Learning objectives

Overview

Questions to consider

List of steps

Running the experiment

Discussion

3.4 List of Steps

You will follow these steps during this experiment:

- Open the movie file.
- Observe the status at the beginning of phase 4 green.
- Observe the two cases for one green indication.
- Summarize your observations.

Structure of Experiments

- Learning objectives
- Overview
- Questions to consider
- List of steps
- Running the experiment
- Discussion

3.5 Running the Experiment

In this experiment, you will consider two cases, each illustrating a different method for the termination of phase 4 (which serves the SB through/right turn movements). You will observe how the phase times (the timing processes for the Minimum Green, Vehicle Extension, and Maximum Green timers), and how it terminates for each case. The two cases have been placed side-by-side in a movie format so that you can observe the traffic flow and timing processes at the same time. The simulation has been set to run at less than real time, slow enough so that you can observe all timing and traffic flow processes.

Step 1. Open the movie file.

- Locate the "MOST input files" folder.
- Go to the "Lab2" folder, then the "Exp1" folder.
- Open the file: "lab2-exp1.wmv."

Step 2. Observe the status at the beginning of phase 4 green.

- Move the animation to t = 45.6 seconds (which is equivalent to about 00:23 on the Windows Media Player clock). Observe the following conditions for the scene on the left for the SB approach.

Learning objectives

Overview

Questions to consider

List of steps

Running the experiment

Discussion

Structure of Experiments

3.6 Discussion

Let's now consider each of the five questions that were presented at the beginning of this experiment.

- Why does the phase terminate for each of the two cases that you observed?
- What is the process followed by the Minimum Green timer from the beginning of the green indication, until the timer expires?
- What is the process followed by the Vehicle Extension timer from the beginning of the green indication, until the timer expires?
- What is the process followed by the Maximum Green timer from the beginning of the green indication, until the timer expires?
- What are the two conditions that separately cause the termination of the green indication?

Take a few minutes to review each question and write brief answers to each question in the box on the right based on your observations from this experiment.

Demonstration: Laboratory 2, Experiment #1

Learning objectives

- Be able to describe the two primary methods for the termination of a traffic phase at an isolated intersection

Overview

- Purpose of the experiment is to observe the timing of a traffic phase and the method by which the phase terminates.

List of steps

You will follow these steps during this experiment:

- Open the movie file.
- Observe the status at the beginning of phase 4 green.
- Observe the two cases for one green indication.
- Summarize your observations.

Questions to consider

- Why does the phase terminate for each of the two cases that you observe?
- What is the process followed by the Minimum Green timer from the beginning of the green indication, until the timer expires?
- What is the process followed by the Vehicle Extension timer from the beginning of the green indication, until the timer expires?
- What is the process followed by the Maximum Green timer from the beginning of the green indication, until the timer expires?
- What are the two conditions that separately cause the termination of the green indication?

Demonstration: Laboratory 2, Experiment #1

Movie File

Demonstration: Laboratory 2, Experiment #1

1. Why does the phase terminate for each of the two cases that you observed?

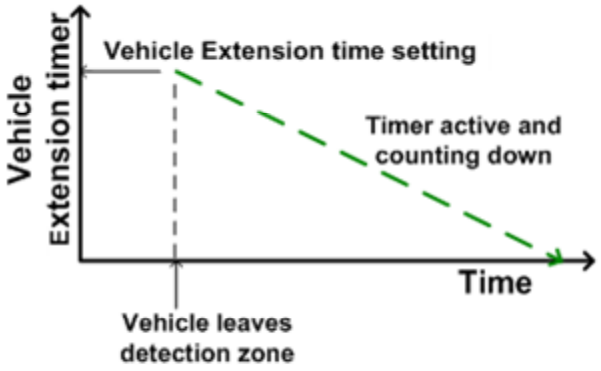
→In the first case, the phase terminated because the Vehicle Extension timer expired ("gapped out"). In the second case, the phase terminated because the Maximum Green timer expired ("maxed out").

2. What is the process followed by the Minimum Green timer from the beginning of the green indication, until the timer expires?

→ The Minimum Green timer begins timing at the start of the green indication. Its initial value is equal to the Minimum Green time. It continues timing until it reaches zero. The duration of the green indication is at least equal to the length of the Minimum Green time. See Figure 3.

3. What is the process followed by the Vehicle Extension timer from the beginning of the green indication, until the timer expires?

→ The Vehicle Extension timer begins timing when the detection zone becomes unoccupied and there is no call on the active phase. If it reaches zero, the green indication may terminate. If it has not expired, the Vehicle Extension timer is reset when another call is received. See Figure 4.



Demonstration: Laboratory 2, Experiment #1

5. What are the two conditions that separately cause the termination of the green indication?

→ There are two conditions for termination of the green indication at an isolated actuated intersection: (1) the Minimum Green timer equals zero and the Vehicle Extension timer equals zero, or (2) the Maximum Green timer equals zero.

Figure 6 shows the ASC/3 controller status at t = 52.6, when phase 4 has just gapped out and the yellow interval has begun. This is the case on the left that you just observed.

Figure 7 shows the ASC/3 controller status at t = 71.4, when phase 4 has just maxed out and the yellow interval has begun. This is the case on the right side of the movie.

Demonstration: Laboratory 2, Experiment #6

8. EXPERIMENT #6: DESIGN EXERCISE- SETTING THE MINIMUM GREEN TIME AND THE VEHICLE EXTENSION TIME

8.1 Learning Objective

- Be able to set the Minimum Green time and the Vehicle Extension time, balancing risks of early termination and inefficient green extension.

8.2 Overview

In the previous experiments, you learned about the effect of detection zone length on the duration of the green indication, the effect of the Minimum Green time in ensuring that a queue has sufficient time to begin to move at the beginning of the green indication, and the importance of the Vehicle Extension time in ensuring that the green indication extends long enough to serve a queue but not any longer.

In this experiment, you will set the Minimum Green time and the Vehicle Extension time for traffic conditions that you might find in the real world. This experiment includes four separate green intervals for the SB approach, with a mix of passenger cars and heavy vehicles, and a range of driver behavior characteristics. As before, the detection zone length is 22 feet. As a starting point, the Minimum Green time is set to 10 seconds and the Vehicle Extension time is set to 5 seconds.

8.3 Questions to Consider

As you begin this experiment, consider the following questions. You will come back to these questions once you have completed the experiment.

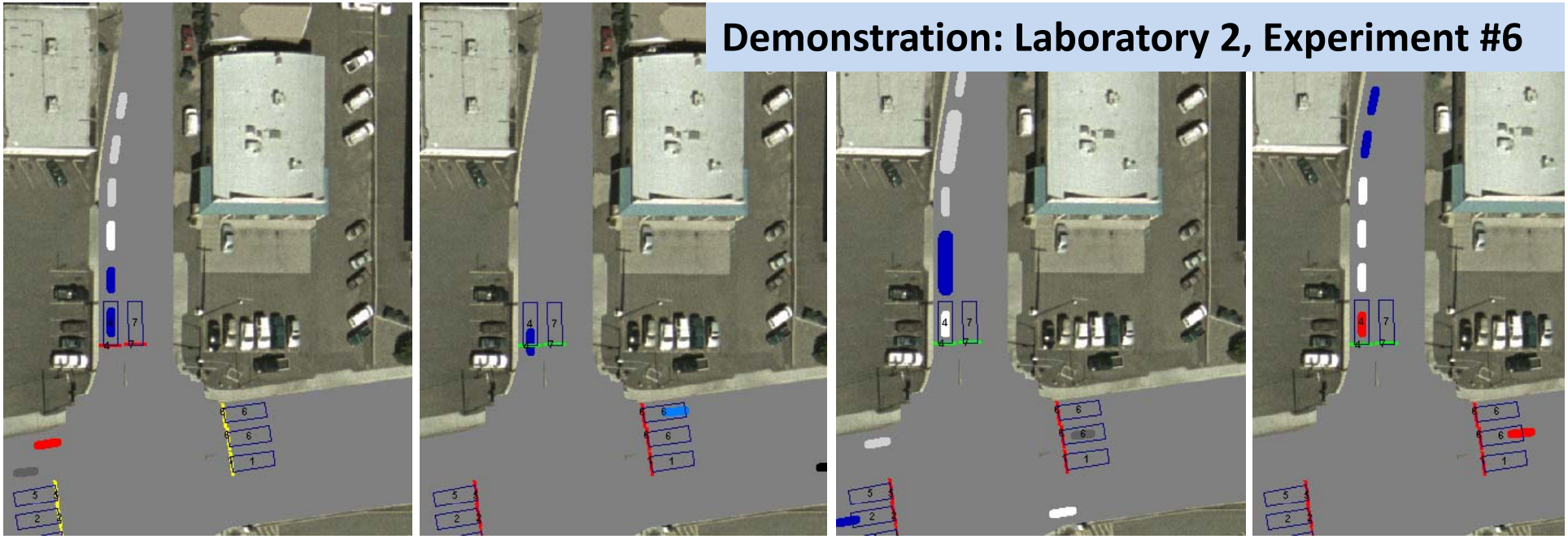
- What are the primary characteristics of the traffic streams for each of the four cycles that you observed that will affect the settings for the Minimum Green time and the Vehicle Extension time?
- What changes did you make to the given settings?
- What are some of the trade-offs that you considered in setting the values for these two timing parameters?
- Have you met the criteria established above?

8.4 List of Steps

You will follow these steps during this experiment:

- Start the MOST software tool and open the input file.
- Observe the simulation of the SB approach with the given values of Minimum Green time and Vehicle Extension time.
- Experiment with the Minimum Green time setting for phase 4.
- Experiment with the Vehicle Extension time setting for phase 4.
- Continue to experiment with the values of these two timing parameters until you reasonably meet the criteria listed below.
- Prepare a justification of your recommended parameters.

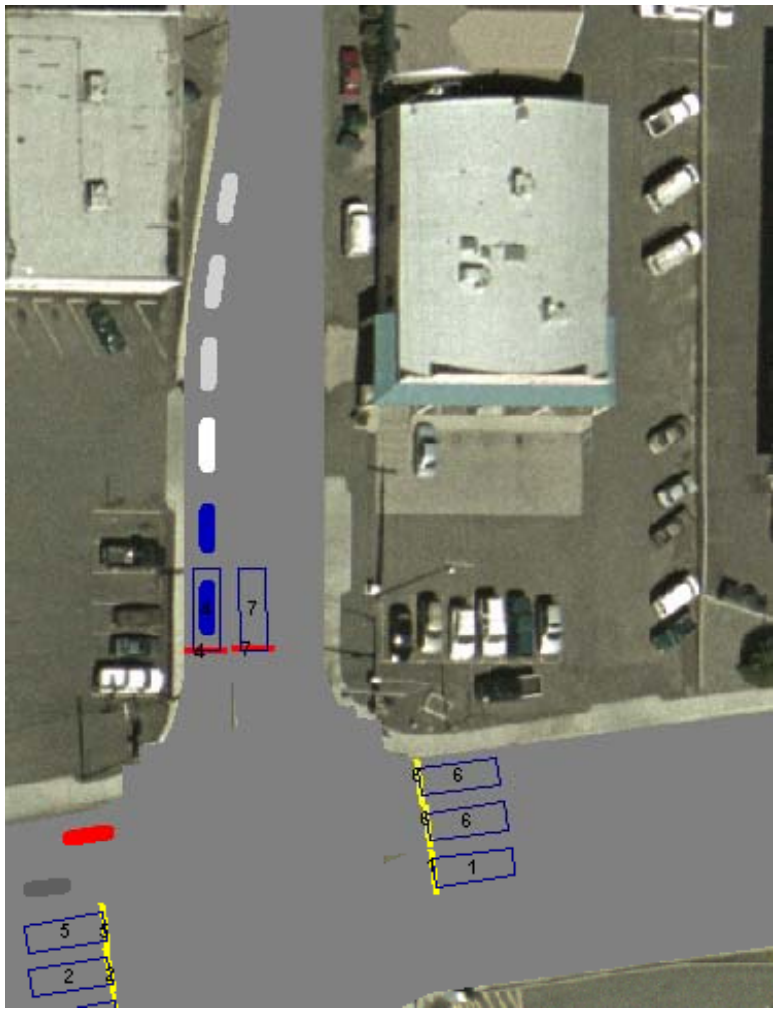
Demonstration: Laboratory 2, Experiment #6



Criteria:

- The phase is not extended inefficiently for a very short queue.
- The phase extends long enough to clear the standing queue.
- The phase doesn't extend beyond the time that it takes for the queue to clear.

Demonstration: Laboratory 2, Experiment #6



Movie File

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MOST

University of Idaho
Purdue University
University of Tennessee
Pline Engineering

Federal Highway Administration
PTV America
Econolite Control Products

Overview of MOST: a hands-on approach to signal timing training:
Michael Kyte, University of Idaho

Demonstration of MOST simulation tools: Kiel Ova, PTV America

Demonstration of experiments relating to isolated intersections:
Michael Kyte, University of Idaho

Demonstration of experiments relating to coordinated systems:
Darcy Bullock, Purdue University

Future of software-in-the-loop simulation training and research:
Thomas Urbanik, University of Tennessee, Knoxville