## Overall document structure

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Traffic Light Control System

From textbook (Laplante '04)

1 INTRODUCTION

Traffic controllers currently in use comprise simple timers that follow a fixed cycle to allow vehicle/pedestrian passage for a pre-determined amount of time regardless of demand, actuated traffic controllers that allow passage by means of vehicle/pedestrian detection, and adaptive traffic controllers that determine traffic conditions in real-time by means of vehicle/pedestrian detection and respond accordingly in order to maintain the highest reasonable level of efficiency under varying conditions. The traffic controller described in this specification is capable of operating in all three of these modes.

1.1 Purpose

This specification defines the software design requirements for an intersection control system for simple, four-way pedestrian/vehicular traffic intersections. The specification is intended for use by end users as well as software developers.

1.2 Scope

This software package is part of a control system for pedestrian/vehicular traffic intersections that allows for (1) a fixed cycle mode, (2) an actuated mode, (3) a fully adaptive automatic mode, (4) a locally controlled manual mode, (5) a remotely controlled manual mode and (6) an emergency preempt mode. In the fully adaptive automatic mode, a volume detection feature has been included so that the system is aware of changes in traffic patterns. Pushbutton fixtures are also included so the system can account for and respond to pedestrian traffic. The cycle is controlled by an adaptive algorithm that uses data from many inputs to achieve maximum throughput and acceptable wait-times for both pedestrians and motorists. A preempting feature allows emergency vehicles to pass through the intersection in a safe and timely manner by altering the state of the signals and the cycle time.
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From textbook (Laplante '04)

1.3.1 10-Base T
Physical connection formed by a twisted-pair as described in IEEE 802.3. Networking connection designed to transfer up to 10 megabits per second.

1.3.2 ADA
Americans With Disabilities Act.

1.3.3 API
Application Program Interface.

1.3.4 Approach
Any one of the routes allowing access to an intersection.

1.3.5 Arterial Road
A major traffic route or route used to gain access to a highway.

1.3.6 Aspect
The physical appearance of an illuminated traffic standard.

1.3.7 Attribute
Property of a class.

1.3.8 Cycle Time
The time required to complete an entire rotation (cycle) of traffic signals at any one intersection.

1.3.9 Direct Route
A route directly through the intersection that does not require the vehicle to turn.

1.3.10 DOT
Department of Transportation.

1.3.11 Downstream
The normal travel direction for vehicles.

1.3.12 Ethernet
The most commonly used local area networking method as described in IEEE 802.3.

1.3.13 Intersection
A system, including hardware and software, that regulates vehicle and pedestrian traffic where two or more major roads traverse. The class of intersection considered in this specification has only two roads.
Traffic Light Control System

*From textbook (Laplante '04)*

**Overall Description**

- All approaches are level, tangent surfaces.

**APPROACHES:**
- W-E
- E-W
- N-S
- S-N
Traffic Light Control System

Product Perspective
- System Interfaces
- User interfaces
- Hardware interfaces
- Software interfaces
- Communication interfaces
- Memory constraints
- Operations

Product functions
- User characteristics
  - Pedestrians
  - Motor vehicles
  - Traffic Regulatory Personnel
  - System Administrators

Constraints
- Regulatory policy
- Network protocols…

Assumptions
- SI units
- Commercial RTOS
  ...

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Traffic Light Control System

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Hardware Interfaces
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Specific requirements:

Top-level use-case diagram
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Specific requirements:

Preliminary class diagram
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Specific requirements:

Sample class description

<table>
<thead>
<tr>
<th>Pedestrian Traffic Standard</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attributes</td>
<td>Commanded Aspect</td>
<td>Commanded aspect from the Intersection Controller.</td>
</tr>
<tr>
<td>Methods</td>
<td>Set Indication</td>
<td>Set the displayed indication to the Commanded Indication.</td>
</tr>
<tr>
<td></td>
<td>Get Indication</td>
<td>Get the actual displayed indication based on signals from the current sensor hardware resource manager.</td>
</tr>
</tbody>
</table>
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*From textbook (Laplante ’04)*

**Specific requirements:**

Statechart for controller sequence
Traffic Light Control System

From textbook (Laplante '04)

Specific requirements:

Timing requirements

<table>
<thead>
<tr>
<th>ID</th>
<th>Designation</th>
<th>Applies to Mode(s)</th>
<th>Object/From Event</th>
<th>Object/To Response</th>
<th>Min Time (ms)</th>
<th>Max Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initialization</td>
<td>All</td>
<td>Hardware/Reset Signal</td>
<td>Intersection Controller/Initialization Complete</td>
<td>-</td>
<td>4900</td>
</tr>
<tr>
<td>2</td>
<td>Set Default Phase</td>
<td>All</td>
<td>Intersection Controller/Initialization Complete</td>
<td>All Traffic Standards/Display of commanded phase</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>Start Normal Operation</td>
<td>ACTUATED ADAPTIVE TIMED</td>
<td>Intersection Controller/Initialization Complete</td>
<td>All Traffic Standards/Display of Phase 1</td>
<td>-</td>
<td>500</td>
</tr>
<tr>
<td>4</td>
<td>Advance Phase - Normal</td>
<td>ACTUATED ADAPTIVE TIMED</td>
<td>Intersection Controller/Phase Time Remaining Reaches 0</td>
<td>All Traffic Standards/Display of Commanded Phase</td>
<td>-</td>
<td>100</td>
</tr>
</tbody>
</table>

(continued)
Summary

- Requirement analysis is critical for good system design
  - Errors made here are very hard to rectify later
- Structured techniques are available
  - Small-scale: FSM, Statechart, Petri-Net
  - Large-scale: Functional, OOAD
- Requirement documents capture essential information
  - Format and content are often regulated by government agencies (FAA, DoD, NASA)