

**Fall 2024**

**Selected Topics in Computer Design-CSE416s**

**Final Project**

**Adaptive Traffic Light Controller-Part A**

**Team #4**

Members:

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* **Controller Specifications:**

The controller is designed for use in a four-way intersection. It uses sensors readings to prioritize traffic flow dynamically. The controller operates through a finite state machine to cycle through traffic light states based on traffic conditions and timing.

**1. Features:**

* **Dynamic Traffic Management**: Adjusts traffic light durations based on real-time vehicle density from four directions (A, B, C, D).
* **Sequential State Transition**: Includes green, orange, and red states for each direction.
* **Sensor-Based Prioritization**: Uses sensor readings (Sa, Sb, Sc, Sd) to determine the next state.
* **Counter-Based Timing**: A configurable counter determines the duration of each traffic light state.

**2. Inputs and Outputs:**

* **Inputs**:
  + **Sa, Sb, Sc, Sd:** Two-bit signals representing traffic density in each direction (00→No cars, 01→Light Traffic, 11→Heavy Traffic).
  + **clk:** Clock signal.
  + **rst\_n**: Asynchronous Active-low reset signal.
* **Outputs**:
  + **Ta, Tb, Tc, Td:** Three-bit signals representing the traffic light state for directions A, B, C, and D (001 → green, 010 →orange, 100 → red).

**3. State Description:**

* **Green States (Ga, Gb, Gc, Gd)**:
  + The corresponding direction has a green light.
  + Counter set to 30 seconds.
  + Transitions to orange state (Oa, Ob, Oc, Od) when the counter expires.
* **Orange States (Oa, Ob, Oc, Od)**:
  + The corresponding direction has an orange light.
  + Counter set to 3 seconds.
  + Transitions to the green state of the next prioritized direction.

**4. Timing:**

* Green light duration: 30 seconds (adjustable via load\_value).
* Orange light duration: 3 seconds (fixed).
* Counter decrements each clock cycle.

**5. Priority Rules:**

* The direction with the highest traffic density has priority for the next green light.
* If multiple directions have equal density, default to a fixed priority order:

**(A → B → C → D).**

* **Traffic Light Algorithm:**

**1. Initialization:**

1. Set current\_state to Ga (Direction A green).
2. Load the counter with 30 for green light duration.

**2. FSM Logic:**

1. **Green States (Gx)**:
   * Check sensor readings:
     + If the current direction (Sa, Sb, Sc, or Sd) has the highest density, remain in the green state (Gx).
   * If the counter expires, transition to the corresponding orange state (Ox).
2. **Orange States (Ox)**:
   * Decrement the counter.
   * If the counter expires:
     + Determine the next direction to prioritize based on sensor inputs:
       - transition to the green state of the direction with the highest traffic density.
       - In case of ties, follow a fixed order (A → B → C → D).
3. **Counter Reload**:
   * When transitioning between states, reload the counter with the appropriate value (30 for green, 3 for orange).

**3. Output Logic:**

Use the current state to determine light signals:

* + In Gx: The corresponding direction is green, and others are red.
  + In Ox: The corresponding direction is orange, and others are red.

Snippets results with identification for each test case on wave form and transcript also i need you to use fsm debug mode and attach a snippet for fsm from tool with your handwrititten one to ensure no difference

Hint : you can run vsim with attribute -fsmdebug to show the fsm in questasim for more info refer to the user guide of the tool

For sure , snippets for your code and test bench also i need your work load for each one