# A Real-time Publish/Subscribe Driver Alert System for Accident Avoidance due to Red Light Running


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## 1. INTRODUCTION

Traffic signals provide the key mechanism to regulate traffic, and promote safe and efficient traffic flow at intersections. However, incidents of red light running can compromise the safety of the system. These incidents stem mostly due to the well known dilemma zone problem where the drivers cannot decide whether slowing down the vehicle would bring their vehicle to a stop or should they increase the speed and cross the intersection. Other factors, such as wet road conditions, make the problem worse.

This paper presents Intelligent Traffic Light (ITL), which is a cyber physical system that combines information technology (e.g., real-time publish/subscribe semantics) and communications technology (e.g., mobility and wireless) with the transportation infrastructure (e.g., vehicles, traffic lights and road-side units) to address the red light running incidents. ITL behaves as the publisher and vehicles subscribe to warning messages published for them. ITL estimates when a traffic light will change to red, and warns drivers of approaching vehicles about when and how much to slow down to avoid red light running. ITL can account for road conditions, which increases its usability in challenging weather conditions. Omnet++ is used for simulations to analyze real time behavior of the system.

## 2. ITL

Intelligent Traffic Light aims at real time dissemination. Next we will discuss the inherent capabilities that make ITL an Event Based Publish/Subscribe System.

### 2.1 Event Driven Architecture

Traffic signal phase changes are based on one of 3 systems: pre-timed, semi-actuated, and fully-actuated [6]. In fixed-time control system each phase of the signal lasts for a specific duration before the next phase occurs; this pattern repeats itself. We will consider this model for initial simulation.



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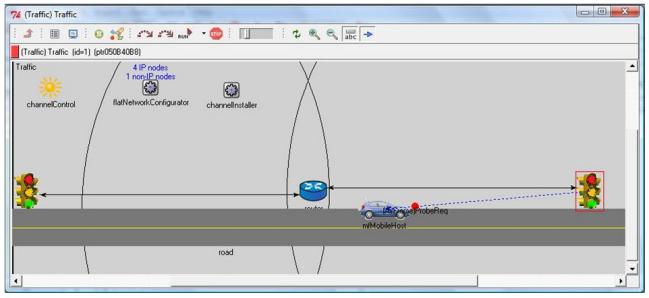


**Figure 1. Simulation using Omnet++ where car receives messages from ITL**

Event Flow in the ITL system can be summarized as:

1. Subscribe: Vehicles detect approaching Traffic Light and subscribe to it for warning messages.
2. Publish: Publish is event driven. It is governed by the event of traffic light changing colors. ITL will estimate the time for light to turn red and send messages accordingly to the particular subscriber.
3. Information Dissemination among car fleet: Cars in a particular range that need to receive the same warning message (cars which are at the same distance from the light) will receive it from a vehicle chosen as fleet head.

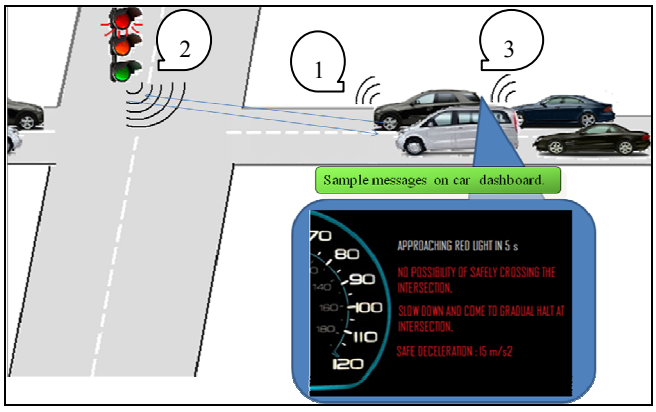


**Figure 2. Event Flow in ITL**

## 2.2 Estimating deceleration for vehicles

An ITL sensor per traffic light will track the state change of each light. In the current model, ITL assumes a fixed-time control system where each phase of the signal lasts for a specific duration before the next phase occurs; this pattern repeats itself regardless of traffic. The sensor relays an impending change in state to a road-side unit (RSU) in its radio range. The RSU senses vehicles in its range that are approaching the traffic light and analyzes their speeds. The vehicles also track the road conditions. The RSUs compute the desired deceleration for the vehicles which are then relayed back to them.

## 2.3 Publish/subscribe architecture

Publish/subscribe is an asynchronous messaging paradigm where publishers of messages are not programmed to send their messages to specific subscribers. Rather, published messages are characterized into classes, without knowledge of what subscribers there may be. Subscribers express interest in one or more classes, and only receive messages that are of interest, without knowledge of what publishers there are. This decoupling of publishers and subscribers can allow for greater scalability and a more dynamic network topology

Technology-wise ITS applications are very demanding. They need real-time, scalable and reliable delivery of information. Many ITS applications have very strict time constraint, like a driver needs to get a red light warning within the time he gets in range and before he needs to decelerate if the vehicle has to be stopped. Scalability becomes critical because the number of vehicles on the road can increase. Reliable dissemination as well as priority based service is required for many ITS applications to become useful. For example, special vehicle notification information needs to be disseminated to security people as fast as possible to warn vehicles that even though they can make it in time they need to stop at the next signal.

Publish/Subscribe architecture in ITL can be explained as follows:

Publisher: ITL will publish messages intended for cars who have subscribed to receive warnings. These messages will be published to the domain pertaining to a particular car.

Subscriber: Vehicles play the role of subscribers and subscribe to receive warning messages from ITL.

ITL procedure can be summarized as follows :

- Intelligent Traffic Signals are equipped with Wi-Fi context aware application. It is also aware of the time frame when light will turn red (Depending on the model followed by the traffic light).
- This application receives subscriptions from incoming cars that includes information about their speed location.
- Based on this information the Intelligent Traffic Light will calculate critical safety distance for the car to start decelerating if it cannot safely cross the intersection before light turns red.
- Vehicles are equipped with GPS (for location), Wi-Fi application to subscribe to and receive messages from traffic light and dashboard to display acceleration/deceleration and warning messages received from Traffic Light.
- Vehicle will detect approaching traffic light and subscribe to ITL.
- Vehicle will display messages indicating if the vehicle should slow down, and the time duration after which Light will turn red.

Publish Subscribe within vehicle fleet:

Since the range and the time window for communication from RSU to vehicle is short, the RSU and a platoon of vehicles form a vehicular ad hoc network (VANET). The RSU chooses a lead vehicle to disseminate an alert message with the suggested deceleration, which is then disseminated to other vehicles that follow.

# 3. CONCLUSION

ITL considers adverse conditions like fog, rain which affects traffic light visibility and makes relaying of warning messages in these conditions possible too. Special vehicles like ambulance, fire brigade etc which need vehicles to modify their travel speed could be equipped with special equipment to converse with Traffic Light. ITL could warn vehicles about approach of these vehicles. ITL could also behave as congestion control unit by being part of RSU network and thus relaying relevant congestion information to vehicles.

# 4. REFERENCES


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