Adaptive Traffic Control Systems (ATCS) — Part 3 — In|Sync

By Ron Whitelock

This article is the third in a series of articles on the new adaptive traffic control systems. If you have just joined our reviews, I suggest you locate and read the previous two article in the Journal (Nov.–Dec. 2013, Jan.–Feb. 2014) as background.

Again, I want to reiterate: These articles are composed mostly by the suppliers — they are the experts on their systems. I have developed a framework (subject areas) to focus the information on key parts and also to be consistent. This complex topic cannot be covered in 1,200–1,500 words. Thus the intent of these articles is:

• To introduce these systems so that you can decide if it is for your agency;
• To provide an overview of the system operation, features, etc so you understand its fundamentals;
• And provide a contact for follow-up;

Here we go! This is In|Sync.

Background

In|Sync® was invented by Dr. Reggie Chandra, PE, PTOE, a traffic operations engineer. Dr. Chandra served most of his career in the public sector synchronizing traffic signals for both city and state governments. Disillusioned with the outdated technology that controlled traffic signals, Dr. Chandra set out in 2006 to make a difference in the industry. After three years of intense research and development, In|Sync was launched in 2008.

System Features

The essence of In|Sync is a processor that is compatible with any make or model of traffic signal cabinet or controller. The processor analyzes data from any vehicle sensor at the intersection (inductive loop detector, camera, magnetometer, radar, etc.) and after communicating with upstream and downstream intersections optimizes traffic signal indication to provide optimum flow for the coordinated movements with minimum delay to the minor movements.

Other key features of the system are:

• In|Sync is fully digital and does not operate based on cycles or have cycle lengths.
• The coordinated movements (can be any, including left turns) are connected together based on travel time without a yield point (Type 170 controller) or a common point in the cycle (NEMA controllers).
• There is no transition between timing plans or after a preemption event.
• After the initial configuration, no human intervention is needed for efficient functioning of the system.
• If In|Sync cameras are used, the video can be monitored over a notebook computer, tablet or a smart phone.

System Architecture

Hardware

The primary hardware is an environmentally-hardened processor that performs optimization. It is plugged into the cabinet and can be rack or shelf mountable. The whole system is Ethernet-centric and an Ethernet network is required between intersections for efficient transmission of video and data.

Other key hardware components:

• IP Cameras: Cat-5e wired with 3-conductor power. The cameras have remote aim and focus.
• Equipment Panel: This is the power and communications hub of the system. It has a 24 VDC power supply, an 8-port 100 Mbps unmanaged Ethernet switch, a camera fuse block, and lightning arrestors.
• Connection Options for Integration: C1 Y-Cable, ABC Y-Cable, SDLC interface module, and a detector card.

The system architecture (Figure 1) and a typical wiring diagram (Figure 2) are shown on page 14.

Software

All video and data can be accessed over a web browser from your smart phone, tablet or computer. CentralSync, which uses a PC platform, is the main software used to configure the In|Sync system.

Optimization Process

Using data from existing sensors (inductive loop detectors, video detectors, magnetometers, radar, etc.), In|Sync creates a patented model for flow along each approach. The model is based on rule-based artificial intelligence (see Wikipedia for definition) that has multiple sub-models including gap estimation and modified “greedy algorithms” (see Wikipedia for definition). At a high level, the In|Sync model can be divided into three modules.

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This module converts analog traffic signal operations to digital finite state machine operations. Rather than emulate an electromechanical controller with the dial, split, fixed point for offset model, the system operates digitally by invoking states. A state is a non-conflicting, concurrent phase pair. By inputting vehicle detector calls for just two phases (states) into a traffic signal controller, the system is able to generate states and state sequences at will, eliminating traffic signal transition and the need for cycle-length based operation.

Local Optimization Module

In|Sync tracks how many vehicles are waiting per lane and the duration of their wait. A token or “cookie” is assigned to each vehicle on arrival and an additional cookie(s) is given for every five seconds of wait on red. Its algorithm changes the light status to minimize the number of cookies that are handed out. The optimization is not based on delay modeling. Instead, it considers the number of vehicles waiting per lane (real-time demand/volume) and the duration of their waiting time (delay). Rhythm Engineering has coined the phrase “intelligent actuation” to describe the local optimization process.

Global Optimization Module

The Global Optimization Module (GOM) facilitates coordinated progression and takes priority over the Local Optimization Module.

Essentially, speed lines are created along the signal network. In|Sync ensures that coordinated phases (compatible states) are initiated along the speed lines, guaranteeing progression. Any state, including left turns, can be coordinated. Unconstrained by analog, sequential cycle-based operation, the system is able to invoke any required state at will, enabling the GOM.

The entire model can be described as follows: The power to turn your coordinated phases on when you want them on and at all other times the signal operated “locally actuated.” With this model, you get the power of progression for your coordinated movements and the power of fully-actuated (free) operation for your traffic signal network.

Data Collection and Reporting

In|Sync collects and reports turning movement counts per lane, queue lengths, duration of waiting on red, and actual time-stamped green time per phase. All data can be archived. Data can be visualized and easily displayed on a standard web browser such as Internet Explorer, Firefox, Google Chrome, etc. Some screen shots of reports are shown on page 16 (Figures 3 and 4).

Fallback Operation

There are multiple failure mitigation strategies built into the system. Most of these mitigation strategies are unique to Rhythm Engineering.

Camera/detection failure

The system accesses historical data for operation without putting maximum recalls on affected phases. For example, the system knows the green duration of Phase 2 on a Wednesday between 2:00 p.m. and 2:15
p.m. for the last four weeks. Based on this information, the system calculates the Phase 2 duration. The system has been known to function flawlessly for six weeks at an intersection with a failed camera.

**Network failure**

Even if the network communications fail, the coordination between signals will continue. During communication failure, the systems revert to mutually-agreed-upon global speed lines. Since there is no central server and all intelligence resides locally, local optimization is not affected by communication failure. The system has been known to run flawlessly, with coordination between signals, on a 64,000 ADT arterial with broken communications for over six months.

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Processor failure

All detector calls are passed on to the existing traffic signal controller. The system can trigger a pin in the controller on failure to initiate time-of-day operations.

System Configuration

The system is configured using CentralSync, a PC-based software that can run on any notebook or desktop computer. Learning CentralSync is simple and can be accomplished in four hours of classroom instruction. Additionally, Rhythm Engineering offers a suite of training videos.

Once all hardware is installed in the field, adaptive operation is turned on in a day. Rhythm Engineering staff evaluate the arterial network and configure In|Sync to operate along the network. A typical 90-day deployment process and configuration is shown below in Figure 5.

Handling Pedestrian Calls, Transit, and Emergency Vehicles

The pedestrian module intercepts the pedestrian push button actuations and passes the information on to the In|Sync processor. The processor analyzes the ramifications of the pedestrian actuation and changes initiation of speed lines accordingly. The whole In|Sync network is optimized to cater to the pedestrian actuation.

The Transit Signal Priority (TSP) can be customized to integrate with each agency’s priority and existing software. The TSP module seamlessly interacts with adaptive algorithm. A transit vehicle can be given a user-defined weight or priority (cookies) that can be further based on whether the transit vehicle is on schedule or not.

The system is compatible with Emergency Vehicle Preemption (EVP). Since the system only places passive detector calls into the existing controller, EVP signals that have a higher priority than detector calls take precedence and get served immediately by the controller. One advantage of the digital system is that there is no transition after the EVP. The system enters smoothly into coordinated operation immediately after the preemption.

Cost

<table>
<thead>
<tr>
<th>Item</th>
<th>Investment</th>
</tr>
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<tbody>
<tr>
<td>In</td>
<td>Sync or In</td>
</tr>
<tr>
<td>In</td>
<td>Sync: Fusion</td>
</tr>
<tr>
<td>Intercept module (Optional)</td>
<td>$5,000</td>
</tr>
<tr>
<td>Project management</td>
<td>$3,500–$10,000 per project. Based on complexity.</td>
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**Included:** Two year warranty on hardware and software, 24/7/365 technical support and complete initial configuration.

For More Information

Please contact Rhythm Engineering at 913-227-0603 or visit rhythmtraffic.com.

Hope you find this information helpful.