Adaptive Traffic Control Systems (ATCS) has been gaining in popularity in recent years. FHWA’s Adaptive Control website notes: “Poor traffic signal timing contributes to traffic congestion and delay. Conventional signal systems use pre-programmed, daily signal timing schedules. Adaptive signal control technology adjusts the timing to accommodate changing traffic patterns and ease traffic congestion.

The main benefits of adaptive signal control technology over conventional signal systems are that it can:

• Continuously distribute green light time equitably for all traffic movements
• Improve travel time reliability by progressively moving vehicles through green lights
• Reduce congestion by creating smoother flow
• Prolong the effectiveness of traffic signal timing.”

It is not surprising, therefore, that adaptive control is finding its way into the mainstream to help agencies with increasing traffic demands; to utilize scarce resources and funds more appropriately.

Note. however, that the predominant ATCS, such as SCOOT and SCATS and the RT-TRACS solutions, are giving way to a simpler, easier to maintain, lower cost solutions. These Next Generation ATCS have the promise of providing enhanced functionality for traffic management to a greater number agencies, especially those with limited resources.

Figure 1 provides an overview of the Adaptive control process. In essence, Traffic Data is collected, processed in a modelling algorithm. The cycles, splits and offsets are then optimized before being sent back to the street. Each system performs these steps differently.

FHWA describes Traffic Systems type in terms of Generations.

<table>
<thead>
<tr>
<th>Generation</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>First-generation interconnected traffic signal control systems are characterized by the TOD/DOW selection of a timing plan from a set of timing plans, which are computed offline</td>
</tr>
<tr>
<td>1.5</td>
<td>Traffic adjusted control 1.5 generation added the capability for timing plans to be selected based on a combination of volume (V) and weighted occupancy (O) sensor data</td>
</tr>
<tr>
<td>2.0</td>
<td>Second-generation UTCS was a first attempt at real-time, online computing of optimized splits and offsets, while keeping cycle length fixed within variable groups of intersections</td>
</tr>
<tr>
<td>3.0</td>
<td>Classic Adaptive Control Systems – SCOOT SCATS RHODES etc</td>
</tr>
</tbody>
</table>

I have added a new level: Next Generation!

A debate is underway around what is ‘adaptive’ and what is ‘responsive’. Matt Selinger (et all) has produced a paper titled “Adaptive Traffic Control Systems in the United States – Updated Summary and Comparison” which approaches the issue this way.

“The term ‘adaptive’ has been used since the first generation technology was developed in the 1960s and 1970’s. Over the past 30 years, technology has made great advances while the term ‘adaptive’ has remained unchanged. Essentially transportation professionals view the term...
‘adaptive traffic control’ to mean ‘an advanced signal control system that updates traffic signal timing in some automated way’.

In our opinion this definition presents a problem. The term ‘adaptive’ should not be used as an all-encompassing term that reflects a generalized meaning for many generations of technology. Instead, the terminology for adaptive traffic control should also be refined to accurately depict the system operation or architecture. Today, we have two distinct types of adaptive systems: responsive adaptive systems and real-time adaptive systems.”

I looked up ‘adaptive’ in Merriam-Webster’s On-Line dictionary. It defines adaptive as “showing or having a capacity for or tendency toward adaptation” where adaptation is “the process of changing to fit some purpose or situation: the process of adapting”. ‘Responsive’ is defined as “reacting in a desired or positive way; quick to react or respond”.

Furthermore, the USDOT / FHWA Traffic Signal Control Handbook (Gordon and Tighe) lists the hierarchical modes of traffic signal operations as:

• Isolated
• Time Based Coordination
• Interconnected Control
• Traffic Adjusted Control
• Traffic Responsive Control
• Traffic Adaptive Control

To avoid a debate with my friend Matt, we may be splitting hairs here. Since the 1960s, traffic control practitioners have used Traffic Responsive to describe the method of selecting pre-set timing plans with some sort of algorithm that process real-time traffic data. On the other hand, Traffic Adaptive has been reserved for an algorithm that creates timing plans on the fly from real-time data. As these definitions are embedded in our culture, there is no intent to change them in this discussion.

In addition, Matt’s article goes on to show that classic-style adaptive systems are being decommissioned at a high rate for a number of reasons. Thus, the need for a Next Generation of adaptive control.

With many thanks to Intel and AMD, the microprocessor experts, we now have the computing power to accomplish advanced functions where we once needed a mainframe computer. The table below provides insight into just how much computing power has changed in the past decade or two. This increased power makes it possible to decentralize the computational aspect of these system – that is to perform much more of the function at the local intersection.

<table>
<thead>
<tr>
<th>Year</th>
<th>Processor</th>
<th>MIPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974</td>
<td>8080</td>
<td>0.33</td>
</tr>
<tr>
<td>1992</td>
<td>80486</td>
<td>54</td>
</tr>
<tr>
<td>2001</td>
<td>P4</td>
<td>3000</td>
</tr>
<tr>
<td>2012</td>
<td>i7</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Table 1: Processor Speed Comparison (MIPS - million instructions per second) Source: Wikipedia

A strong case has been made for using adaptive traffic control techniques. Accordingly, manufacturers are jumping into the fray with innovative approaches. Over the next few articles, we will investigate these new ideas with the ‘Next Generation’ category.

In fact, FHWA’s “Everyday Day Counts” program states its objective “is to mainstream the use of the ASCT (Adaptive Signal Control Technology) as a traffic operations strategy. FHWA supports the deployment of this technology …”

A lot has been written about the RHODES, SCOOT, SCATS etc. ATCS’, so no need to discuss them again. The Next Generation ATCS’ requires a closer look!

In the future editions of the Journal, we will take a look ‘under-the-hood’ at:

• FHWA’s ACS Lite
• Rhythm Engineering’s InSync
• McCain’s QuicTrac
• Miovision’s Spectrum
• Delcan’s MAC

Something to think about!