From the Flintstones to the Jetsons: How PennDOT District 8 Is Improving Traffic Monitoring, Operations and Incident Response with ITS

The Pennsylvania Department of Transportation (PennDOT) oversees transportation issues within the Commonwealth of Pennsylvania’s state highway network. Administratively, PennDOT is composed of eleven (11) Engineering Districts in order to localize design, maintenance and construction of state highways and bridges. District 8-0 is located in south central Pennsylvania and includes the counties of Adam, Cumberland, Dauphin, Franklin, Lancaster, Lebanon, Perry and York, as well as the State capital, the City of Harrisburg.

The Harrisburg Metropolitan Area has experienced ongoing changes in travel demand by virtue of its location at the intersection of several major transportation corridors that serve as key routes for interstate commerce, stretching from the Canadian border in the North to Tennessee in the South, and linking the Atlantic Coast with manufacturing and farming centers in the Midwest. Regional highways also serve as an inland alternate for Interstate 95.

To address increasing travel demand, manage congestion and improve safety and operations, District 8-0 completed an Intelligent Transportation Systems (ITS) project in the Harrisburg Metropolitan Area. The project focused on accelerating the integration and interoperability of ITS in metropolitan and rural areas. Through a best value contract selection mechanism, PennDOT selected the Wellington Power/Jacobs Engineering team for this Design-Build Project, covering nearly sixty (60) miles of limited access routes, including the Harrisburg Capital Beltway at a current cost of $19M.
Designed to improve transportation efficiency and promote safety, the project included the design, procurement, installation, integration and testing of ITS devices, all of which are operated, managed, maintained and leveraged via a central Physical Security Information Management (PSIM) platform. The PSIM software technology enables the District to monitor and effectively manage traffic flow and incidents from its Regional Traffic Management Center (RTMC), which was created as part of this project and replaced the previous three-person office.

Serving as the focal point for information collection and dissemination of all traffic management operations within the District, the RTMC is open 24/7/365. The RTMC enables personnel to monitor and manage traffic incidents and flow, using real-time information to identify and react to roadway incidents more effectively, as well as to deploy critical resources efficiently. Since its creation, it has become a critical asset, addressing day-to-day traffic incident management. The RTMC enables the District to be better prepared for any incident, coordinate with other service providers more efficiently, and clear incidents more quickly. The technology within the Center enables operators to verify incidents and complaints much more quickly and assign appropriate action to resolve each situation. Additionally, the technology provides more accurate detail of which roadways are closed and why they are inaccessible during incidents or severe weather conditions. For example, over the past several months, the District has experienced severe thunderstorms that resulted in downed trees and power lines, a hurricane that caused major flooding and power outages, and a somewhat surprising major snowstorm in October with wet, heavy snow that also downed trees and power lines. The RTMC was able to centrally manage every situation that unfolded during these weather situations and coordinate response efforts with Counties and other agencies, including the Pennsylvania Emergency Management Agency (PEMA), Pennsylvania State Police and County 9-1-1 centers, all while minimizing additional disruption throughout the District’s highways.

Figure 2. District 8-0 RTMC
Technology Leveraged
To create the RTMC, PennDOT first establishes a control room with video walls, operator consoles and workstations, and installed PSIM software from VidSys, which was required for the command and control of the ITS field devices including Dynamic Message Sign (DMS), Closed Circuit Television (CCTV), and Highway Advisory Radio (HAR). The PSIM software integrates and analyzes information from PennDOT’s existing disparate security devices, surveillance technologies and information systems, and provides a common operating picture (COP) with intelligence that enables faster, more effective decision making for traffic management and incident response while saving resources and potentially lives. For example, the PSIM software can help monitor and manage the flow of traffic so that during peak travel hours, drivers could be re-routed as necessary and electronic signs could be updated with appropriate warning messages for slow-downs and construction – all of which could, in turn, reduce the risk for crashes. Additionally, as the PSIM software captures traffic events as they occur and applies pre-established rules to the event data, it also flags exceptions, such as congestion that is not normal for a particular stretch of road at a particular time of day. If there is an exception, the PSIM software enables operators to immediately access the nearest cameras to assess the situation and determine if action is required.

The project also involved field-to-field and field-to-center integration. The field-to-field integration included the integration between one Roadway Vehicle Detector and a DMS. The field-to-center device integration included the integration of ITS field devices (DMS, CCTV, and HAR) with the central PSIM software installed at the RTMC. The field-to-central integration allows the command and control of the ITS field devices from the PSIM software residing at the RTMC. Field ITS devices communicate with the RTMC over the leased telecommunication lines using IP technology. This digital architecture provides for a scalable solution that over the long term will meet growing needs such as adding cameras, servers, storage, technologies and users.

Figure 3. Video Management System
By serving as the central platform for the RTMC, the PSIM software enables faster, more intelligent decision making for traffic management and incident response while saving resources and potentially lives. With real-time data streaming into the RTMC, the PSIM software puts intelligence into the District operators’ hands, helping them quickly verify situations by presenting relevant data in a quick and easily digestible form as it is unfolding, slashing response times. As a result, the District is better able to manage daily transportation incidents and reduce congestion on its roadways.

Results to Date
The implementation of ITS projects can have positive effects on traffic flow and safety. These systems can be effective in reducing recurring congestion and the associated accidents common to stop and go traffic conditions. Rear end collisions and crashes resulting from the sudden slowing or stoppage of traffic are typical of the conditions where ITS systems can be effective in reducing accident frequency.

The ITS system implemented in PennDOT District 8 provided CCTV, DMS, and HAR devices across the primary limited access routes in the Harrisburg metropolitan area. The routes included for ITS coverage were I-81, I-83, PA 581, and US 22/322. Together, these routes form a “beltway” around the Harrisburg capital district, with I-81 and I-83 carrying significant volumes of through and commercial traffic.

A review of PennDOT crash statistics for the calendar years 2006 and 2010 was made for I-81 between Carlisle and the I-78 interchange, I-83 from Exit 32 to I-81, PA 581 from I-83 to I-81, and US 22/322 from I-81 to Amity Hall. These portions of roadway comprise the core of the recurring congestion found in the metropolitan Harrisburg area. In addition, a crash data review of westbound US 22/322 at the Clarks Ferry Bridge over the Susquehanna River was performed in order to measure the effectiveness of a truck speed warning system installed in advance of the curve leading onto the bridge.

The crash statistics were obtained from PennDOT’s Crash Data Analysis Retrieval Tool (CDART). Annual Average Daily Traffic (AADT) data for 2010 were also obtained for the roadways. AADT data for 2006 were not available and were therefore calculated, assuming an increase of 1% per year. Each roadway was evaluated in order to determine the overall crash rate per million vehicle miles traveled, as well as for a comparison between the 2006 and 2010 crash rates. The evaluation found that the 2006-2010 crash rate decreased by 17.1% on PA 581 (0.71 in 2006 and 0.59 in 2010), increased by 24.4% on US 22/322 (0.22 in 2006 and 0.28 in 2010), increased by 0.4% on I-83 (0.746 in 2006 and 0.749 in 2010), and increased by 6.1% on I-81 (0.25 in 2006 and 0.26 in 2010). The increase in overall crash rates may be attributed to the increase in traffic volumes along the roadways.

The PennDOT crash statistics reflects an overall decrease in rear end accidents on the “beltway” routes between 2006 and 2010, with the maximum decrease occurring on PA 581, where this type of accident decreased 29.3%. Sudden slowing/stop crashes also showed improvement with a decrease of 14.35% on I-83 and a decrease of 50% on I-81. Both of these routes carry high volumes of through and commercial traffic, as well as regional commuter type traffic with the typical rush hour congestion issues. Also, during the same time period, the I-81 and I-83 corridors experienced decreases of up to 16.4% in the number of large truck crashes.
In addition to the ITS devices previously described, PennDOT District 8 requested the development of a warning system to address a series of large truck crashes on the US 22/322 westbound approach to the Clarks Ferry Bridge. The Wellington/Jacobs team provided a radar speed warning system with the speed display located ½ mile prior to the beginning of the left horizontal curve where the series of crashes had occurred. In the years 2006 through 2008, three (3) crashes involving large trucks occurred with one (1) involving fatal injuries. Two (2) of the three (3) crashes resulted in the truck rolling over, including the fatal incident. The remaining crash was a barrier impact without the vehicle rolling over. The radar speed warning system was placed in service during 2009. Crash records for 2009 and 2010 indicate that no crashes have occurred in the same area as the 2006 through 2008 crashes. The implementation of this radar speed warning system has not only reduced the number of crashes, but is direct evidence of the benefits that can be derived through the effective placement of ITS devices.

As the crash analysis has shown, the “Beltway” corridors surrounding the Harrisburg Metropolitan Area experienced improvement in the number of crashes and traffic flow following the completion of the PennDOT District 8-0 ITS project.

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