Statewide Traffic Operations and Response Management Program

Concept of Operations

April 2019

Georgia Department of Transportation

CONTENTS

TABLES

FIGURES

VERSIONS AND APPROVALS

Date	Approval	Version No.	Version Update Comment
3/22/2019		2.0	Update to version 1.0 released in 2011
3/28/2019		2.1	Revised to address GDOT review comments.
4/15/2019		2.2	Revised to include the program name and updated diagrams

1 INTRODUCTION

1.1 PURPOSE OF DOCUMENT

The purpose of this Concept of Operations (ConOps) document is to define the envisioned operational framework for the Georgia Department of Transportation (GDOT) Statewide Traffic Operations and Response Management (STORM) program. The ConOps captures the existing conditions; establishes the reasons for change; identifies stakeholders; communicates users' needs and expectations; and provides the overall concepts used to govern the implementation and execution of the STORM program.

This ConOps was developed following the systems engineering process. The International Council of Systems Engineering (INCOSE) defines "systems engineering" as follows:

> *"Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem (Operations, Cost & Schedule, Performance, Training & Support, Testing, Manufacturing, and Disposal).*
>
> *Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs."*

Systems engineering is a stepped and incremental process of relating the various stages in the system life cycle to one another. The systems engineering process is often graphically described as the systems engineering "V" Diagram, which is shown in Figure 1-1. The process reads from left to right, starting with the Regional Intelligent Transportation System (ITS) Architecture. Planning and design activities along the left side of the "V" become further defined and detailed towards implementation. From the bottom and up the right side of the "V," integration and subsequent graduated testing verifies design and system requirements were met. The results trace back to their related design or system requirement and recompose to validate the operational concepts and scenarios identified in this ConOps.

The ConOps document aims to identify high-level user needs and system capabilities later used to develop the requirements of the STORM program. The ConOps document derives from extensive interviews with the stakeholders and users of the current programs. The ConOps document development gives stakeholders the opportunity to provide their input on how they want the program structured, implemented, and managed. The document is the users' document and should reflect all their needs accurately.

The ConOps is a living document and should be modified throughout the lifecycle of the program.

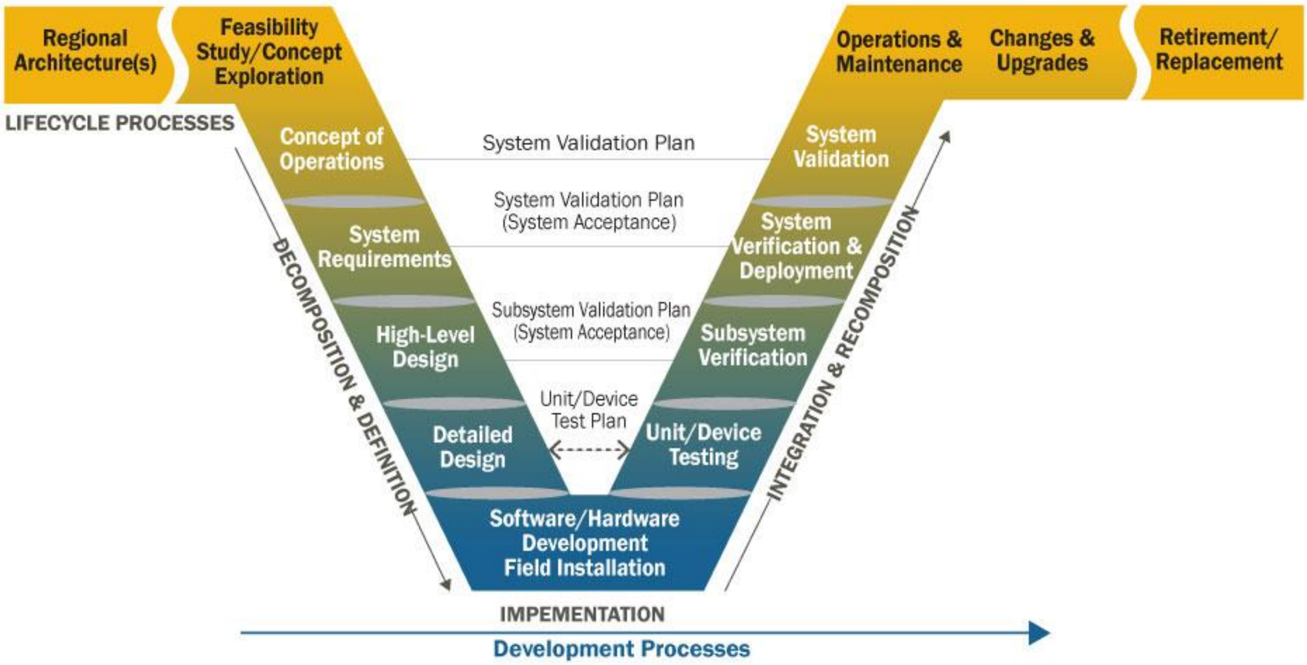

FIGURE 1-1: SYSTEMS ENGINEERING "V"- DIAGRAM

1.2 PROJECT SCOPE

The primary scope of this project is to update GDOT's traffic signal program ConOps document. The update will capture the evolution of the traffic signal operation programs and guide the integration of the programs into a cohesive statewide program. The ConOps will be supported by information gathered from those who are involved in the current traffic signal programs and from reviews of the best practices from the other states' traffic signal programs. The project includes conducting interviews with GDOT and consultant staff who are actively engaged in the programs. Questionnaires will be used to gather stakeholder input on the current programs and to gather needs for the programs as they evolve. The information gathered will be used to document the goals, vision and operational concepts for the STORM program meeting the needs of traveling public, GDOT, and local agencies.

2 REFERENCES

2.1 REFERENCE DOCUMENTS

The following documents were referenced in developing the GDOT STORM program Concept of Operations document:

- Regional Traffic Operations Program, Concept of Operations, URS, February 2011
- Georgia Department of Transportation, Automated Traffic Signal Performance Measures Reporting Details, Atkins, December 2016
- TEAMS Standard Operating Guidelines, August 2018
- Standard Operating Guidelines, Traffic Signal Operations Specialists, Draft - May 2018
- Draft GDOT Traffic Signal Maintenance and Operations Plan, October 22, 2018, Revised February 5, 2019
- UDOT Traffic Signal Management Plan, February 5, 2016

2.2 STAKEHOLDER IDENTIFICATION VISITS

A series of on-site visits with GDOT staff and consultants were conducted. The purpose of the meetings was to gather information about the current traffic signal maintenance and operations programs. A list of on-site visits is provided below:

- Regional Traffic Operations Program (RTOP) Manager – January 16, 2019
- Regional Traffic Operations Program (RTOP) Supervisor – RTOP 1 & RTOP 3 – January 16, 2019
- State Traffic Signal Engineer & Regional Traffic Signal Operations (RTSO) Manager – January 17, 2019
- Assistant State Traffic Engineer – January 17, 2019
- Jacobs Engineering – January 17, 2019
- Regional Traffic Operations Program (RTOP) Supervisor – RTOP 2 & RTOP 4 – January 18, 2019
- Arcadis– January 18, 2019
- State Traffic Engineer – January 22, 2019
- Kimley Horn & Associates – February 7, 2019
- AECOM – February 14, 2019

2.3 STAKEHOLDER SURVEYS

An online survey was prepared and hosted to gather local agency input related to GDOT's existing traffic signal programs. A sampling of local agencies was provided a link to the survey. Survey results were compiled from the following local agencies:

- Cobb County
- Dekalb County
- Gwinnett County
- Paulding County
- City of Alpharetta
- City of Atlanta
- City of Brookhaven
- City of Dalton
- City of Gainesville
- City of Rome

2.4 ACRONYMS AND TERMS

Table 2-1 lists and defines selected project-specific terms used throughout this ConOps document.

TABLE 2-1: ACRONYMS & TERMS

Acronym/Term	Description
AD	Administrative
ATSPM	Automated Traffic Signal Performance Measures
C2C	Center to Center
CATT	Center for Advanced Transportation Technology
CCTV	Closed Circuit Television
CID	Community Improvement District
CO	Collaboration
ConOps	Concept of Operations
CU	Customer
DO	Documentation
DOT	Department of Transportation
DSRC	Dedicated Short Range Communications
Engr	Engineer
FHWA	Federal Highway Administration
GDOT	Georgia Department of Transportation
INCOSE	International Council of Systems Engineering
IT	Information Technology
ITS	Intelligent Transportation Systems
LAN	Local Area Network
MA	Maintenance
MARK	Measurement, Accuracy, and Reliability KIT
MOU	Memorandum of Understanding
OP	Operations
PE	Personnel
PeMS	Performance Monitoring System
PII	Personal Identifiable Information
PM	Program Manager
PTI	Planning Time Index
RD	Reports and Data
RFP	Request for Proposal
RITIS	Regional Integrated Transportation Information System
RSU	Roadside Unit
RTOP	Regional Traffic Operations Program
RTSO	Regional Traffic Signal Operations
SME	Subject Matter Expert

Acronym/Term	Description
SO	Software
SOP	Standard Operating Procedure
SPaT	Signal Phasing and Timing
STORM	Statewide Traffic Operations and Response Management
TBD	To Be Determined
TCC	Traffic Control Center
TE	Technology
TEAMS	Traffic Engineering Asset Management Software
TMC	Transportation Management Center
TMDD	Traffic Management Data Dictionary
TSOE	Traffic Signal Operations Engineer
TSOS	Traffic Signal Operations Specialists
TTI	Travel Time Index

3 PROJECT OVERVIEW

3.1 BACKGROUND

The Georgia Department of Transportation (GDOT) operates and maintains over 3,000 traffic signals across the State of Georgia, out of approximately 6,500 on-system signals and over 10,000 total traffic signals in the state. GDOT also manages and operates over 200 interstate ramp meters in the Metro Atlanta area.

Of the on-system signals not maintained and operated by GDOT, the local municipalities and governments rely on GDOT support with much of the equipment and infrastructure required to operate these signals. There are approximately 100 local agencies and municipalities in the State of Georgia that operate and maintain their own traffic signals and systems, relying on the Department for support in these efforts. The programs GDOT offers for support range from detector repair and maintenance all the way to active management of a traffic signal system.

The driving public expects the traffic signal systems to consistently operate in an efficient and safe manner. Regardless of jurisdiction or route, it is expected that every signal operates with the same efficacy. The typical driver also does not associate a signal with a particular jurisdiction, as GDOT is typically considered responsible for any malfunction or operational inefficiency on a roadway. This increases the need for GDOT to have a more active role in establishing and enforcing region-wide and statewide maintenance and operational standards.

GDOT currently has communications to over 6,000 traffic signals on a single centralized system, all operating on the same firmware in the field controller. Communications to these signals is over either a fiber optic network or 4G LTE wireless communications. This system also logs high-resolution controller data for all the signals connected to this network, providing for remote and automated monitoring of performance metrics through open-sourced software platforms.

3.2 DESCRIPTION OF CURRENT OPERATIONS

3.2.1 OVERVIEW

GDOT has seven district offices throughout the state. Each of these district offices has its own traffic operations group, which consists of engineers and technicians dedicated to the maintenance and operations of traffic signals. Permitting is a big focus of the district staff, as well as front lines for maintenance and emergency repair of traffic signals. The central staff, located at the Transportation Management Center (TMC), focuses on programmatic activities and statewide initiatives, such as contractor and consultant support.

3.2.2 REGIONAL OPERATIONS

GDOT developed traffic signal programs to manage the traffic signals throughout the state of Georgia. These programs support different geographical areas of the state but are intended to address local and regional transportation needs in a consistent manner leveraging methods and techniques learned from each program. These programs are the Regional Traffic Operations Program (RTOP) and Regional Traffic Signal Operations (RTSO) program and are described below.

3.2.2.1 REGIONAL TRAFFIC OPERATIONS PROGRAM (RTOP)

GDOT manages RTOP in the Metro Atlanta area. With active management of over 1,900 signals, the RTOP utilizes many advanced features in traffic signal software to provide optimum operation of traffic signals. These signals are found on several "regionally significant corridors" throughout the Metro Atlanta area. Many of these signals have CCTV cameras located at each intersection that allows for remote monitoring, which reduces response time and allows for more wide-spread active management.

RTOP originally focused on corridors of regional significance, meaning those corridors that carry high volumes of vehicles and which experience recurring congestion. A secondary focus was added to include corridors that were important to mobility throughout the region. As RTOP matured and expanded regionally, the program shifted from a corridor to a zone approach. This change was implemented to more efficiently manage their human resources and allow for better regional coordination.

There are multiple RTOP consultant contracts for signal maintenance and operations. Each consultant contract oversees an area and the consultant provides an area program manager. The areas are divided into zones. Each zone has a zone manager. The RTOP 1 consultants manage Area 1 which consist of Zones 1, 2, 3, and 8. The RTOP 1 consultants also provide Traffic Signal Operations Specialists (TSOS) that monitor traffic signal systems from the TMC for both RTOP areas. The RTOP 2 consultants manage Area 2 which consist of Zones 4, 5, 6, and 7. The RTOP 2 consultants are also responsible for website management, data analytics, and reporting.

The RTOP zone boundaries were designated with the goal of balancing the RTOP corridors. The number of intersections, level of effort required, and geographical region were all factors in designating zone boundaries. Each zone is managed by a zone manager who has a group of engineers assigned to them. Each consultant contract also has dedicated signal timing, communications, and maintenance teams that assist all the zone managers within that area.

3.2.2.2 REGIONAL TRAFFIC SIGNAL OPERATIONS (RTSO)

GDOT manages a RTSO program focused on providing operational and maintenance support for traffic signals outside of the Metro Atlanta area defined in RTOP. It aims to apply a contextual approach to the active management of arterials through improved signal operations. RTSO is a newer program that continues to evolve with a goal of improving and expanding signal communications. This will allow for proactive operations and maintenance of all traffic signals in Georgia, regardless of their location or ownership.

The RTSO program is comprised of three (3) regions. The regions are defined along GDOT District boundaries. Region 1 includes Districts 1 and 6; Region 2 includes Districts 3, 4, and a portion of District 7 (Cobb, Douglas, and Fulton Counties); and Region 3 includes Districts 2, 5 and a portion of District 7 (DeKalb, Rockdale, and Clayton Counties). The RTSO regions in GDOT currently have a separate consultant contract supporting each of the regions. These consultant contracts utilize Traffic Signal Operations Engineers (TSOE) to remotely provide traffic signal monitoring and needed adjustments to the traffic signal systems.

3.2.2.3 ORGANIZATION

Figure 3-1 depicts the Regional Traffic Signal Operations and Maintenance programs' organizational structure. The organizational elements with the dark yellow background are GDOT positions which are described in sub-section 4.4.1. Those with the grey background are consultant positions which are described in sub-section 4.4.1.3.

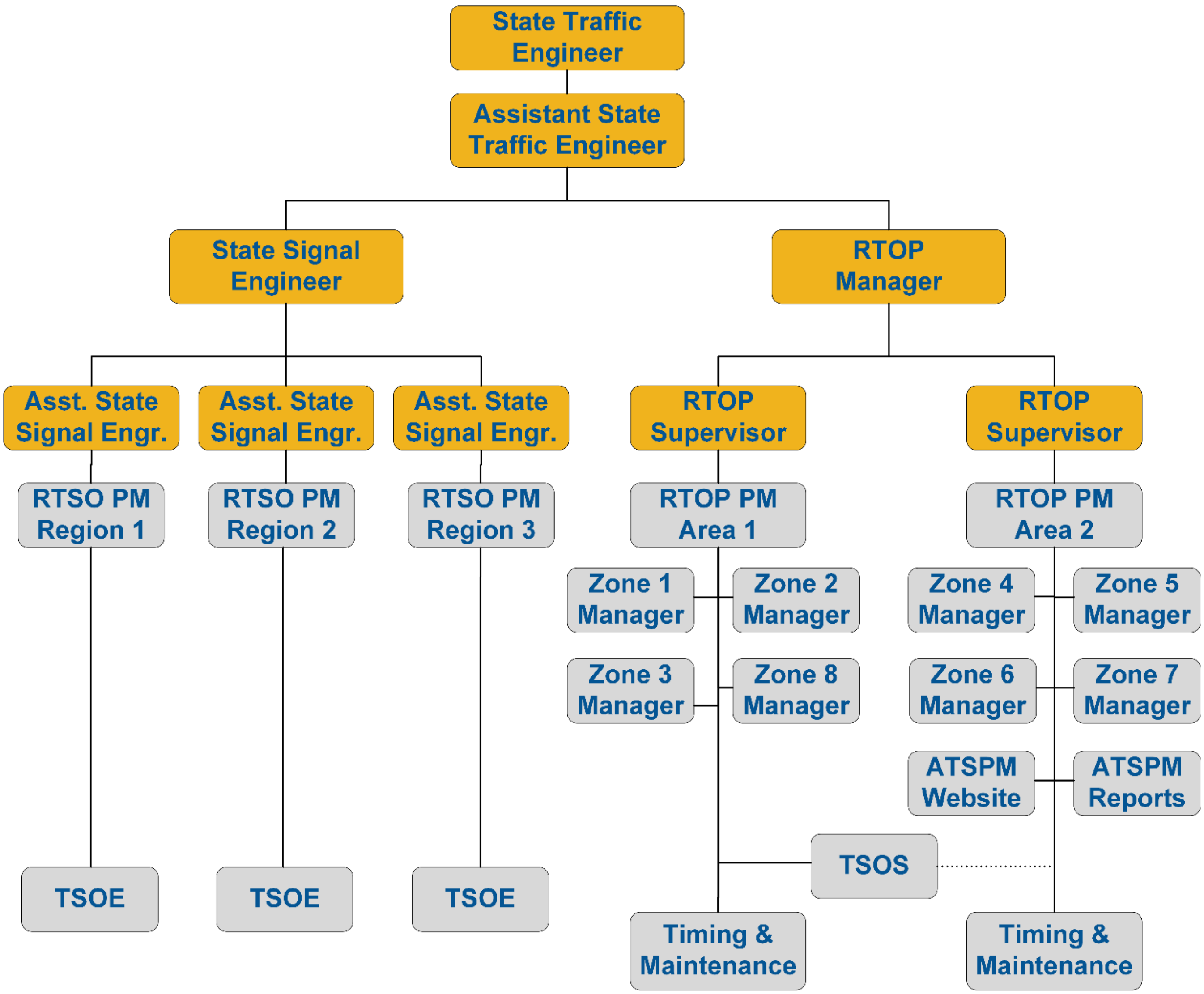

FIGURE 3-1: GDOT EXISTING TRAFFIC SIGNAL PROGRAMS ORGANIZATIONAL CHART

3.2.3 SOFTWARE AND SYSTEMS

Various software products and services are used to support the overall regional traffic signal management programs. These software products and any interactions between them are identified in Figure 3-2 and are described in this Section.

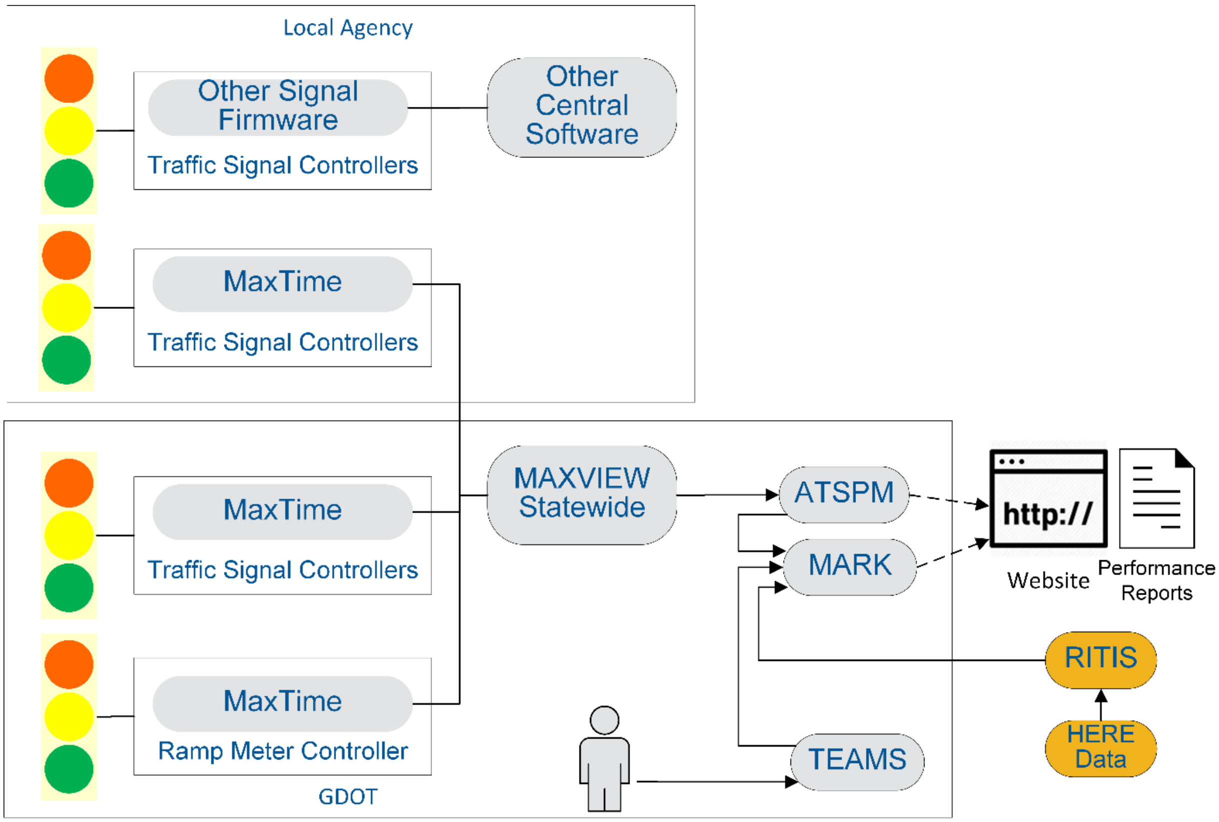

FIGURE 3-2: GDOT EXISTING TRAFFIC SIGNAL OPERATIONS APPLICATIONS

3.2.3.1 MAXVIEW AND MAXTIME

GDOT currently uses MaxTime for their local traffic signal controller firmware and MaxView for their central traffic signal management software. These software platforms were selected based on their standardized platform and their ability to evolve as technology grows.

The MaxTime firmware runs on GDOT traffic signal controllers and is used to control the operation of the individual traffic signals and associated systems such as pedestrian accommodations, preemption, and connected vehicle applications. The MaxTime firmware is also being implemented on local agency traffic signal controllers for operational compatibility.

The MaxView software runs on servers at the TMC as the statewide central traffic signal management software. It provides a single, consistent interface to manage the operations of all traffic signal systems within the GDOT network. Some local jurisdictions have stand-alone installations of MaxView on their servers. These stand-alone installations currently do not communicate with the statewide MaxView software.

MaxView communicates with the MaxTime firmware running on local agency and GDOT traffic signal controllers. Through this communication, signal systems can be monitored and controlled remotely. It also allows for the collection of high-resolution signal data to be used for performance monitoring and reporting.

The MaxView software is also used to operate the GDOT ramp meters installed at entrances to the freeway system in the metro Atlanta area.

3.2.3.2 OTHER SIGNAL FIRMWARE AND CENTRAL SOFTWARE

Local agencies that do not utilize MaxTime on their traffic signal controllers use other firmware, such as SCATS or TACTICS, to manage their signals. The firmware being used would communicate to the central software being used by the agency. As shown in Figure 3-2, these systems do not communicate with the statewide central software.

3.2.3.3 AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES (ATSPM)

The ATSPM software was originally developed by UTAH DOT. It is an open source software that GDOT has adopted and modified for their use. ATSPM show real-time and historical functionality at signalized intersections. The data used for the ATSPM comes from a “data-logger” program that runs in the background of the traffic signal controller firmware collecting high-resolution signal performance data. ATSPM passes data to MARK.

3.2.3.4 MEASUREMENT, ACCURACY, AND RELIABILITY KIT (MARK)

MARK was developed, based on open source code, to track signal performance measures such as throughput, arrivals on green, queue spillback rate, split failures, and travel time metrics. It also tracks various volumes by corridor, equipment uptime, and TEAMS tasks activities. Users can query and view data via the MARK website.

MARK currently tracks data for RTOP signals and signals for some GDOT Districts and local agencies. The goal is to eventually track signal performance for all Georgia traffic signals in MARK. MARK obtains data from ATSPM, RITIS, TEAMS, and NaviGAtor.

3.2.3.5 REGIONAL INTEGRATED TRANSPORTATION INFORMATION SYSTEM (RITIS)

RITIS is an automated data fusion and dissemination system that provides an enhanced overall view of the transportation network. RITIS was developed and operated by the University of Maryland Center for Advanced Transportation Technology (CATT) Laboratory. RITIS is used to view overall traffic system performance and trends as well as perform bottleneck and trend analysis when new signals are requested.

3.2.3.6 TRAFFIC ENGINEERING ASSET MANAGEMENT SOFTWARE (TEAMS)

TEAMS is an application that is used for traffic signal system asset management; and task creation and monitoring. The TEAM tasks activities data is passed to MARK to be accessed via the MARK website. It is also used to track project and maintenance work. Task types include Malfunction, Incident, Operation, and Preventive Maintenance. TEAMS also has a reporting function. Incremental changes have been made to the TEAMS software to address the needs of GDOT.

3.2.4 CONNECTED VEHICLES AND EMERGING TECHNOLOGY

GDOT started deploying connected vehicle technology along arterials in the Metro Atlanta area and are currently expanding these deployments to additional signalized intersections within the Metro Atlanta area. These deployments consist of roadside units (RSU); software applications to produce and transmit signal phasing and timing (SPaT); and MAP messages to vehicles and systems implemented with connected vehicle technology.

4 USER-ORIENTED OPERATIONAL CONCEPT DESCRIPTION

This section defines the project mission, vision, and goals from a user perspective to enable users, stakeholders, regional partners, and system developers to achieve consensus and understanding of how the GDOT Traffic Signal programs will operate and benefit their interests.

Existing policies and constraints are also identified to understand how they will affect the Traffic Signal programs and its users. Stakeholders roles and responsibilities are also identified.

4.1 PROJECT MISSION, VISION & GOALS

The following mission, vision, and goals are the driving force behind the use of GDOT resources, consultants, and partnerships with stakeholders to continually improve traffic signal operations for the benefit of the traveling public.

4.1.1 MISSION

The Mission of GDOT's Statewide Traffic Operations and Response Management program is to proactively manage and maintain traffic signals statewide by leveraging existing and emerging technology.

4.1.2 VISION

The Vision of the GDOT Statewide Traffic Operations and Response Management program is to provide consistent, safe, reliable, and secure travel through improved traffic signal operations.

4.1.3 GOALS

The following goals guide the statewide operation and maintenance of traffic signals in Georgia. They can be classified as Safety, Reliability, Efficiency, and Customer Service Goals.

Safety Goals:

- Provide a safe, efficient, and well-maintained statewide traffic signal system

Reliability Goals:

- Facilitate informed data driven decision making through technology

Efficiency Goals:

- Efficiently manage and allocate financial and contract resources
- Provide a flexible, accountable, scalable, and transparent traffic signal program
- Promote collaboration and cooperation between statewide, regional, and local partners

Customer Service Goals:

- Provide a high level of customer satisfaction for traffic signal operations and maintenance

4.1.4 OBJECTIVES

The objectives identified in this Section are actions the Department may implement to achieve the goals detailed in Sub-section 4.1.3

- Be proactive in the maintenance and operations of traffic signals
- Utilize data and data analytics to inform decision-making
- Utilize resources and technology to achieve a full situational awareness of traffic signal maintenance and operations
- Be responsive to customer service needs
- Maintain good progression on selected arterials at selected times of day
- Provide safe and consistent signal timing to maximize efficiency and reliability
- Update traffic signal hardware, software, and communications statewide
- Migrate all traffic signals in the state into the State's Traffic Signal Program
- Deploy technology smart corridors
- Increase the Capability Maturity Model level for Georgia's traffic signal systems
- Improve coordination with District offices and local agencies
- Promote open communication with District offices, local agencies, and consultants
- Define success and performance goals of traffic signals based on operational context
- Demonstrate flexibility and responsiveness in the processes, policies, procedures, tactics, strategies, and objectives of the traffic signal program
- Build and maintain public trust
- Keep the public fully informed about the development and operation of the traffic signal system
- Provide facilities at traffic signals to safely and efficiently accommodate all road users
- Operate traffic signal system at its maximum efficiency within the context of a balanced, multimodal operation
- Undertake maintenance in a cost-effective manner
- Coordinate cooperatively with local agencies to develop and implement regional solutions to traffic problems related to regional issues
- Design traffic signal system elements that are sustainable in a fiscally responsible manner
- Sustain a traffic signal infrastructure that is appropriate for accommodating current mobility goals
- Maintain operational efficiency of signal system
- Ensure that traffic signals provide equitable service to all users
- Manage investments through performance measures and useful reports
- Support periodic evaluation and updating of the programs

Table 4-1 identifies the Goal(s) that each Objective is meant to help achieve.

TABLE 4-1: OBJECTIVE TO GOAL MAPPING

Objectives	Goals					
	Provide a safe, efficient, and well-maintained statewide traffic signal system	Provide a flexible, accountable, scalable, and transparent traffic signal program	Promote collaboration and cooperation between statewide, regional, and local partners	Facilitate informed data driven decision making through technology	Efficiently manage and allocate financial and contract resources	Provide a high level of customer satisfaction for traffic signal operations and maintenance
Be proactive in the maintenance and operations of traffic signals	X	X	X			
Utilize data and data analytics to inform decision-making	X	X	X	X	X	
Utilize resources and technology to achieve a full situational awareness of traffic signal maintenance and operations	X	X		X	X	
Be responsive to customer service needs	X				X	X
Maintain good progression on selected arterials at selected times of day	X		X			
Provide safe and consistent signal timing to maximize efficiency and reliability	X					X
Update traffic signal hardware, software, and communications statewide	X	X	X	X		X
Migrate all traffic signals in the state into the State's Traffic Signal Program	X	X	X	X		
Deploy technology smart corridors	X			X		
Increase the Capability Maturity Model level for Georgia's traffic signal systems	X	X	X	X		X

Objectives	Goals					
	Provide a safe, efficient, and well-maintained statewide traffic signal system	Provide a flexible, accountable, scalable, and transparent traffic signal program	Promote collaboration and cooperation between statewide, regional, and local partners	Facilitate informed data driven decision making through technology	Efficiently manage and allocate financial and contract resources	Provide a high level of customer satisfaction for traffic signal operations and maintenance
Improve coordination with District offices and local agencies			X			X
Promote open communication with District offices, local agencies, and consultants			X			X
Define success and performance goals of traffic signals based on operational context				X		
Demonstrate flexibility and responsiveness in the processes, policies, procedures, tactics, strategies, and objectives of the traffic signal program	X	X	X		X	X
Build and maintain public trust	X	X	X		X	X
Keep the public fully informed about the development and operation of the traffic signal system						X
Provide facilities at traffic signals to safely and efficiently accommodate all road users	X					X
Operate traffic signal system at its maximum efficiency within the context of a balanced, multimodal operation						X
Undertake maintenance in a cost-effective manner	X	X		X	X	X

Objectives	Goals					
	Provide a safe, efficient, and well-maintained statewide traffic signal system	Provide a flexible, accountable, scalable, and transparent traffic signal program	Promote collaboration and cooperation between statewide, regional, and local partners	Facilitate informed data driven decision making through technology	Efficiently manage and allocate financial and contract resources	Provide a high level of customer satisfaction for traffic signal operations and maintenance
Coordinate cooperatively with local agencies to develop and implement regional solutions to traffic problems related to regional issues			X			
Design traffic signal system elements that are sustainable in a fiscally responsible manner	X	X	X	X	X	X
Sustain a traffic signal infrastructure that is appropriate for accommodating current mobility goals	X				X	
Maintain operational efficiency of signal system	X				X	
Ensure that traffic signals provide equitable service to all users	X					
Manage investments through performance measures and useful reports			X		X	
Support periodic evaluation and updating of the programs	X	X	X	X	X	

4.2 POLICIES

The following policy and procedure documents may affect or constrain the development, operation, testing, or maintenance of the system:

- GDOT Procedure 13-6 – IT Development Procedures
- GDOT Policy 6785-1 – Traffic Signals
- GDOT Policy 6785-2 – Left Turn Phasing

4.3 CONSTRAINTS/CHALLENGES

The following operational constraints or challenges will impact the effectiveness of the Statewide Traffic Operations and Response Management program in the State of Georgia:

- Some of the local agencies currently have their own installation of traffic signal central software. These local agency central software installations will need to exchange information with the statewide traffic signal central software to be included in the STORM program.
- The STORM program is one of the first operational initiatives funded by the Department. The programs must continue to show value so that they do not lose that priority in the budgeting process.

4.4 STAKEHOLDERS

4.4.1 INTERNAL STAKEHOLDERS

There are many units within GDOT that contribute to the success of the existing Regional Traffic Signal programs with each having defined roles and responsibilities. Key stakeholder groups within GDOT were identified. Meetings were scheduled with subject matter experts from each group to gather information on their day-to-day interaction with the regional traffic signal programs and to collect input on what aspects of the programs work well, which do not, and what features they would like to incorporate as the program matures. The following subsections provide an overview of each internal stakeholder group and their corresponding roles and responsibilities.

4.4.1.1 OFFICE OF TRAFFIC OPERATIONS

The GDOT Office of Traffic Operations is one of the four offices that are part of the Permits and Operations Division. This office is led by the State Traffic Engineer and is responsible for the coordination of traffic management and incident management programs. It oversees programs that include traffic signal design, maintenance, and operations; and ITS and traffic safety. The Office of Traffic Operations' role is to provide management of the Georgia traffic signal programs and report the performance of these programs to upper management.

4.4.1.1.1 ASSISTANT STATE TRAFFIC ENGINEER

The Assistant State Traffic Engineer is responsible for the regional traffic signal programs; arterial programs; and emerging technology.

4.4.1.1.2 STATE SIGNAL ENGINEER

The State Signal Engineer is responsible for statewide traffic signal management. Their role is to support District staff with signal operations and manage the Regional Traffic Signal Operations program currently called RTSO.

4.4.1.1.3 ASSISTANT STATE SIGNAL ENGINEERS

There are three (3) Assistant State Signal Engineers who are responsible for the day to day operations and management of all signal related tasks within the three (3) RTSO regions. This includes managing operations and maintenance consultant contracts; design contracts; and serving as Subject Matter Experts (SME) for signal design and construction project reviews.

4.4.1.1.4 REGIONAL TRAFFIC OPERATIONS PROGRAM MANAGER

The Regional Traffic Operations Program Manager is responsible for the management of the overall Atlanta Metro Regional Traffic Signal program referred to as RTOP. This responsibility includes making sure that the different RTOP areas are run consistently.

4.4.1.1.5 RTOP SUPERVISORS

There are two (2) RTOP Supervisors who are responsible for the day to day operations and management of the program's consultant contracts. They serve as the point of contact for traffic signal communication/network infrastructure, signal design, plan review and ATSPM.

4.4.1.2 INFORMATION TECHNOLOGY DIVISION

The Division of Information Technology is the GDOT division that manages the Department's new and existing computer applications and networks; and develops the agency's IT policy and standards. As such, they have an integral role in the deployment and maintenance of the applications used in the signal programs.

4.4.1.2.1 OFFICE OF IT APPLICATION SUPPORT

The Office of IT Application Support provides IT support and maintenance for GDOT applications and databases in the production environment. This includes the management of the signal program applications on the servers. They provide support and resolution when applications and databases encounter issues.

4.4.1.2.2 OFFICE OF IT INFRASTRUCTURE

The Office of IT Infrastructure is responsible for the operation and management of the Department's computer hardware and system software. They provide network and server services and products in support of the TMC. This includes managing the network infrastructure out to the Layer 3 switches in the ITS HUBs.

4.4.1.3 TRAFFIC SIGNAL PROGRAM CONSULTANTS

The Traffic Signal Program consultants perform the day to day work of configuring, monitoring, and operating the traffic signal systems that are a part of the State's Regional Traffic Signal programs. These day to day responsibilities, at a minimum, include:

- Provide a skilled work force
- Proactively monitor and manage the traffic signal systems
- Work with GDOT Districts to address their traffic signal needs
- Coordinate and collaborate with Local Agencies
- Coordinate with Community Improvement Districts (CID)
- Share best practices across the different traffic signal programs
- Provide qualified Traffic Signal Operations Specialist staff
- Maintain GDOT's traffic signal performance management and reporting systems
- Maintain and use GDOT's traffic signal asset management system
- Maintain and use GDOT's maintenance and repair ticketing system
- Develop and maintain standard operating procedures (SOP)
- Employ concepts outlined in this document

4.4.1.3.1 RTOP AREA PROJECT MANAGERS

The RTOP Area Project Managers are responsible for the management of their consultant contracts and the engineers and staff working on the RTOP contracts.

4.4.1.3.2 RTOP ZONE MANAGERS

The RTOP Zone Managers are responsible for the operational aspects of the zone that have been assigned to them. They are consultant staff reporting to their respective RTOP Area Project Managers and lead the engineers and staff supporting the operational needs of their assigned zone.

4.4.1.3.3 RTSO REGION PROGRAM MANAGER

The RTSO Region Program Manager is responsible for the management of their consultant contracts and the engineers and staff working on the RTSO contracts.

4.4.1.3.4 TRAFFIC SIGNAL OPERATIONS SPECIALISTS

The main objective of the Traffic Signal Operations Specialists (TSOS) is to monitor and analyze traffic signals on identified Atlanta Metro corridors and zones for incidents, congestion, delays, and to take actions required to remedy any identified deficiencies. TSOS are housed at GDOT's statewide Transportation Management Center (TMC). This work is performed during the hours of 6:00 AM - 7:00 PM Monday through Friday and 9:00 AM – 6:00 PM Saturday and Sunday. In addition to normal working hours, TSOS can provide services for planned and unplanned events.

4.4.1.3.5 TRAFFIC SIGNAL OPERATIONS ENGINEERS

The RTSO contractors utilize Traffic Signal Operations Engineers (TSOE). A TSOE, like a TSOS is responsible for monitoring and analyzing the traffic signal network in their region. However, because RTSO does not have regional managers in the field, it utilizes engineers in the TSOS role since they must have engineering knowledge to make changes based on data observed remotely.

4.4.1.4 TRAFFIC SIGNAL PROGRAM MAINTENANCE CONTRACTORS

The Traffic Signal Program Maintenance Contractors perform the day to day maintenance of Traffic Signal system hardware. GDOT currently has multiple Traffic Signal Maintenance contractors under contract to provide the resources necessary to provide traffic signal maintenance in any part of the state and supporting the needs of the different regional traffic signal programs.

4.4.1.5 DISTRICTS

GDOT has seven (7) districts covering the state of Georgia. Districts are responsible for construction, maintenance, and operations of the transportation system within their geographic areas.

4.4.1.5.1 DISTRICT TRAFFIC OPERATIONS

The District Traffic Engineers as part of the District Traffic Operations offices are responsible for the maintenance and operations of traffic signal systems within their geographic areas. They are also responsible for coordination with their local agencies on matters related to traffic engineering.

4.4.2 EXTERNAL STAKEHOLDERS

The regional traffic signal programs coordinate and cooperate with other government agencies to achieve a seamless transportation network across multiple jurisdictions. It also works to relay information to the traveling public though various mediums to help them make informed decisions that keep traffic moving. Phone surveys and interviews were conducted with identified external stakeholders to gauge their interaction with the various current regional traffic signal program functions and to identify any issues. The following subsections provide an overview of each external stakeholder group and their corresponding roles and responsibilities.

4.4.2.1 LOCAL AGENCIES

Local agencies include cities and counties within the State of Georgia. A number of these cities and counties own and operate traffic signal systems within their local jurisdictions. Some local agencies operate their traffic signals outside of the regional traffic signal programs; some local agencies operate their signals in cooperation with the regional traffic signal programs; and some local agencies allow the regional traffic signal programs to monitor and operate their traffic signals.

4.4.2.2 COMMUNITY IMPROVEMENT DISTRICTS

Community Improvement Districts (CID) have been established to provide a means to address the needs for construction and maintenance of city streets, public transportation, and other governmental services and facilities. There are currently more than twenty-five (25) CIDs in the state of Georgia. Most of these are within the greater Atlanta area. There are currently six (6) CIDs established within the City of Atlanta. These are Airport West CID, Atlanta Downtown Improvement District, Buckhead CID, Little Five Points CID, Midtown Improvement District, and West End CID.

Various CIDs are actively involved in the regional traffic signal programs.

5 STATEWIDE TRAFFIC OPERATIONS AND RESPONSE MANAGEMENT PROGRAM CONCEPT

The Statewide Traffic Operations and Response Management program will build upon and leverage the existing regional programs (RTOP & RTSO) and expand upon the relationships formed with local agencies and operational lessons to provide a more proactive and enhanced traffic signal management program statewide. This section provides an overview of the identified program needs and program concepts.

5.1 PROGRAM NEEDS

Based on information gathered from the stakeholder outreach meetings and surveys, GDOT document reviews, and traffic signal management best practices, program needs were identified. These needs are documented in Table 5-1. The needs are classified by functional categories (Administrative, Collaboration, Customer, Documentation, Maintenance, Operations, Safety, Personnel, Reports & Data, Software, and Technology). Each program need is assigned a unique reference number. The scheme of the reference number is as follows: the first character of "N" indicates that it is a "Need;" next is the two-character functional category abbreviation; and last is a reference number. The reference number for each need does not denote a prioritization.

TABLE 5-1: PROGRAM NEEDS

REF #	Needs
Administrative (AD)	
N-AD-1	Need to demonstrate that the Traffic Signal Programs are worth the investment.
N-AD-2	Need maintenance contracts to be flexible
N-AD-3	Need to be good stewards of available funding
N-AD-4	Need to investigate additional funding opportunities
N-AD-5	Need to keep qualified products list current
Collaboration (CO)	
N-CO-1	Need to collaborate with District Traffic Engineers
N-CO-2	Need to collaborate with Local Agency Traffic Engineers
N-CO-3	Need to develop memorandums of understandings (MOU) with local agencies
N-CO-4	Need to maintain trust and relationships with local agencies
N-CO-5	Need to reestablish the Regional Traffic Operations Task Force (RTOTF)
Customer (CU)	
N-CU-1	Need to be responsive to reported issues
N-CU-2	Need to provide consistent customer service
Documentation (DO)	
N-DO-1	Need to develop Statewide Standard Traffic Signal Operating Guidelines and Procedures

REF #	Needs
Maintenance (MA)	
N-MA-1	Need to maintain electronic records of traffic signal maintenance activities
N-MA-2	Need a more systematic approach to maintenance
N-MA-3	Need comprehensive asset management system
Operations (OP)	
N-OP-1	Need to have consistent and context sensitive goals and objectives for each corridor/zone
N-OP-2	Need to optimize signal timing
N-OP-3	Need to proactively monitor the status of traffic signal operations
N-OP-4	Need to monitor device uptime
N-OP-5	Need to apply standard approaches to timing traffic signals to accommodate for multimodal needs
N-OP-6	Need to routinely evaluate staffing levels for each function
N-OP-7	Need to track multimodal performance measures
N-OP-8	Need the flexibility to include roadways in the program on demand
N-OP-9	Need the flexibility to include additional traffic signals in the program on demand
N-OP-10	Need to develop signal timing emergency response plans
N-OP-11	Need to proactively identify, track, and resolve operational issues
N-OP-12	Need to allow for various responses to traffic signal management
Safety (SA)	
N-SA-1	Need to monitor and evaluate operational changes for safety impacts
N-SA-2	Need to monitor and evaluate device deployments for safety impacts
N-SA-3	Need to proactively identify potential intersection safety improvement projects
Personnel (PE)	
N-PE-1	Need to optimize staffing to support traffic signal operations and maintenance
N-PE-2	Need to have a trained workforce
N-PE-3	Need to have dedicated staff to oversee maintenance for each program
Reports and Data (RD)	
N-RD-1	Need to make traffic signal operational data available to third party entities
N-RD-2	Need to share traffic signal operational data with local agencies
N-RD-3	Need to receive real time data from all traffic signal systems in the state
N-RD-4	Need to produce accurate data
N-RD-5	Need to establish baseline data for each traffic signal program Region
N-RD-6	Need to utilize automated reporting tools and data analytics to routinely fine-tune system operation
N-RD-7	Need to routinely evaluate performance measures and their outputs
N-RD-8	Need to have a user friendly, comprehensive reporting system

REF #	Needs
Software (SO)	
N-SO-1	Need to standardize traffic signal central software
N-SO-2	Need to maintain and backup intersection signal timings using central software
Technology (TE)	
N-TE-1	Need to standardize traffic signal local controller systems
N-TE-2	Need to bring all traffic signals up to a standard platform
N-TE-3	Need to establish and maintain communications to all traffic signal systems in the state
N-TE-4	Need to deploy communication and detection infrastructure statewide
N-TE-5	Need to strategically deploy physical hardware in the field
N-TE-6	Need streamlined remote connectivity to access GDOT network
N-TE-7	Need to establish communications to local partner central software systems
N-TE-8	Need to embrace new and innovative technology
N-TE-9	Need to have additional public IP addresses
N-TE-10	Need to deploy CV/AV technology
N-TE-11	Need to develop corridors to support the deployment of emerging technologies
N-TE-12	Need to analyze and implement physical and cyber security measures
N-TE-13	Need to be continually positioned as a technology HUB

5.2 PROGRAM ORGANIZATION

The STORM program organizational structure is not expected to change from what was depicted in Figure 3-1. However, the functionality within the structure will evolve to provide seamless management of traffic signals throughout the state. Staffing needs for the program will be evaluated and adjusted (decreased or increased) to make sure that as technology, methods, and operational needs evolve the workforce is right sized.

5.3 TRAFFIC SIGNAL MAINTENANCE

Traffic signals and associated devices such as detectors, cameras, and communications play an integral role in the Department's ability to monitor operations for the benefit of the traveling public. It is imperative that these devices are maintained and operational. By tracking and monitoring signal activities and performance, the Department can proactively address equipment issues before they adversely impact the operations of the traffic signal system. This ability is greatly enhanced if all signals and associated devices within the state are accessible through a central software system.

5.3.1 PREVENTATIVE MAINTENANCE

Preventative maintenance programs have been shown to extend the life of traffic signal equipment and decrease the life cycle cost of traffic signal systems. A preventative maintenance program will be put into place and enhanced over time to reduce device failures leading to a more reliable and cost-effective system.

5.3.2 ASSET MANAGEMENT

Tracking traffic signal and associated equipment installation, maintenance, and repair activities will continue to be an important part of the overall statewide traffic signal management program. A comprehensive asset management system will allow the Department to evaluate maintenance activities to better identify equipment with frequent failures, capture actual maintenance costs per device, and make more informed procurement, maintenance, and support decisions.

5.3.3 LOCAL AGENCY ASSISTANCE

There are many agencies across the state that have and maintain traffic signal systems. These agencies have various levels of capabilities and resources. The Department provides maintenance assistance and resources to local agencies to keep their traffic signal systems in a state of good repair and operating efficiently. By continuing to provide this support, the Department builds upon current relationships and trust with the local agencies and provides more consistent and reliable traffic signals throughout the state.

5.3.4 AUTOMATED MONITORING AND REMOTE TROUBLESHOOTING

A high level of system uptime and remote troubleshooting are imperative to optimal system operations. Because it is impractical to physically visit each traffic signal system in the state on a routine basis, it is necessary to utilize technology to monitor these systems automatically and provide remote diagnostics and troubleshooting for any issues discovered. Remotely troubleshooting issues not only can sometimes resolve the issue without field intervention, it also provides technicians additional information required to focus on the necessary resources required if a field visit is warranted (e.g. is a bucket truck needed or not). When additional Department or local agency traffic signal systems are brought into the STORM program they will also be monitored, and issues diagnosed remotely. New monitoring and troubleshooting tools and technologies will be evaluated to see if there is enhanced functionality that can be cost effectively implemented to expand the monitoring and troubleshooting capabilities.

5.4 TRAFFIC SIGNAL OPERATIONS

Integrating and expanding the existing traffic signal operations programs into a statewide program will provide a coordinated, consistent, and efficient approach to traffic signal operations. The critical elements to efficiently operating a traffic signal system are communication, detection, timing, and coordination. The STORM program aims to establish and maintain communication to all traffic signal systems in the state allowing for operations to be more seamlessly integrated. This will be done by standardizing traffic signal central software, traffic signal local controller firmware, and deploying communication and detection infrastructure statewide. Standardizing traffic signal systems across the state, would allow any system to be added and managed on demand when conditions warrant.

5.4.1 PROACTIVE OPERATIONS

The program's traffic signal systems will be proactively monitored to identify any operational issues or trends, which may degrade the operations of those systems and the associated corridors. Once operational issues are identified they can be evaluated, and corrective actions can be remotely applied to resolve the issues. Corrective actions may be temporarily applied to resolve an abnormal condition which returns to normal or permanently applied when the condition becomes the new normal.

The TSOS, TSOE, and other traffic signal operations staff will have access to the MaxView software and video from intersection cameras to view the status and operations of the traffic signal system. This team will also have access to the ATSPM and TEAMS website, which will provide them with current and historical performance data used to determine trends that can be proactively mitigated.

5.4.2 SYSTEM EFFICIENCY

The intent of maintaining and increasing system efficiency is to provide optimal system performance through context appropriate operational objectives. These may include reducing delay, eradicating wasted green time, increasing throughput, minimizing pedestrian delays, providing progression, and safe travel. With multiple resources often interacting with a traffic signal, it is important to maintain a repository of how a traffic signal should be operating and a log of changes that were made. This ensures that the signal is operating in the way it is intended and designed and as efficiently as it can. Measuring the performance of traffic signals on an automated basis provides for a situational intelligence that allows resources to be allocated to where operational intervention is warranted, as compared to just on an arbitrary time basis. It is also important that the operational context of a traffic signal be what defines how performance is measured. Additionally, maintaining operations and efficiency during construction is imperative for ensuring optimal system efficiency.

5.4.3 COORDINATION AND SIGNAL SYSTEMS

Outcomes for coordinated timing and system operations are achieved through context driven signal-timing strategies. Consistent approaches to the timing and operation of coordinated systems provides for consistent operations across regional lines as well as maintaining driver expectations. Additionally, context of a system can be applied to best engineer the coordination of a signal system to meet the objectives of that system.

5.4.4 GENERAL DESIGN AND SPECIFICATIONS

Comprehensive and agile design guidelines help to provide for consistent design of traffic signals across the state, helping to provide consistency for drivers. There is also increased efficiency in the operations and maintenance of traffic signals in that uniformity in their construction reduces the need for additional specialized training based on the location of a traffic signal. Consistent maintenance and operations of traffic signals is accomplished through uniform design.

5.5 SOFTWARE AND SYSTEMS

This Section builds upon the current software products and services used to support the overall regional traffic signal management programs identified in sub-section 3.2.3. In addition to those software products and interactions, new ones are identified in Figure 5-1 and described in this Section.

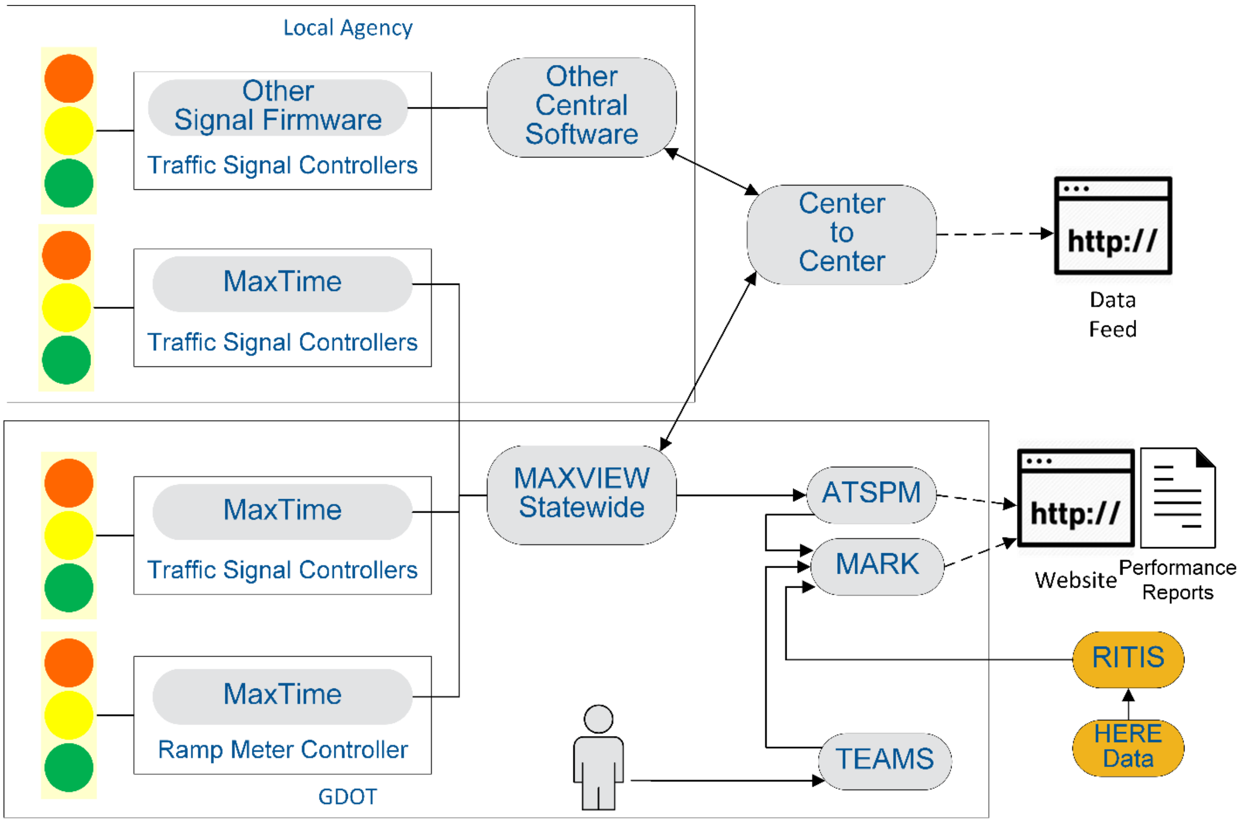

FIGURE 5-1: GDOT PROPOSED TRAFFIC SIGNAL OPERATIONS APPLICATIONS

5.5.1 CENTER TO CENTER

Center to Center (C2C) is the name given to software systems designed to share similar transportation related data from similar and dis-similar systems. This software is based on national Traffic Management Data Dictionary (TMDD) standards. GDOT and some local agencies are currently operating independent traffic signal central systems and C2C is a way to share information between these systems. C2C can also be used to share transportation data with external entities.

5.5.2 THIRD PARTY DATA FEED

With the advancement of externally developed transportation related applications and research there is a need to provide as much information about the traffic signal system as feasibly possible making sure to protect personal identifiable information (PII). Having access to the traffic signal system data will allow third parties to develop applications, metrics, evaluate trends, etc. Data sharing can be done using C2C.

5.6 CONNECTED VEHICLES AND EMERGING TECHNOLOGY

GDOT is building upon its current connected vehicle program to increase deployments within the Metro Atlanta area and throughout the state. GDOT has a planned deployment of up to 1,700 Roadside Units (RSUs) to complement the RSUs already deployed. As GDOT moves forward, additional connected vehicle solutions will be evaluated and deployed where specific needs can be addressed when traditional solutions are inadequate. However, GDOT expects to blend traditional ITS technologies with Connected Vehicle to create a connected corridor capable of supporting Connected and Automated Vehicles. As Connected Vehicle deployments move toward ubiquity, the need for traditional ITS technologies will decrease. The additional deployments will be focused on the needs of the Department and local stakeholders.

GDOT wants to identify corridors where additional infrastructure can be deployed in order to be prepared to quickly and efficiently deploy and test emerging technology.

5.7 PROGRAM SUMMARY

Successfully implementing the Statewide Traffic Operations and Response Management program operational concepts positions the Department to efficiently address any issue or scenario that may arise. It is expected that this proactive approach to maintenance, monitoring, and operations on a day to day basis will allow the Department to address issues before they even become an issue or be in a position to address more complicated issues with ease.

6 PERFORMANCE MEASURMENT

An initial set of performance measures that could be used to evaluate the success of the Statewide Traffic Operations and Response Management program are shown in Table 6-1. Feasible and practical targets for some of these performance measures will need to be established. Over time, these performance measures and their target output should be reviewed to see if they are providing the expected results for the program. Additional performance measures should be evaluated and implemented if they can add value to the program. Consideration should be given to the need for adequate base line data to validate the performance measure and target.

It should be noted that different performance measures or targets may need to be applied to different intersections or corridors based upon the operational conditions of those traffic signals and traffic signal systems.

TABLE 6-1: PERFORMANCE MEASURES

Metric	Target	Goal Categories
Proactive maintenance versus reactive maintenance.	Allocate 70% of maintenance resources to proactive maintenance activities.	• Safety • Reliability • Efficiency
Travel Time Index (TTI)	Feasible and practical targets will need to be determined.	• Safety • Reliability • Efficiency
Planning Time Index (PTI)	Feasible and practical targets will need to be determined.	• Safety • Reliability • Efficiency
Overall device uptime	Maintain 95% device uptime.	• Safety • Reliability • Efficiency
Vehicle Detection Functioning	Maintain 95% of vehicle detection at traffic signals at all times, even during construction.	• Safety • Reliability • Efficiency • Customer Service
Pedestrian Detection Functioning	Maintain 95% of pedestrian detection at traffic signals at all times, even during construction.	• Safety • Reliability • Efficiency • Customer Service
Ground Preventative Maintenance Performed	Perform ground preventative maintenance semi-annually at all signals	• Safety • Reliability • Efficiency
Aerial Preventive Maintenance Performed	Perform aerial preventative maintenance annually at all signals.	• Safety • Reliability • Efficiency

Metric	Target	Goal Categories
Throughput	Sustained or increased throughput during peak hours	• Safety • Reliability • Efficiency • Customer Service
Arrival on Green	Feasible and practical targets will need to be determined.	• Safety • Reliability • Efficiency • Customer Service
Spillback Rate	Feasible and practical targets will need to be determined.	• Safety • Reliability • Efficiency • Customer Service
Split Failures	Feasible and practical targets will need to be determined.	• Safety • Reliability • Efficiency • Customer Service
Response Time of Maintenance Work Orders	Respond to and resolve maintenance work orders within one (1) day.	• Safety • Reliability • Efficiency • Customer Service
Signals Communicating with Central System	Maintain 95% signal communications with central system.	• Safety • Reliability • Efficiency
Response time for Emergency calls	Respond to all emergency events within four (4) hours.	• Safety • Reliability • Efficiency • Customer Service
Response time for General Service calls	Respond to and resolve general service calls within four (4) days.	• Safety • Reliability • Efficiency • Customer Service

APPENDIX A - 13-6 – IT DEVELOPMENT PROCEDURES

GDOT Publications
Policies & Procedures

Procedure:13-6 - IT Development Procedures
Section:Information Technology Procedures
Office/Department: IT Applications
Reports To: 020DivInformation Technology
Contact: 404-631-1000

IT Development Procedures

- GDOT will provide a Hyper-V virtual/SharePoint Developer Environment (SPD) for the development activity to occur within. The SPD can reside in the consultants/contractors environment.
- Contractors will be responsible for providing licenses within their IT environment
- GDOT will be responsible for providing licenses within the GDOT IT environment
- GDOT's IT will be engaged on system requirements, system design/architecture, development, integration, and GDOT IT support of the various components/deliverables
- Consultants will gather/document Requirements (functional and non-functional/technical/system requirements)
  - Based on business requirement specifications the consultant shall identify the potential risks or issues that need to be mitigated in the Architectural Design.
  - Expected levels of service, high availability architecture needs, business continuity (BC), and Disaster Recovery (DR) requirements shall be documented.
  - Open Records/Freedom of Information Act (FOIA) and information security requirements (e.g. data encryption) shall be documented.
  - Consultants will work with the business steward to assess the risk of unauthorized alteration, unauthorized disclosure, or loss of the data for which the business steward is responsible and ensure, through the use of monitoring systems, that the GDOT is protected from damage, monetary or otherwise.
- Consultants will provide Business Requirements to GDOT for review/approval. This review/approval from GDOT will include Sponsoring Business Offices and the Division of Information Technology
- Within 10 business days after Requirements have been provided to GDOT a preliminary architectural discussion can occur. This discussion will be a general approach based upon the Requirements, GDOT's Technical Standards, Current Department applications; this discussion must occur prior to commencement of any development activities. GDOT's IT Enterprise Architects must attend this discussion.
- Consultants will develop an Architectural Design for this development effort and present this Architectural Design to the GDOT IT Enterprise Architects for review/approval
- Development activities can commence after GDOT approval of the Architectural Design.
- The consultant shall provide logical and physical database schemas (as entity relationship diagrams), data dictionaries, and any data migration workflows to enterprise architects and DBA's for review/approval.
- Data migration shall be documented using GDOT's data mapping template and guidelines to indicate all source tables and columns which are or are not to be migrated and their corresponding target tables and columns. All tables and columns in the source and target shall be accounted for in the documentation. Look-up table values and or geodatabase domains shall also be identified from source to target in data mapping documentation.
- All documentation shall be updated to match final/accepted deployed physical product implemented at GDOT. Documentation is expected to be complete and correct as per GDOT specification.

Procedure: 13-6 - IT Development Procedures
Date Last Reviewed: 11/20/2012
Page **1** of **4**

- Consultants will not have direct access to testing/QA or production database schemas or objects. All objects, tables, etc., that need to be created/altered should be scripted and provided to GDOT's database resource assigned to the project for implementation within GDOT.
- Consultant may perform Unit/System development in the GDOT IT "sandbox" development environment provided.
- GDOT will perform UAT, QA/QC in GDOT's Testing/QA environments to ensure the application will work within GDOT's Environment; Coordination must occur to deploy the application to GDOT's Testing/QA environments. Deployment to GDOT's QA environments can only be accomplished by GDOT personnel. QA deployments can occur within pre-production environments.
- User Acceptance Testing will also occur within GDOT's QA Environments. Deployment to GDOT's QA environments can only be accomplished by GDOT personnel.
- User Training will occur within GDOT's Training Environment. Deployment to GDOT's Training environment can only be accomplished by GDOT personnel.
- Deployment to Production. Deployment to GDOT's Production environment can only be accomplished by GDOT personnel and must be scheduled in advance. GDOT requests at least one week of notice for deployments to production (unless it is a support issue/bug fix). GDOT IT shall indicate if deployment or upgrade will occur during business operation hours or if it must be performed after business operation hours.
- Business Continuity (BC)/Disaster Recovery (DR) will occur within GDOT's Business Continuity/Disaster Recovery Environments. Systems are expected to use storage based replication to GDOT's Business Continuity/Disaster Recovery Environments which can only be accomplished by GDOT personnel.

Expected Deliverables*

- Business Requirements Document (BRD)
  - Each requirement (e.g., hardware, software, user, operator interface, and safety) identified in the design specification shall be evaluated for accuracy, completeness, consistency, testability, and correctness. Design document shall be evaluated to verify that:
    - There are no internal inconsistencies among requirements;
    - Requirements compatibility with existing systems and systems integration;
    - All of the performance requirements for the system have been spelled out;
    - Fault tolerance, safety, and security requirements are complete and correct;
    - Allocation of software functions are accurate and complete; and
    - All requirements are expressed in terms that are measurable or objectively verifiable.
  - A system requirements traceability analysis shall be provided to trace software requirements to (and from) the user interface.
  - Documented business unit data owners and business unit data maintenance responsibilities
  - Documented data retention policy
  - Report Description: Description of each report. Included are reporting requirements, all input parameters and sample output.
  - Training Requirements: Description of what training materials are to be produced and degree of online or classroom training to be implemented
- Architectural Design Document (ADD)
  - System Design Overview: Includes program specifications developed in the planning phase of the project and description of the system/subsystem functions, and the logic flow of the entire system/subsystem in the form of a diagram.
  - Operational Environment: Includes operations, equipment, support software and interfaces.

Procedure: 13-6 - IT Development Procedures
Date Last Reviewed: 11/20/2012 Page **2** of **4**

  - Object Reference: Identifies and describes all program (sub-program) objects developed.
  - Database Models: High level description of database design and schema
  - Entity Relationship Diagrams: Shows data relationships for tables/objects in the database
  - Database Normalization: Description of normalization implementation
  - Stored Procedure Reference: All stored procedures, database links, and custom procedures are defined and described.
  - Data Dictionary: All table layouts are defined with appropriate information such as data types, length, and size; identifying primary and foreign keys with all indexes. Document describing all fields by field name with description of information to be stored in data field.
  - Data Mapping Reference: Detailed mapping of source to target database; indicates disposition of all legacy fields (retired, migrated, etc.); validation that all source data is accounted for in target such as cross-table references, data relationships, look-up tables, constraints, or geographic domains
  - Integration with other GDOT and external data sources: Describe the implementation of the system with the other departmental or external data sources. This includes logical descriptions of program functionality.
  - Data history, audit trails, user tracking, and archiving
  - Security Reference: Define the security model utilized for the system, data source and users.
- Application (Code)
  - Programming Language Source Code: All source code of the system divided by module.
  - Stored Procedure Source Code: All transact SQL source code for all procedures, divided by procedure.
  - SQL Script Printout: All transact SQL source code for all scripts.
  - All scripts needed to build the database schema, procedures, and user permissions
  - Installation executables will be stored within GDOT Software Repository/ClearCase source code repository.
- Datasets/Databases (as per GDOT policy/standards)
  - Scripts to build/alter database and associated objects and installation instructions
  - Entity Relationship diagrams (logical and physical)
  - Data Dictionary (logical and physical)
  - Metadata Registry (see GDOT Metadata Registry policy)
  - Deliverable datasets/databases
- Application Support Document (ASD)
  - Overview: Detailed technician level instruction for supporting the developed system.
  - Dependencies: Description of all required support software by operating system, operating system version, support software, support software version, and software location on server. Also includes all database, data warehouse, Geographic Information System (GIS), and web service dependencies.
  - Support roles, responsibilities, and procedures
  - Service/system performance and alert monitoring (e.g. MOM/SCOM, SCCM) parameters for server and database administrators
  - Web application usage monitoring agents (e.g. Google Analytics)
  - System backup, restore, and non-production database refresh procedures
  - Security protocols
- Training Materials
  - Quick Reference Guides (QRG)
  - Administrator Manuals, User Manuals, and Instructor Guides
  - Web Based Training (WBT) or Videos
  - Rebrand training materials to GDOT context

   - All soft-copy of help/user-manuals must be in editable non-proprietary format
- Deployment Document
   - Installation, configuration, and deployment instructions
   - Scripts for automated deployment within databases and web/application servers

*During architectural discussions, GDOT and the Consultant may agree on the expected deliverables, application specifications, and versions of hardware/software to be used. Any changes must be discussed and approved by GDOT IT Change Control Board (CCB).

Web Applications

- Web applications deployed on GDOT websites will support mobile device browsing and interaction within SharePoint

SmartPhone Applications

- Currently GDOT uses Verizon as its cell phone carrier. No application will be developed which requires a cell phone that Verizon does not carry.
- For SmartPhone Applications which GDOT pursues it is assumed that the application will only work when the SmartPhone is within the carrier's coverage area.
- For SmartPhone Applications which are web browser based, it will use HTML 5 and not the native operating system for the SmartPhone.
- For SmartPhone Applications that need native phone OS capabilities, the corresponding Mobile OS SDK will be used.

References:

None

History:

corrected office name: 09/21/18;
updated logo: 08/21/18;
added to Publications: 10/24/12

Procedure: 13-6 - IT Development Procedures
Date Last Reviewed: 11/20/2012 Page **4** of **4**

APPENDIX B - 6785-1 – TRAFFIC SIGNALS

Georgia Department of Transportation

GDOT Publications
Policies & Procedures

Policy: 6785-1- Traffic Signals
Section: Traffic Signals
Office/Department: 6Traffic Operations
Reports To: 6Div Director Operations
Contact: 404-635-8048

INTRODUCTION

A traffic signal should only be installed after other alternatives have been evaluated as outlined in the Manual on Uniform Traffic Control Devices and the GDOT Intersection Control Evaluation (ICE) Policy. Although traffic signals can provide several benefits, a signal can also cause excessive delay and increased frequency of crashes. Unwarranted traffic signals can cause disobedience of traffic control devices. Traffic signals that are properly designed and timed can provide multiple advantages such as increasing the amount of capacity at an intersection, providing an orderly movement of traffic, reducing the frequency and severity of certain types of crashes and providing levels of accessibility for pedestrians and side street traffic.

SIGNAL PERMIT AND AUTHORIZATION FORMS

All traffic signal devices erected on the State Route System must have a permit application from the local government to the Department of Transportation and a Traffic Signal Authorization issued by the Department prior to their installation. The Signal Permit Application serves as the agreement between the Department and the local government for the signal. Even in communities where signals are maintained by GDOT, a formal document of agreement is needed. The permit application is used to allow local government to formally request the use of a traffic signal. This application indicates the approval of the local government for the use of the signal. It also commits local government to provide electrical power to the intersection (and communication when applicable).

The Traffic Signal Authorization is the permit indicating the formal approval of the Department for the use of the traffic signal at the intersection. Design drawings are a part of the authorization form showing the intersection details, the signal head arrangement, the signal phasing and the detector placement. Regardless of the method of funding and installation, a signal authorization is needed. The original of this authorization is kept by the Office of Traffic Operations with copies sent to the District Office and from the District Office to the local government for their records.

TRAFFIC SIGNAL REQUESTS

Requests for traffic signals come to the Department from a wide variety of sources. State, city and county elected officials responding to their constituents will often request the Department to evaluate an intersection for a traffic signal. All inquiries are considered a request for assistance and should be investigated to determine if a signal or some less restrictive improvement should be implemented.

Once a request is received, the District Traffic Engineer should initiate an engineering study using the methods described in the MUTCD and GDOT's ICE Policy. It is the Department's preference that only signals that meet Warrants 1 (Eight-Hour Vehicular Volume) or 7 (Crash Experience) in the MUTCD at 100% be installed; however, other warrants may be evaluated if engineering judgment determines that other applications are appropriate. Intersection evaluations indicating that a signal will not meet Warrants 1 or 7 may be denied by the Department. Proposed signals may also be denied if they do not meet the minimum spacing requirements in the Driveway Manual. As the MUTCD states: **"The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal."**

STUDY AND APPROVAL PROCESS

The traffic engineering study should document the need for an improvement and include, at a minimum, the following: reason for investigation, existing conditions, crash history of the site with a diagram illustrating the number of correctable crashes that occurred within a consecutive 12 month period of the last 3 years, 12 hour turning movement counts on each approach with hourly totals (if there are only ADTs available then the 5.6% method may be applied) and a warrant analysis of MUTCD warrants 1 and 7 at the 100% threshold. The study should ~~first~~ consider less restrictive measures such as improved signing, marking, sight distance, operational improvements, etc. The study should also evaluate the other intersection control types that are outlined in GDOT's Intersection Control Evaluation (ICE) Policy. GDOT has also created a tool to assist with choosing an intersection control type. If a traffic signal is chosen, an ICE document will need to be provided along with the study and permit request.

New signals are often requested in the anticipation of increased traffic due to proposed developments. Studies should show the amount of anticipated volumes from developments using the current Edition of the ITE Trip Generation Manual. Since these volumes are only projections, the State Traffic Engineer may determine that generated volumes are not appropriate, and a warrant analysis should be performed once the development is built and use actual volumes. If a signal is approved based on generated volumes, it should be restudied one (1) year after the signal is installed to determine if the actual volumes meet warrants. If the signal does not meet warrants after re-study, the signal should be removed using methods outlined in the MUTCD. Additionally, when a signal is approved based on generated volumes, the installation will only be allowed once the development is substantially underway.

The completed Traffic Engineering study shall have a signature page that includes the conclusions and recommendations of the study. Recommendation lines shall be included for the District Traffic Engineer, State Traffic Engineer, and Division Director of Operations.

The completed Traffic Engineering study shall have a signature page that includes the conclusions of the study and the recommendations of the District Traffic Engineer. Approval blocks should be included for the District Traffic Engineer, District Engineer (optional), State Traffic Engineer, and Division Director of Operations.

Once completed, the Traffic Engineering study will be sent to the District Office of Traffic Operations for review. If the District Office of Traffic Operations agrees with the findings of the Traffic Engineering study that a traffic signal is justified, they will forward the study and a Traffic Signal Authorization to the State Traffic Engineer. A permit approval form will be prepared and the entire package sent for signatures by the Division Director of Operations and final approval by the Chief Engineer of the Department. A copy of the approved permit and the design will be returned to the District Traffic Operations Office for transmittal to the local government for their records.

A formal permit application is not necessary for the Department to begin an investigation about the need for a traffic signal. However, the approval package will not be sent to the local government until a formal application for the traffic signal has been received.

SIGNAL PERMIT REVISIONS

Signal permit revisions will be required for all changes made to the signal operation or design. Any proposed intersection improvements will require an ICE document before a permit revision can be approved and issued by the State Traffic Engineer. In certain cases such as adding a left turn phase or upgrading signal equipment, an ICE waiver may be submitted to the District Engineer for approval. Once the waiver is approved, it will be submitted along with permit revision.

SIGNALS IN ROAD CONSTRUCTION PROJECTS

If a signal is being proposed as part of the construction project, the permit application, signal authorization form and Traffic Engineering study ~~is~~ are still necessary for the signal to be installed. Existing signals requiring upgrades may be included in the construction project and should follow the same process as signal revisions that are not included in construction projects. The District Traffic Engineer should be the primary initiator for new signals or signal revisions on construction projects. This is to be accomplished as early in the project life as possible, preferably at the design concept stage.

The Traffic Engineering study prepared for the proposed signal should follow the guidance outlined in the **Study and Approval Process**.

Due to the detrimental effect of traffic signals on the flow of arterial traffic, a traffic signal may not always be to the benefit of the State Highway System. Therefore, it is likely that signals which are justified by design year traffic volumes will be denied or deferred if initial traffic volumes do not warrant their inclusion in the project. Justification for the signal is even more important in this case as it will document conditions at a point in time and will assist in the decision making process to determine the right time to approve signalization.

PEDESTRIAN ACCOMMODATIONS AT SIGNALIZED INTERSECTIONS

Crosswalks and pedestrian signal heads, including ADA considerations, shall be installed on all approaches of new traffic signal installations or revised traffic signal permits unless an approach prohibits pedestrian traffic. Exceptions may be granted if the pedestrian pathway is unsafe for pedestrians or the traffic engineering study documents the absence of pedestrian activity. The District Traffic Engineer, Project Manager, Consultant, local government, or Permit Applicant must document the conditions and justification for eliminating pedestrian accommodations for each approach being requested. The documentation will be included in the permit file if accepted.

In the case of one or more pathways being determined unsafe to cross at a signalized intersection, appropriate MUTCD signing prohibiting pedestrian traffic must be erected. Use of MUTCD signing may also be appropriate when it is necessary to restrict access to one pedestrian pathway.

Turn Lanes

Turn lanes are one of the more effective ways to enhance safety and operations at an intersection. Turn lanes improve safety and operations by removing stopped or decelerating vehicles from the through lanes. Left turn lanes have been shown to reduce crashes by 50% on average and should be added on all approaches of an intersection.

A lack of left turn lanes will likely result in the denial of a signal permit request unless engineering justification is provided and approved. The determination of the omission of left turn lanes will be up to the State Traffic Engineer. Please see Policy 6785-2 for guidance on adding left turn phases.

Policy: 6785-1 - Traffic Signals
Date Last Reviewed: [Date Last Reviewed] Page **3** of **4**

References:

None.

History:

updated logo: 11/09/18;
added to TOPPS: 04/10/96;
added to Manual of Guidance: 01/05/87

APPENDIX C - 6785-2 – LEFT TURN PHASING

GDOT Publications
Policies & Procedures

Policy: 6785-2- Left Turn Phasing
Section: Traffic Signals
Office/Department: 6Traffic Operations

Reports To: 6Div Director Operations
Contact: 404-635-8048

The purpose of this policy is to provide guidance concerning the use of permissive-only, protected-only and protected/permissive turn phases at signalized intersections.

I. LEFT TURN PHASING

Protected left turn phases for signals at intersections are often overused or misused and can cause an intersection to function with less capacity than is desirable. Typically, left turn phases are not to be used at new or upgraded traffic signal installations unless justified based on the criteria below. Left turn phases should typically not be used at intersection approaches where a left turn lane has not been provided. A new traffic signal permit (new signals) or a permit revision (existing signals) shall be approved by the State Traffic Engineer before the addition or modification of any left turn phases.

A. Protected –Permissive Left Turn Phasing

Left turn phasing will typically be installed as a protected/permissive left turn movement (assuming some form of protection is needed). This will keep the intersection capacity and efficiency at the highest possible operation level. Protected-permissive phasing can be used for left turn phases if conditions meet any of the criteria below:

1. The cross-product is greater than 50,000 for a leading left turn phase or greater than 30,000 for a lagging left turn phase.*

$$Cross\ Product = left\ turn\ volume\left(\frac{opposing\ through\ volume}{number\ of\ opposing\ through\ lanes}\right)$$

2. The left turn volume is 125 vehicles or greater per hour for a leading left turn phase or is 75 vehicles or greater per hour for a lagging left turn phase.*

3. The number of left turn crashes under permissive operation is 4 or more in a 12 month period; or 6 or more in a 24 month period.

4. Additional criteria can also be taken into consideration when evaluating requests for left turn phases. These include but are not limited to:

    - insufficient left turn lane storage
    - delay
    - the angle of the left turn
    - number of opposing through lane
    - speed of opposing traffic
    - the signal is included in a coordinated signal system

*Note: If a left turn phase only meets the lagging thresholds, then it must operate as a lagging only phase and must be shown in the phasing diagram as such. Any lagging left turn phases shall also require a 3-section permissive-only FYA signal head for the opposing left turning movement if the opposing left turn movement does not have a left turn phase.

B. Protected-Only Left Turn Phasing

A protected-only left turn phase will only be allowed when conditions satisfy one or more of the following criteria:

1. Limited sight distance due to a permanent obstruction that will not allow permissive turns (See Table 1)
2. Conflicting left turn paths (may require lead/lag protected-only operation)
3. Additional criteria such as unusual intersection geometrics or a high volume of pedestrians
4. Left turn crashes under a protected-permissive phasing equals or exceeds 5 crashes in 24 months for the proposed movement

Decisions on the use of left turn phases will be approved by the State Traffic Engineer. Request for left turn phase approvals should be accompanied by supporting documentation as outlined above. In some cases, PO/PP-TOD may be appropriate (See Section D)

C. Converting Single Lane Left Turn From Protected-Only to Protected/Permissive

An existing single lane, protected-only left turn phase may be changed to a protected/permissive left turn operation if the following documentation is submitted to and approved by the State Traffic Engineer:

1. Table with the minimum required sight distance (calculated) and the field measured maximum sight distance for the movement being considered. The minimum sight distance required should be based off the calculated red clearance interval for the left turn movement and the speed of opposing vehicles (See Table 1).

$$Red\ Clearance\ Interval = \frac{W + L}{V_{LT}}$$

W Distance from stop bar to outside edge of the travel lane of the farthest conflicting movement along the vehicle's travel path

L Length of vehicle (ft) - 20 ft typical

V_{LT} 85th percentile speed of left turning vehicle (ft/sec) - 25 mph typical

Minimum Left Turn Sight Distance for Permissive Operation

Design Speed (mph)	Red Clearance Interval (sec)								
	2.0	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**
25	150	165	185	205	220	240	260	275	295
30	180	200	220	245	265	290	310	330	355
35	205	235	260	285	310	335	360	385	415
40	235	265	295	325	355	385	415	440	470
45	265	300	330	365	400	430	465	495	530
50	295	330	370	405	440	480	515	550	590
55	325	365	405	445	485	525	565	605	645

Policy: 6785-2 - Left Turn Phasing

Date Last Reviewed: 3/22/2017

Page **2** of **5**

LTSD Minimum Left Turn Sight Distance

V_{major} Design speed of oncoming through traffic (ft/sec)

$$LTSD = V_{major}(2 + \frac{W + L}{V_{LT}})$$

2. Confirmation that all files for the subject intersection have been reviewed and that no documentation exists indicating that the Protected-Only left turn operation was installed to mitigate crashes. A protected/permissive phase may still be considered if geometric improvements that improve sight distance have been made since the crash history was documented.

D. Protected-Only/Protected-Permissive by Time-of-Day (PO/PP-TOD)

In cases where sight distance constraints are temporary (i.e.: a vehicle in the opposing left turn lane is constraining sight distance, but if no vehicle is present, sight distance is acceptable) protected-only/protected-permissive by time-of-day operation should be considered. PO/PP-TOD operation may be used (for example: between the hours of 10 pm and 5 am) when traffic volumes are much lower. The District Traffic Engineer will determine when the left turn phase operates as protected-only and when it operates as protected-permissive. A note should be placed under the phasing diagram that states which left turn phases will operate as PO/PP-OD.

The left turn sight distance should be measured with and without temporary obstructions, compared with the calculated minimum from Table 1, and submitted to the State Traffic Engineer. It may be also be appropriate to use PO/PP-TOD based on engineering judgment (i.e. difficulty getting acceptable gaps due to saturated opposing flow; crashes during certain times of the day).

E. Permissive-Only Left Turn Phasing

In cases where a left turn phase is not warranted it may be appropriate to use a 3-section permissive-only FYA signal head (i.e. offset left turn lanes or opposing a lagging left turn phase).

II. FLASHING YELLOW LEFT TURN ARROWS

A flashing yellow arrow (FYA) left turn signal head should be installed where protected/permissive as well as PO/PP-TOD and permissive-only left turn operation is warranted. FYA is the required alternative over the five-section "dog-house" signal head configuration when new signals are installed or signals are upgraded.

The regulatory sign R10-5a, explaining the flashing yellow arrow operation to approaching motorist, should be placed on the mast arm or span wire adjacent to the flashing yellow arrow signal head to coincide with the public outreach. The installing agency should conduct public outreach prior to the installation of FYAs in a new area, which should include media segments (radio and television), pamphlets, mailings addressed to the surrounding public and/or portable message signs.

A five-section (dog-house) left turn signal head should not be used as a protected/permissive left turn treatment at the same intersection that a FYA signal head has been installed. When the intersection is in flash, due to a malfunction, the FYA head shall flash the red arrow.

Policy: 6785-2 - Left Turn Phasing
Date Last Reviewed: 3/22/2017 Page **3** of **5**

A four-section FYA head cannot be used as protected-only head full time at an intersection; if a FYA signal becomes protected-only full time, the FYA signal head must be replaced with the appropriate protected-only left turn signal head as defined in the GDOT signal design manual.

III. RIGHT TURNING PHASING

Right turn phasing and overlaps can provide an operational benefit to a signalized intersection. A protected right turn phase should only be installed if an exclusive right turn lane exists. Any protected right turn phase, including overlaps, should be shown in the phasing diagram and/or noted below the phasing diagram. Single signal indication of an overlap is recommended with a single right turn lane.

For dual right turn lanes, permissive operation (including right turn on red) should be used if adequate sight distance is provided. The red right arrow should only be installed where right-turn-on-red is prohibited.

IV. SPLIT PHASING

Split phasing at a signalized intersection can significantly impede the capacity of the intersection and should only be implemented after documentation has been submitted and the permit has been approved by the State Traffic Engineer. Documentation should satisfy one or more of the following criteria:

1. Side street has a left turn lane and a shared through/left lane
2. Crash history associated with the side street having a shared through/left lane
3. Unbalanced opposing traffic volumes, where opposing movement does not need to be served each cycle, thus resulting in reduced intersection delay
4. Unusual intersection geometrics (offset side streets)
5. Paths of opposing left turn movements conflict but the preferred lead/lag operation is not desirable
6. Limited sight distance but protected-only left turns on the side street is not desirable

Although the left turn movements of split-phased approaches operate as protected-only, if the intersection is ever converted from split phased to concurrent phasing, all left turn phases should meet the appropriate criteria before approval.

Policy: 6785-2 - Left Turn Phasing
Date Last Reviewed: 3/22/2017 Page **4** of **5**

References:

None.

History:

updated logo: 11/09/18;
added to TOPPS: 04/10/96;
added to Manual of Guidance: 01/05/87
Reviewed: 3/22/2017

Policy: 6785-2 - Left Turn Phasing
Date Last Reviewed: 3/22/2017 Page **5** of **5**