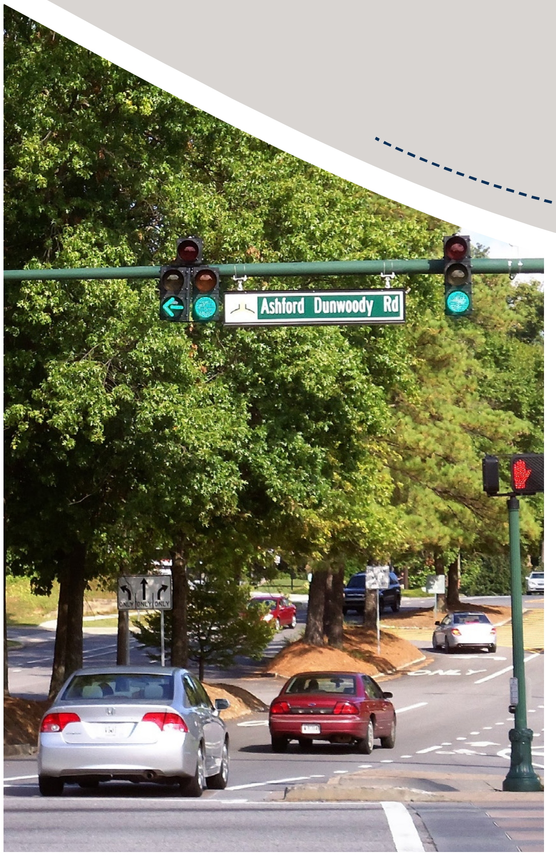
City of Sandy Springs

INTELLIGENT TRANSPORTATION SYSTEMS
ITS MASTER PLAN

Adopted November 5, 2019



Kimley»Horn

Table of Contents

List of Figures

List of Tables

Introduction

The City of Sandy Springs has an established history of being at the forefront of emerging technologies. As the sixth largest city in the state, Sandy Springs has embraced the challenge of continuing to innovate and integrate technology for the purpose of managing, operating, and enhancing the existing multi-modal transportation system. For example, the City of Sandy Springs was one of the first municipalities to adopt next generation wireless vehicular detection technology in the Southeast and is now seen as the technology leader when it comes to deployment of advanced technology.

The City has a forward-thinking approach to implementing state-of-the-art Intelligent Transportation Systems (ITS), connected and automated vehicle, smart city, and internet of things applications based on the commitment to existing communications, traffic signal, and data-centric deployments. In addition, the City's collaboration and coordination with partner agencies and openness to public-private partnerships with programs such as Georgia Department of Transportation (GDOT) Regional Traffic Operations Program (RTOP) will continue to provide opportunities to gain efficiencies and remain at the forefront of the industry within Georgia.

Document Purpose

Contemporary transportation landscapes are typified by unpredictability and inefficiency. Country-wide, the established culture of car-centricity has resulted in over-utilized roadways, while traditional capacity-focused infrastructure projects are no longer feasible congestion mitigation measures. Anticipated population growth and the corresponding increase in travel demand threaten to further intensify transportation network pressures. Consequentially, leaders and decision makers must address the prevalent transportation issues with alternative measures that act within the existing facilities. ITS has emerged as a viable way to utilize rapidly-advancing technologies to manage and integrate transportation systems for improved operational efficiency and safety. ITS encompasses a wide range of measures to efficiently monitor, communicate, and manage transportation pressures.

The concept emphasizes collaboration across regional jurisdictions and agencies to facilitate streamlined coordination and a cohesive vision for improvement. An ITS Master Plan provides a comprehensive evaluation of a jurisdiction's existing ITS applications, needs, and implementation steps to achieve an integrated approach for enhanced region-wide mobility and safety. It acts as a compilation of relevant jurisdictional needs and responsibilities, centralizing information and contributing to an integrated transportation future.

The purpose of this document is to provide an ITS Master Plan that will serve as a comprehensive roadmap to achieving the City's established vision of enhanced safety, mobility, connectivity, efficiency, and resident quality of life throughout all modes of travel within its transportation network through the use of technology. The Plan evaluates existing conditions, assesses current and future needs, and provides recommendations, with a focus on long-term geographic scalability and regional interagency collaboration.

Plan Development

The ITS Master Plan development process included robust solicitation of stakeholder input. Two stakeholder workshops, 11 partner agency interviews, and an interagency meeting were conducted through the process to outline the ITS vision and needs of the City, investigate interagency collaboration potential, and refine high-level recommendations.

Stakeholder Engagement

Workshops were used to reach a larger group of stakeholders and solicit feedback to guide the development of the ITS Master Plan.

ITS Vision and Needs Workshop

The ITS Vision and Needs Workshop was held on March 4, 2019 and was widely attended by internal stakeholders. The primary focus of the workshop was to solicit information about existing and future needs for the Sandy Springs ITS network. Participants broke out into two groups to participate in discussions on the vision and needs for various ITS topic areas. The breakout discussion takeaways centered around interdepartmental and interagency collaboration regarding data and resource sharing, as well as more specific service layer needs. The following service layer summaries were discussed.

Vision and Needs Workshop

ITS Infrastructure

Workshop attendees, all of whom are representatives of various City departments, expressed the overall need for better communication of events and emergencies, including closures (roads, waterways, and parks) between traffic operators, the police force, fire department, and public. They also expressed their desire to integrate the Federal Emergency Management Agency's (FEMA) information system into communication channels. Attendees indicated that the City's priority is to implement underground utilities wherever possible, rather than aerial utilities. Attendees determined that it is feasible in the City's GIS system to use real-time feeds, fleet management, WAZE data, and other functions to diagnose traffic conditions and automate messaging.

Traffic Signal Systems

Workshop attendees agreed that emergency vehicle preemption needs to be expanded city-wide and that signal timing and real-time travel information needs to be connected to emergency responder route information systems. They also indicated the existing potential to use ITS devices and future Signal Phase and Timing (SPaT) information for origin-destination study and other planning efforts for the City.

Communications Infrastructure

The City communications infrastructure discussion elicited a response from workshop attendees that called for several additional fiber connections. Attendees expressed a need to connect FirstNet (the first responder 4G communication system), the City of Roswell, and adjacent jurisdictions to the City of Sandy Springs communications network to advance integration. Other needs discussed included additional redundancy fiber routes, communications to all existing and future traffic signals, fiber communication to outlying signals for closed circuit television (CCTV) camera coverage, and better monitoring of additional traffic signals, warning and messaging signs, including diagnostic information. Attendees also noted that an Advanced Transportation Management System (ATMS) project will increase the current fiber network within Sandy Springs. Additionally, the City currently utilizes Glance cellular communication to school flashers and other ITS field devices.

Transportation Management Center

The Sandy Springs Transportation Management Center (TMC) is the nexus of transportation information and resource dissemination within the city. Workshop attendees expressed a desire to connect emergency vehicle live video feeds and police cameras to the TMC and Emergency Operations Center (EOC). They reiterated the need to transition from a call-in alert messaging system to an automated platform for traffic signal and ITS device information. Furthermore, to facilitate around the clock operations of the TMC, the staffing responsibilities were defined as a joint effort between the Public Works and Police departments. Finally, additional funding was deemed necessary for an additional server for the City's advanced traffic signal central system fail over system.

Connected and Automated Vehicles

Connected and Automated Vehicles (CAV) were determined to be a high priority for the City representatives. Primarily, they anticipate opportunities to use CAV technologies to provide emergency vehicle preemption (EVP). In addition, the City identified opportunities for autonomous shuttles to connect parking facilities, Metropolitan Atlanta Rapid Transit Authority (MARTA) stations, schools, and parks and greenspace. A potential pilot project was discussed for the Glenlake area for a MARTA station autonomous shuttle that would connect Mercedes-Benz, Kaiser, and UPS campuses using a shared use path.

Traffic Incident Management and Emergency Transportation Operations

Current Traffic Incident Management (TIM) and Emergency Transportation Operations (ETO) procedures incite a need for improved automation, consistency, and coordination to improve efficiency. To that end, attendees concluded that incident and inclement weather monitoring and communications should be transitioned away from manual procedures to an automated or technologically-advanced system. It was stressed that incidents should be tracked and communicated consistently, and that emergency vehicle preemption should be implemented. Finally, standard operating procedures should be created for improved interdepartmental coordination.

Transportation Demand Management

Transportation Demand Management (TDM) is proven to be effective in reducing congestion and inciting mode shift, recently demonstrated by many local hospitals. Workshop attendees recognized that TDM initiatives are present in the city, but not well promoted or utilized at a municipal or employer level. The public-private coordination, especially within the Perimeter Community Improvement District (PCID) was identified as a gap in current TDM procedures. Attendees expressed a desire to explore WAZE's mobile carpool support application as a viable resource for City TDM initiatives. There should also be a more conscious effort toward encouraging the use of active transportation facilities like trails and sidewalks. The integration of traveler information as an additional way to encourage mode shift or altered demand was also discussed.

Other ITS Needs

Workshop discussions produced consensus that the City would benefit from additional traveler information kiosks and improved travel information (real-time location and estimated time of arrival) at bus stops. Work zone management can be improved with better coordination mechanisms for Georgia Department of Transportation (GDOT) work permits and utility work, as well as a more efficient review process for work zone permits as they pertain to Manual of Uniform Traffic Control Devices (MUTCD) compliance. Though the City has access to a vast amount of traffic data, the ability to more easily analyze and report the data needs to be developed. Finally, better asset management procedures would improve consistent data updates.

At the end of the meeting, each participant was given a survey asking them to consider their ITS priorities for Sandy Springs. Altogether, the 14 survey respondents indicated that cameras, communications, and traffic signal technologies should be prioritized over other ITS measures, denoted by their respective average priority scores of 4.54, 4.54, and 4.38 out of 5. The full ITS priority survey results are presented in the Appendix.

Interagency Interviews and Meeting

Interagency interviews were conducted and focused on current interoperability, successes, and opportunity for improvement within the realm of transportation management and operations through the use of transportation technology. These interviews served as an opportunity for each agency to provide input and ideas specific to what was most relevant to their current needs and experience with the City of Sandy Springs.

Interagency coordination interviews were held with the following agencies:

- Northside Hospital
- Perimeter Community Improvement District (PCID)
- City of Dunwoody
- City of Brookhaven
- City of Roswell
- City of Atlanta
- Cobb County
- Gwinnett County
- MARTA
- State Road and Tollway Authority (SRTA)
- GDOT

Each stakeholder participated in a short interview. The responses from the interviews were summarized into regional interoperability themes: 1) Existing interoperability; 2) Future interoperability; 3) Collaboration opportunities; and 4) Smart Cities/CAV opportunities. The major takeaways from the stakeholder interviews informed the direction of the interagency meeting, where congruent topics were deliberated.

An Interagency Coordination Meeting was held on April 24, 2019 with stakeholders whom had been interviewed previously. The goal of this meeting was to openly discuss and identify potential interoperability between partner agencies. Interoperability, in this context, focuses on the coordination and sharing of information and resources across jurisdictions as a method to improve visibility and efficiency of transportation management systems.

In the meeting, representatives from Atlanta Regional Commission (ARC), PCID, City of Dunwoody, City of Brookhaven, City of Roswell, City of Atlanta, GDOT, Gwinnett County, Fulton County Aging Services, and Fulton County Public Schools engaged in open dialog about each of the regional interoperability themes. The dialogue primarily revolved around the opportunities and limitations related to interagency and cross-jurisdictional ITS collaboration. The major takeaways from the discussion are presented below, categorized by regional interoperability theme.

Existing Interoperability

The City of Sandy Springs collaborates with GDOT and the Regional Traffic Operations Program (RTOP) team on the operation and maintenance of the existing Split, Cycle, and Offset Optimization Technique (SCOOT) system, including the design of additional SCOOT corridors. There are 52 SCOOT intersections in Sandy Springs. Sandy Springs is also coordinating with GDOT to convert the signal systems to a Linux-based system to enhance the interoperability potential for Automated Traffic Signal Performance Measures (ATSPM). Additionally, the sharing of camera footage between Sandy Springs and city, county, and state agencies is available through remote access, with the potential for direct sharing if the City segments the traffic network from the IT network. The functionality of direct sharing with GDOT is contingent on state decisions about their new platform. With the public, camera footage is confined to snapshots and live streaming. There have been regional-level conversations about a need for improved standardization and communication related to shared information and resources during emergency events, but no action has been taken. However, Fulton County Emergency Operations and Fulton Country Schools have coordinated to stagger school release times during emergency events to mitigate delays and manage system demand.

Future Interoperability

Transit priority was a primary discussion topic for future cross-jurisdictional collaboration opportunities. MARTA is converting their Automatic Vehicle Location (AVL) system to sim cards which will provide more frequent GPS location, which could support Transit Signal Priority (TSP). Gwinnett County is installing transit signal priority on their Smart Corridor project. Future technologies, dedicated short range communications (DSRC) and 5G, were discussed as both having potential opportunities for the future and being installed by The City of Sandy Springs and The City of Atlanta. To improve coordination and shared knowledge and resources, GDOT showed a willingness to help fund technology as it develops to fully take advantage of current interoperability opportunities. Standards for traveler information, traffic signal, and ATSPM data were discussed to streamline data sharing between partner agencies. Maintaining open source data would provide similar opportunity for technology groups and app developers. Participants shared the view that on-going, interoperability-focused discussions and the development of regional guidelines are necessary to effectively direct the influence of ITS technologies at all municipal levels.

Collaboration Opportunities

Agency stakeholders discussed in more detail the tangible opportunities for collaboration and progress. Fulton County Schools shared their bus technology, stating that they use AT&T FirstNet on their 1,000 buses to get road closure, detour, and other traffic alerts; they have a geo-located application that notifies parents when the bus is arriving by student ID numbers; and they are looking to install Wi-Fi on their buses to expand their Angel Tracks system to include live feed capabilities. Additionally, Fulton County Aging Services indicated that they have GPS in their fleet of 60 buses. Both agencies expressed a willingness to participate in any pilot projects. The idea of a centralized, single cross-jurisdictional web or app-based information communication channel for accurate and efficient dissemination of work zone and event information was discussed. The City of Sandy Springs indicated that it would be beneficial for the city to evaluate the protocols related to sharing traveler information, permitting, work zone information, and incident notifications.

Smart Cities / Connected and Automated Vehicle Opportunities

The City of Sandy Springs Fire Department is researching and will deploy emergency vehicle preemption throughout the city. The City of Brookhaven is researching parking demand management and routing applications that allow intercity data sharing. Buses, ride-share companies, vehicles, signal systems, transit, and other modes have data that can be shared; managing those data for effective use for each jurisdiction is a challenge as well as a great opportunity.

ITS Recommendations Workshop

The Sandy Springs ITS Master Plan Recommendations Workshop was held on August 16, 2019. The workshop was attended by internal stakeholders. The workshop provided information about existing and future needs for the Sandy Springs ITS network and the draft high-level recommendations were introduced. During the workshop participants discussed each of the recommendations and provided feedback for inclusion and refinement. The recommendations were broken up into ITS initiatives, network recommendations, and system recommendations.

Recommendations Workshop

ITS Vision

The information and guidance provided by the workshops and stakeholder discussions steered the development of the City of Sandy Springs ITS Master Plan vision. The Sandy Springs ITS Master Plan vision defines the future of ITS in Sandy Springs:

> *Utilize Intelligent Transportation Systems (ITS) to enhance safety, mobility, connectivity, and efficiency throughout **all modes of travel;** using technology to improve the quality of life for the residents of Sandy Springs.*

This vision was used to guide the development of ITS recommendations and priorities within the implementation plan.

Outreach and Education

In addition to the stakeholder and employee outreach workshops, educational materials were developed to further inform stakeholders of the purpose and scope of ITS within the city. The complexity of subject matter within ITS dictates that a more streamlined outreach mechanism be used. For that reason, summary fact sheets were created for four principal aspects of the ITS Master Plan: existing ITS conditions, advanced signal timing, connected and automated vehicles, and ITS Master Plan recommendations. These fact sheets, shown in the Appendix, aim to provide a basic description of the purpose and benefits of ITS in the City of Sandy Springs. This adds to the value of the overall ITS Master Plan by engaging a broader audience and demonstrating the value of the current and continued use of ITS investments. A summary of each fact sheet is provided below.

Existing ITS Fact Sheet

The existing conditions fact sheet outlines that the City of Sandy Springs has a vast network of transportation facilities spanning over 330 miles and already embraces the use of cutting-edge transportation technologies. Measures like traffic signal systems, vehicle and pedestrian detection, CCTV monitoring devices, and an extensive fiber communication network comprise a majority of existing ITS infrastructure in the city. The City's TMC acts as the monitoring and communication nexus for the transportation network.

Advanced Traffic Signal Timing Fact Sheet

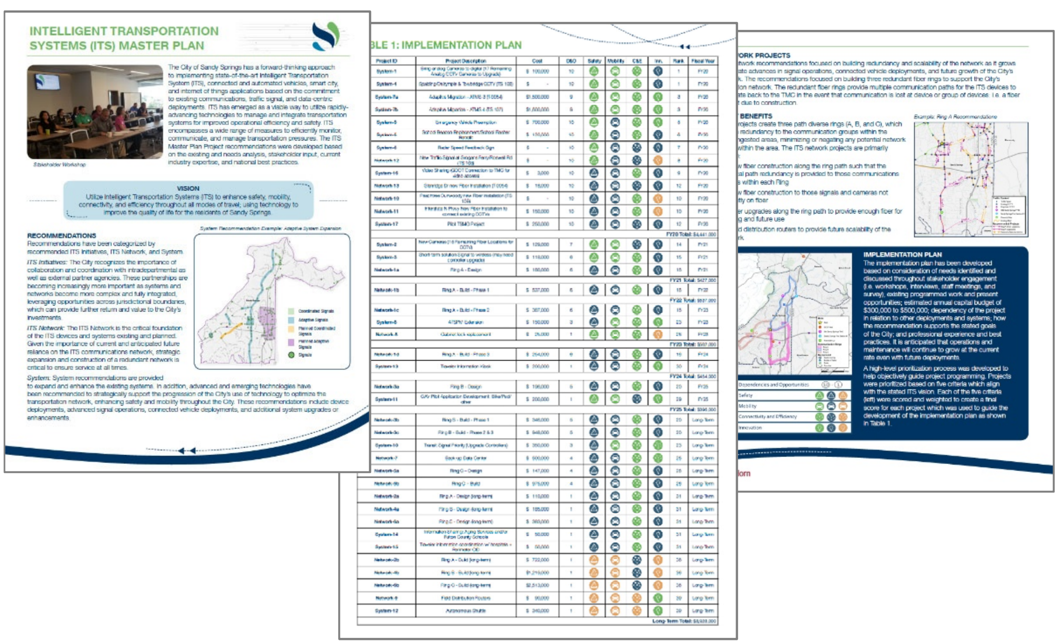
The advanced traffic signal timing fact sheet describes the various types of traffic signal control that are deployed in the City of Sandy Springs and explains the value of implementing advanced signal timing strategies to optimize traffic. Traditional signals have uncoordinated timing mechanisms, meaning that the signal works within a range of signal lengths that vary as a function of current traffic volumes at a single intersection. In contrast, coordinated signals incorporate overall traffic patterns of the corridor into maximize reliability and safety along the entire passage. Adaptive traffic signal control uses real-time travel pattern data to adjust cycle lengths constantly to reflect the current demand. This mechanism is used to accommodate unpredictable traffic patterns. United States Department of Transportation (USDOT) research indicates that transitioning from uncoordinated to coordinated signal timing demonstrates benefits of 17 to 62 times the capital investment.

Connected and Automated Vehicles Fact Sheet

In the age of connectivity and "smart" systems, Connected and Automated Vehicle (CAV) technology allows for communication between vehicles and the built infrastructure (V2I/I2V) as well as between vehicles (V2V). The "talking" between vehicles, smartphones, roads, and other infrastructure creates safer, more efficient, and more mobile communities. The connected and automated vehicles fact sheet provides examples of specific types of connectivity and how they facilitate transportation benefits, including real-time, location-specific information, emergency vehicle preemption, transit signal priority, or advanced pedestrian and bicycle detection.

ITS Master Plan Fact Sheet

The ITS Master Plan fact sheet provides a summary of the ITS Master Plan development and recommendations. This is intended to be a very high-level, brief explanation of the overall process, vision, recommendations, and implementation plan. It is envisioned that the fact sheet will be a convenient resource for those interested in understanding the Plan.



Existing ITS Assessment

The City of Sandy Springs operates and maintains an extensive ITS network which is managed through its Traffic Management Center (TMC). The current communication network is made up of fiber optic cable, wireless radios, and cellular modems. This communications network supports the City's ITS devices including, traffic signals and equipment, vehicle and pedestrian detection devices, closed circuit television (CCTV) cameras, and Bluetooth readers.

Traffic Management Center

The City's ITS devices and traffic signal system are monitored and controlled from the Traffic Management Center (TMC) located at 1 Galambos Way in Sandy Springs, GA. The facility features an operations room where the CCTV camera images, signal operations, and ITS devices are monitored and managed on a 5.75 ft. H X 13.5 ft. W video wall.

Traffic Management Center

To further enhance operations across jurisdictional borders, the City of Sandy Springs has direct center-to-center fiber communication connection with Georgia Department of Transportation (GDOT), City of Roswell and City of Dunwoody. Current coordination between jurisdictions for interoperability and maintenance is accomplished via telephone, email, and conversation; there is no automated coordination at this time.

Communications Network

The City of Sandy Spring's communication infrastructure is comprised of approximately 43 miles of fiber optic cable with approximately 34 miles of underground cable in conduit, nine (9) miles of aerial cable, and 300 feet of cable connecting directly to the Sandy Springs TMC. Fiber optic cable is the preferred and main method of communication for the majority of the city's ITS network as it links all field devices back to the TMC. Communication is additionally enhanced using six (6) wireless radios and 45 cellular modems. These devices are located throughout the City where fiber optic cable was determined not feasible due to cost, time, or physical obstacles. Figures 1 and 2 present the existing fiber optic cable infrastructure.

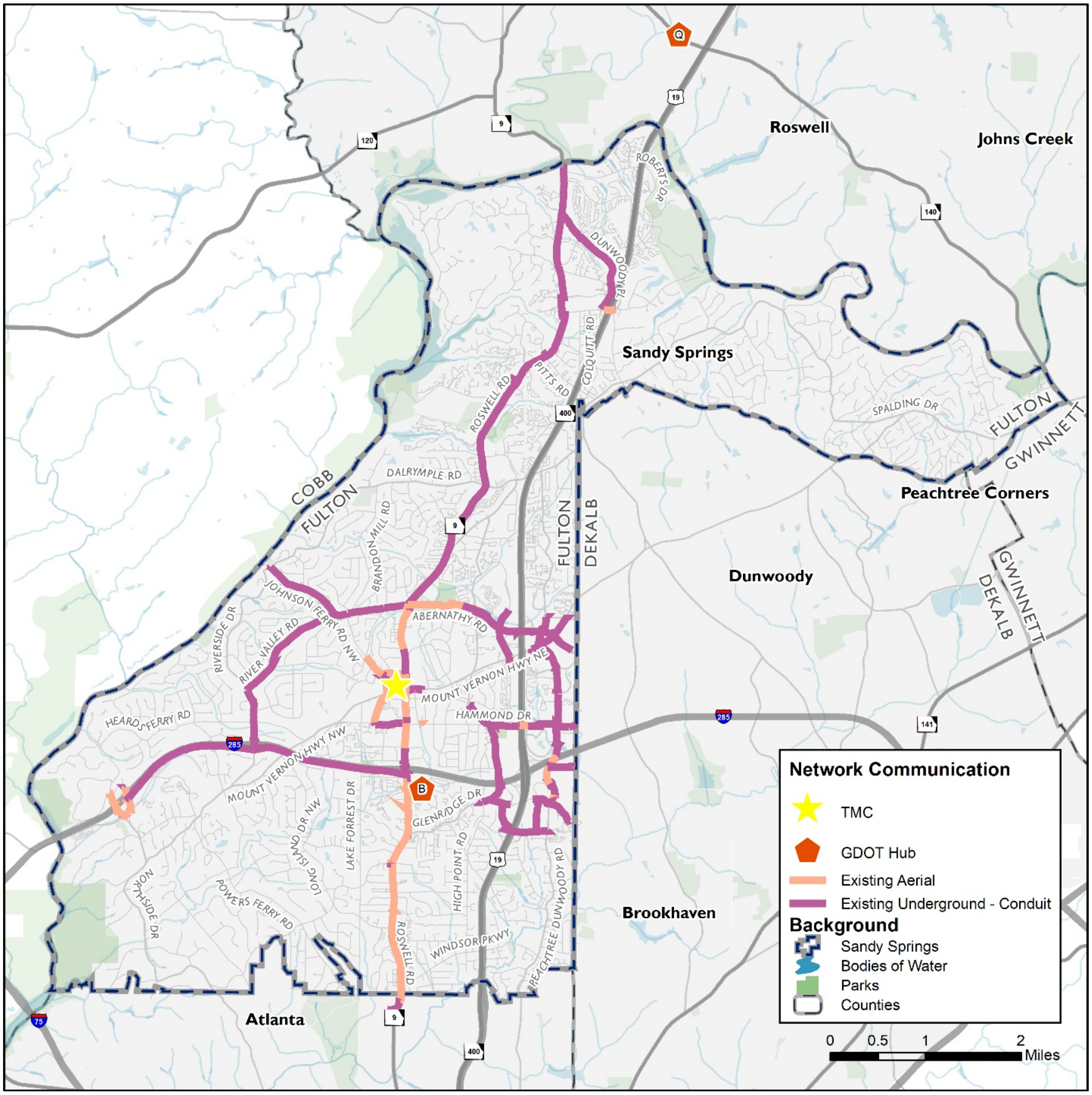


Figure 1: City of Sandy Springs Existing Fiber Network Map

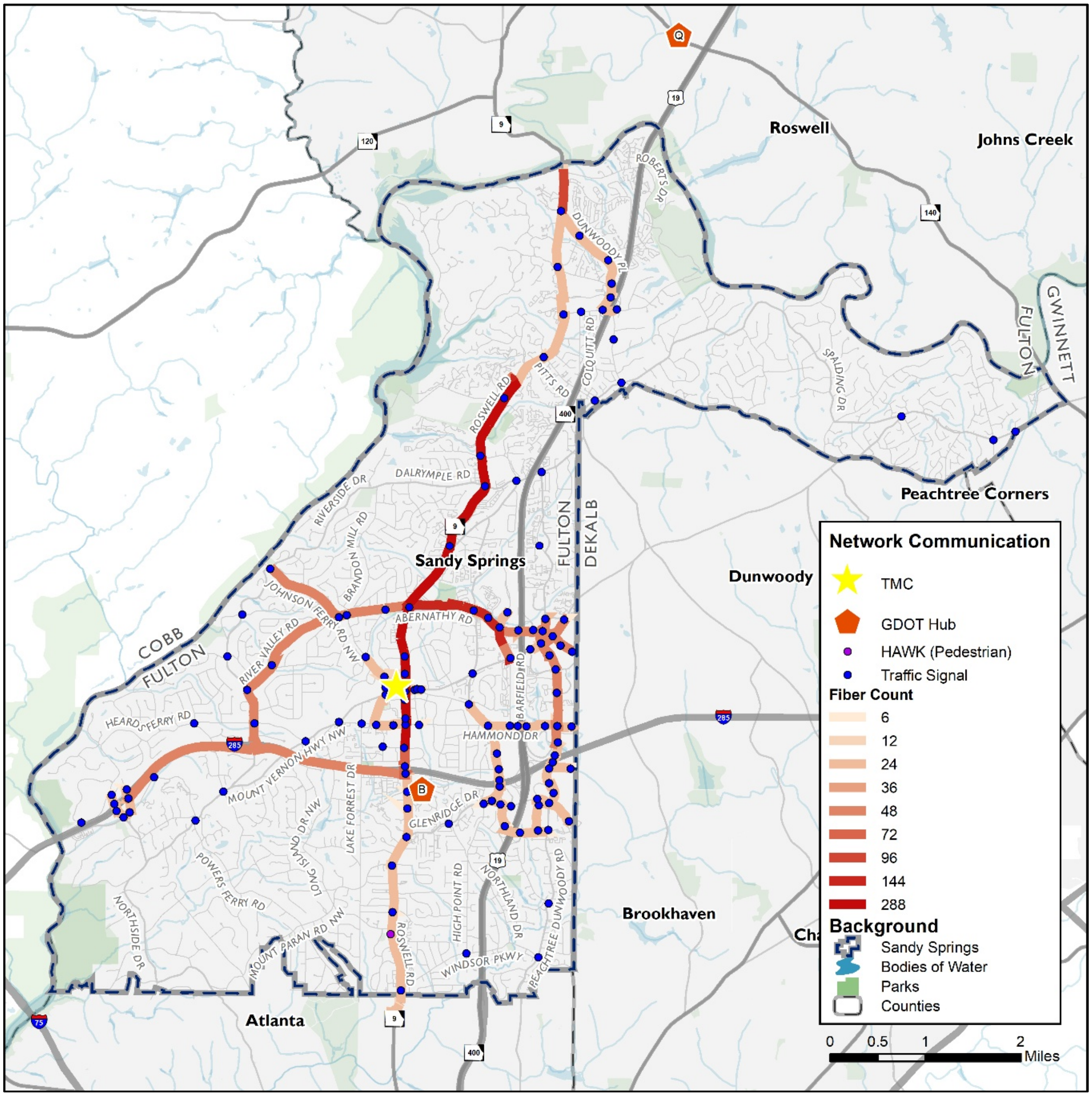


Figure 2: City of Sandy Springs Existing Fiber Count Network Map

Two primary fiber communication topologies are deployed by the city to communicate with ITS field devices. Figure 3 presents the methodology deployed by the majority of the communication channels which is a drop-and-repeat method with no existing redundancy; therefore, a cut or device failure renders all devices downstream of the fault off-line.

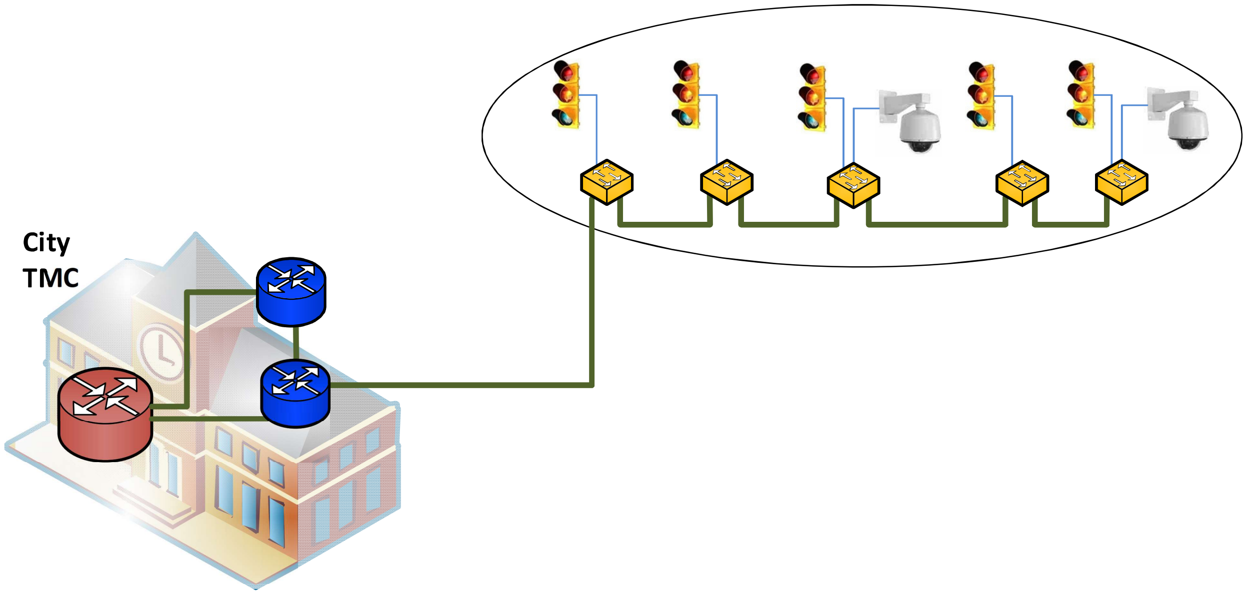


Figure 3: Network Topology A – No Redundancy

Figure 4 presents the second methodology which utilizes a drop-and-repeat method, but also provides redundancy either through the same route (i.e. folded loop) or a physical path diverse route. Communication group 4, in the Hammond Drive, Peachtree Dunwoody Road, Glenridge Connector area, currently uses folded loop redundancy. Devices deployed in this fault tolerant topology are able to maintain connectivity when a fiber cable is damaged or cut (in the case of a path diverse route) or a switch failure (in the case of a folded loop). Path diverse redundancy is preferable due to the resiliency that an independent path provides.

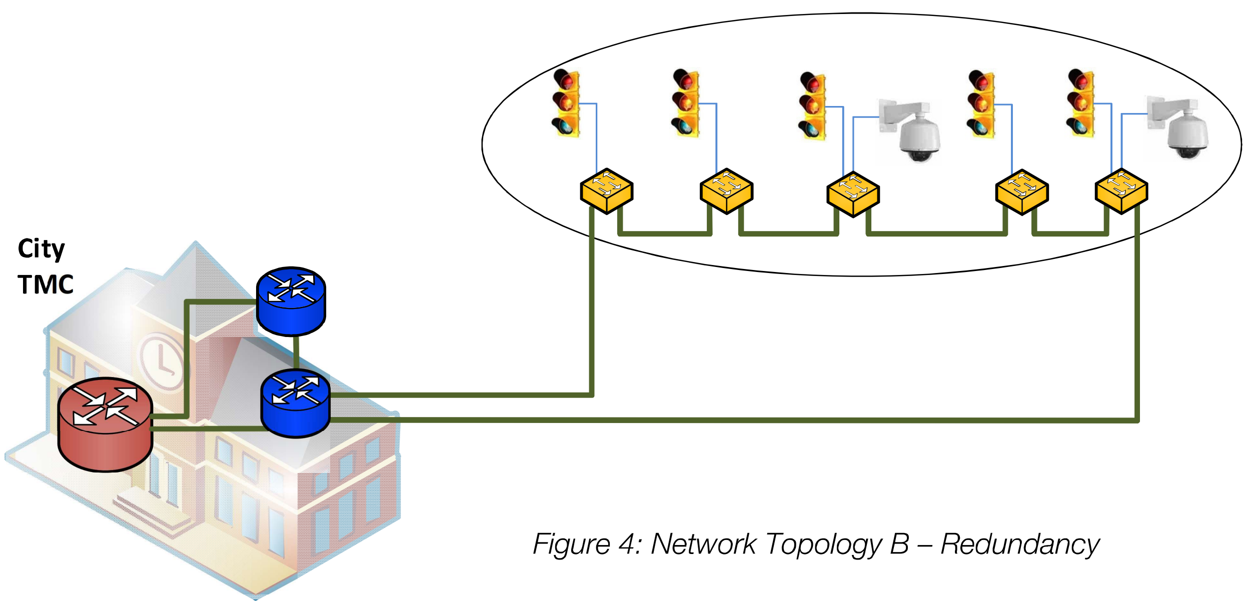


Figure 4: Network Topology B – Redundancy

The ITS field devices primarily communicate via IP/Ethernet protocols with several cameras currently being migrated from serial/analog to digital video. The City primarily uses Ruggedcom RS900G network switches and co-locates field devices where possible. Data (i.e. signal controller traffic) and video traffic are segmented with the City's current virtual local area network (VLAN) schema. This allows for a more stable network environment and prevents video traffic from interfering with higher priority data traffic.

Traffic Signals

The City of Sandy Springs traffic signal system currently includes 136 signalized intersections, most of which are maintained by the City with assistance through GDOT. The traffic signal system uses two Siemens traffic controller software programs and central servers that work together to provide users with a safe and efficient travel experience. The majority of the existing traffic signals currently operate Siemens SEPAC 2070 local controller software monitored with Siemens TACTICS central system software. These controllers support fixed time, actuated, and traffic responsive operations.

The remaining traffic signals operate using Siemens adaptive signal timing system, Split, Cycle, and Offset Optimization Technique (SCOOT) and is monitored with the SCOOT central software. The City of Sandy Spring's current SCOOT network includes 52 signals along State Route (SR) 9 (Roswell Road), Riverside Drive, Northside Drive, and New Northside Drive, plus an additional four (4) intersections located outside the City of Sandy Springs. The City is in the process of constructing the infrastructure to add approximately 50 signals along Mt. Vernon Highway, Abernathy Road, Peachtree Dunwoody Road, Hammond Road, Glenridge Drive, Glenridge Connector, and Johnson Ferry Road to the SCOOT network.

The City of Sandy Springs is currently part of the GDOT Regional Traffic Operations Program (RTOP), which focuses on regional traffic flows. The RTOP team works closely with the City to actively monitor and manage 87 of the 136 signalized intersections during peak periods; providing signal timing, upgrading/installing equipment, and monitoring communications.

GDOT traffic signal system uses Intelight MaxTime traffic controller software program and Intelight MaxView central server to monitor and control their network. GDOT traffic signal system includes traffic signals located on State trunk lines, highway ramp meters, and other ITS devices. Gwinnett County, Cobb County, City of Brookhaven, City of Dunwoody, City of Atlanta, and City of Roswell also use MaxTime and MaxView for their traffic signal systems. The GDOT and the local agency systems are connected through center to center connections to share signal information with GDOT and between all agencies. The City of Sandy Springs currently has direct center to center connection with GDOT and is working to upgrade their signal controller platform to a Linux based platform to provide interoperability between the TACTICS and MaxView systems.

Additionally, the City operates and maintains a network of warning flashers and signals, and speed advisory signs. Traffic signals and systems are displayed in Figure 5.

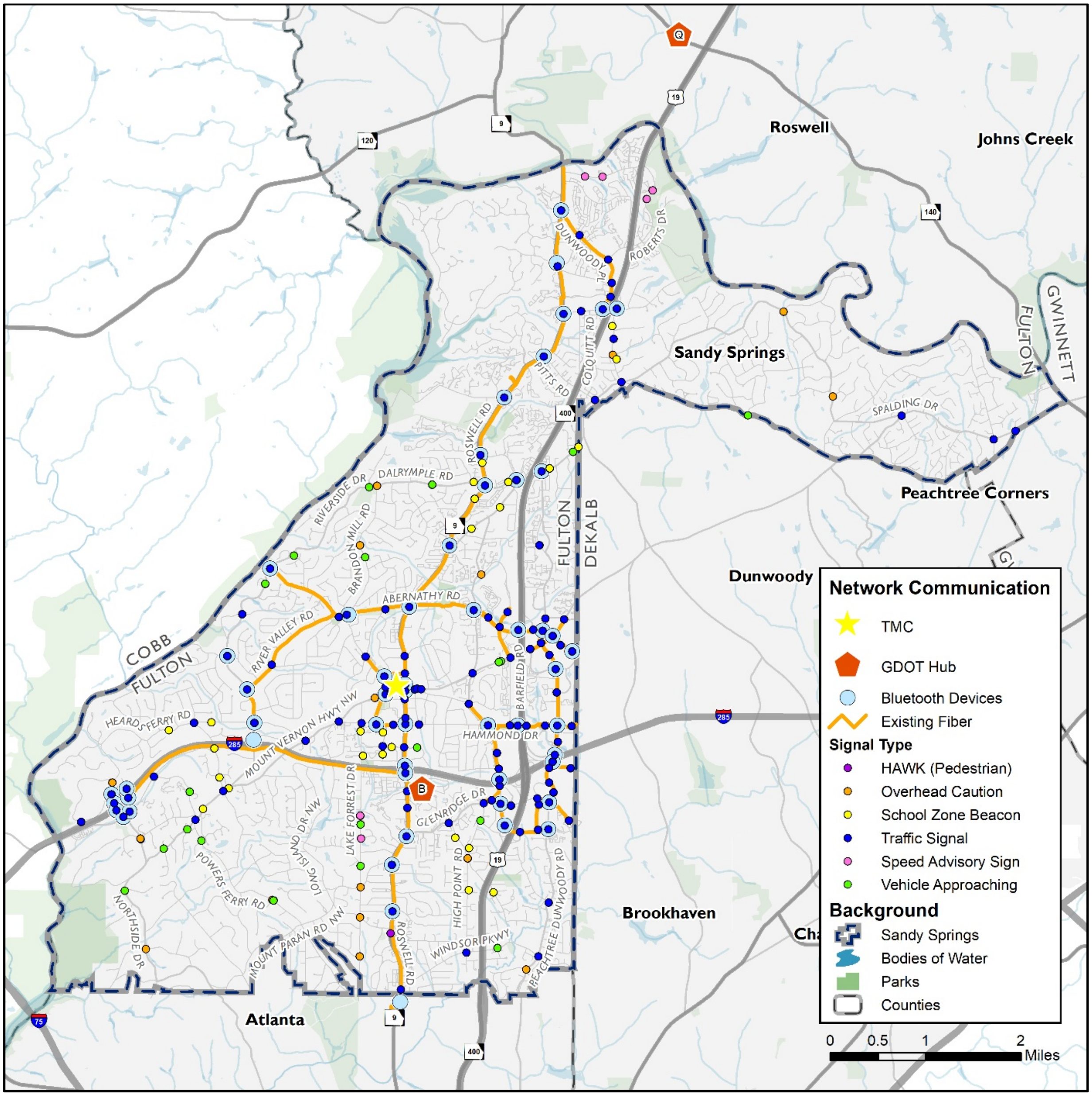


Figure 5: Existing Traffic Signal Map

Battery Backup Systems

The City of Sandy Springs utilizes uninterrupted power supplies (UPS) and battery backups systems (BBS) to sustain traffic operations during power interruption and power loss events. If power is lost in the area, the UPS will recognize the loss of power, maintain current operations, and switch over to full battery backup without loss of power to or operation of the signal. It also protects against power spikes and dips, which may impact operations. The BBS units provide battery backup but do not monitor the power. When power is lost in the area, the signal will go dark and will then be brought back into flashing operations by the BBS. Some of the existing UPS and BBS units are Ethernet compatible and are being monitored from the TMC.

CCTV Cameras

Currently, there are 95 closed circuit television (CCTV) cameras overseeing the City's signalized intersections and corridors. These CCTV cameras include pan-tilt-zoom (PTZ) functionality and are used for traffic monitoring from the TMC, situational awareness, incident detection and verification, and traffic equipment monitoring and maintenance. Currently, about 30% of the CCTV cameras are analog and use an encoder either in the TMC or in the CCTV cabinet for conversion to be IP capable. These cameras are scheduled to be upgraded to a digital format. The other 70% of cameras are natively IP and connect directly to a field Ethernet switch.

The City of Sandy Springs uses Genetec software to manage video deployed in the TMC. The Genetec software resides on a Sandy Springs TMC server. Partner jurisdictions such as City of Dunwoody, City of Brookhaven, City of Roswell, and Cobb County have access to the Genetec through license sharing agreements and the direct center-to-center communication connections. Figure 6 displays the location of the CCTV cameras throughout the City.

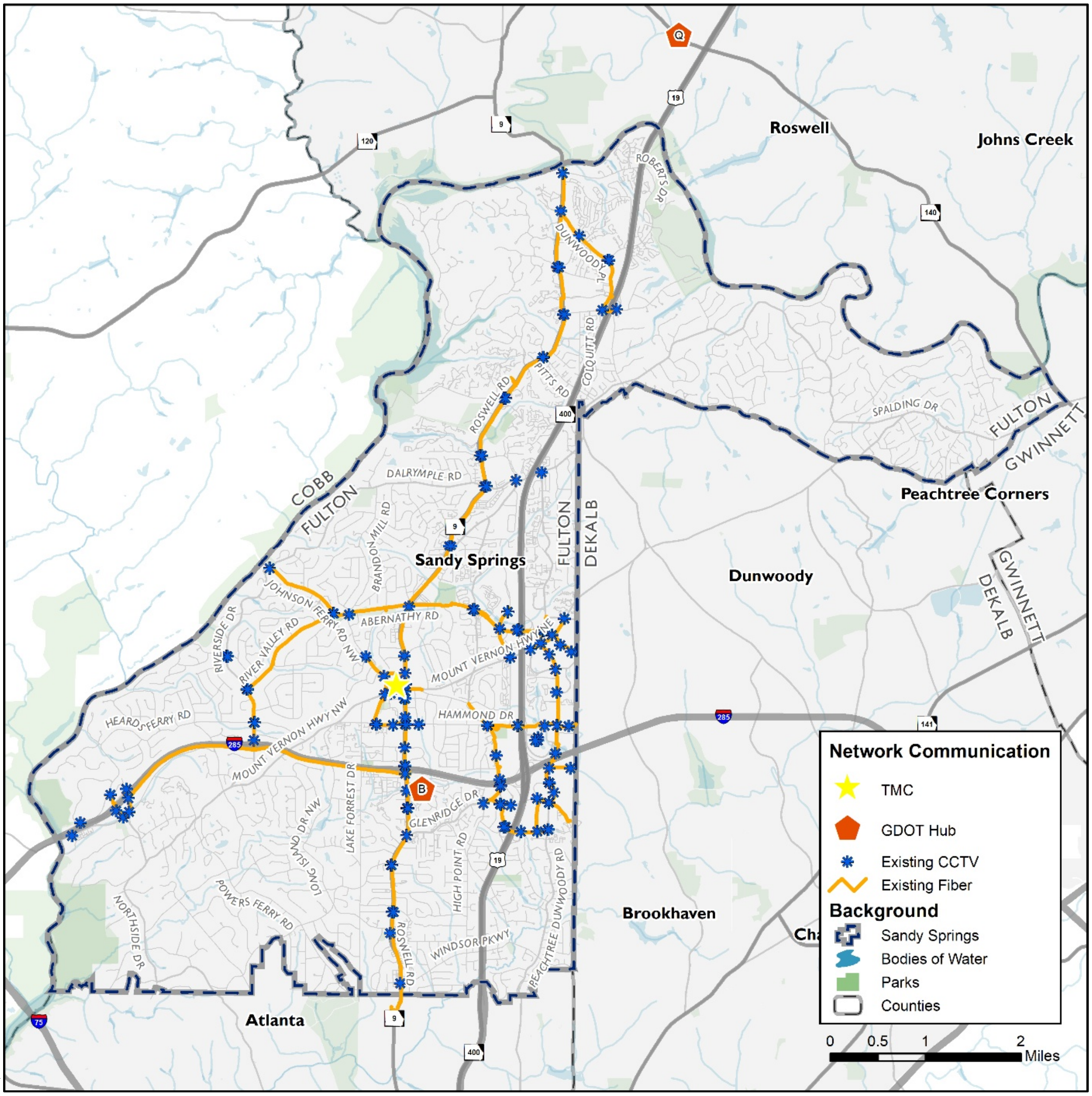


Figure 6: City of Sandy Springs Existing CCTV Camera Map

Detection

The City of Sandy Springs traffic system utilizes vehicle and pedestrian detection to maximize the efficiency of its traffic signals and decrease motorist delay. Various methods of vehicle detection such as video, in-pavement loops, and wireless detection are deployed across the City. Sensys Networks wireless in-pavement detection units are the preferred method for vehicle detection in Sandy Springs. Through a web-based application the Sensys detection is monitored at the TMC providing alerts to detection failures to increase awareness and expedite repair time. Pedestrian detection is also used in conjunction with vehicle detection in the form of pedestrian push buttons.

Sandy Springs Fire Department currently utilizes a traffic signal preemption system at the two following locations:

- Station 1 – Spalding Drive @ Roberts Drive
- Station 2 – Sandy Springs Circle @ Johnson Ferry Road

The current traffic signal preemption systems are push button activated, which initiate signal timing changes to allow the emergency vehicles to exit the station and route quickly through providing green signals. Sandy Springs is currently considering Emergency Vehicle Preemption (EVP) devices for the Fire Department. The EVP devices will be installed at traffic signals and on the emergency vehicles. These devices will provide information to the traffic signals to provide signal timing along the route of the emergency vehicle reducing response time and increasing safety.

Bluetooth Readers

The City of Sandy Springs has deployed Bluetooth detection technology; Travel-time Origination and Destination (BlueTOAD) devices, at 54 intersections around the City. BlueTOADs collect and calculate travel-time data through anonymous Machine Access Control (MAC) addresses transmitted from Bluetooth-enabled devices, such as cell phones, as the devices pass each Bluetooth reader along a corridor. The data collected is sent via the network either through fiber optic cable or cellular communication and the TMC. This information is used to understand current traffic patterns, evaluate travel time reliability and travel time reductions, and provide traveler information to the public.

ITS Asset Management

Sandy Springs currently uses NexusWorx software to document its existing fiber network allocations. This system is a GIS based system and is used to document the location, asset inventory information, fiber allocations, and network connections. Currently, there is no formal process in place for monitoring and updating the data in the system.

Additionally, Sandy Springs maintains a GIS database for documenting the City's ITS assets. This database includes location and asset information for traffic signals, CCTVs, fiber communications, Bluetooth readers, traffic calming devices, roadways, and sidewalks. This information is available to the public through the City of Sandy Springs website.

Partner Agency Collaboration

Sandy Springs partners with various other agencies to share data, video, network connections, and other information. By collaborating with partners throughout the region, the City is able to enhance the safety and reliability of the local transportation network.

Metropolitan Atlanta Rapid Transit Authority

Metropolitan Atlanta Rapid Transit Authority (MARTA) operates the passenger train and bus transit systems within the Metro Atlanta Region. Sandy Springs works with MARTA to coordinate incident or event management, route changes, and detours. There is no formal process in place for this coordination and the communication is accomplished through manual call or email.

MARTA bus systems currently use Automatic Vehicle Location (AVL) technology which provides GPS locations of their vehicles. This technology can be used to provide location information or when supported with a Transit Signal Priority (TSP) system. TSP uses detection devices deployed onboard the transit vehicle which communicate with the traffic signals and signal system to determine if signal timing adjustments can be made to increase efficiency of the transit vehicle. Currently, the AVL technology does not communicate frequently enough for Sandy Springs to receive the AVL information or have a TSP system deployed within the City. However, MARTA has expressed an intent to upgrade their AVL system and stakeholders have expressed interest in the TSP technology.

In addition, MARTA operates a number of CCTV cameras throughout their network and is open to sharing access to the video streams. This sharing of resources extends the agency's monitoring capabilities and provides additional support to the transportation system. Currently, Sandy Springs does not share video with MARTA, but may want to consider this potential opportunity in the future.

State Road and Tollway Authority

State Road and Tollway Authority (SRTA) currently operates Express Bus route 401 which provides service through the City. The Express Bus route is operated using a fleet of approximately 165 vehicles which are housed and maintained within two of SRTA's garages. These vehicles are equipped with devices which provide information to a central system which tracks performance metrics such as on-time performance, ridership, and accidents/breakdowns. These devices are also used to provide information to users through website and phone applications.

SRTA also operates and maintains the Peach Pass system on Georgia's highway systems. The Peach Pass system uses devices to collect vehicle speeds and volumes to provide traveler information to determine toll rates. This system provides information to users through website and phone applications.

It is anticipated that in the future these systems will work together along with GDOT and local jurisdictions and with the traffic signal systems. The integration of these systems could be used to develop Bus Rapid Transit (BRT) or TSP systems to provide a safer more efficient transit system across the region. However, there is currently no sharing of data with Sandy Springs at this time.

Fulton County Aging Services

Fulton County Aging Services uses GPS systems on their bus and shuttle fleet of approximately 60 vehicles. The GPS system is used for routing of the vehicles. The system provides data on road closures, traffic incidents, and detours and collects information such as location, speeds, and travel times. There is currently no automated sharing of data with the City, however this may be an opportunity to consider in the future.

Fulton County Schools

Fulton County Schools operates approximately 1,000 buses. The buses are equipped with GPS devices and use AT&T FirstNet routing system. FirstNet provides data on road closures, detours, and other traffic alerts to the drivers. Additionally, Fulton County School has developed the Angel Tracks System which is a geo-located app which notifies parents of bus arrival times based on student ID numbers. The Angel Tracks system includes a CCTV camera located on each bus to record events that is activated by the driver. Through the Angel Tracks system, Fulton County School plan to install Wi-Fi on their busses which will include CCTV camera live feed capabilities. There is currently no automated sharing of data with the City, however this may be an opportunity to consider in the future.

Communication Systems

The City of Sandy Springs uses various means of communications to notify stakeholders and residents of road closures, work zones, and incidents. Road closure and work zone information is sent out via email through the City's Communications Department to stakeholders, posted on the City's website on the Road Work Advisory page, and issued via social media. Additionally, residents can sign up for Sandy Springs Alerts which sends updates via email or text messages for emergency closure information and weekly traffic and closure updates.

Existing Plan Review

The table below provides a brief summary of plans and documents completed in the City of Sandy Springs that have been reviewed for transportation technology relevant information. Chronologically organized, the inventory summarizes planning efforts from 2008 to current and includes comprehensive plans, corridor studies, a bicycle/pedestrian plan, and transit plans.

Table 1: Existing Plan Review

Name	Description	Major Recommendations
Livable Cities Initiative: Roswell Road LCI Report, July 2008	Report summarizes the different improvements and initiatives for Roswell Road, and lays plans for future improvements.	– Improve and increase pedestrian and bicycle facilities – Improve traffic operations and safety – Promote economic development
City of Sandy Springs Transportation Master Plan, August 2008	Long-range transportation plan that lays out goals and investment locations in the City.	– Increase transit – Improve pedestrian and bicycle facilities and trails – Improve traffic operations and safety
City Center Master Plan, December 2012	Transportation and redevelopment plan for the Sandy Springs City Center that lays out goals and plans for future development.	– Provide walkable environment in mixed-use redevelopment – Green space network – Community development
Bicycle, Pedestrian and Trail Implementation Plan, December 2014	Long-range plan that lays out goals and investment locations for pedestrian and bicycle facilities and trails.	– Complete Streets policies – Pedestrian and bicycle initiatives
North Fulton Comprehensive Transportation Plan, July 2016	Short term regional transportation plan for how budgets will be spent in the next 3 years as it relates to the long-range transportation plan.	– Improve traffic operations and safety – Increase transit – Increase pedestrian, bicycle and trail infrastructure
The Next Ten Comprehensive Plan, Sandy Springs, February 2017	Long range plan that lays out framework and goals for future development in the City.	– Improve traffic operations and safety – Increase transit – Develop and improve pedestrian and bicycle trails – Enhance public spaces

ITS Needs Assessment

The City of Sandy Springs anticipates significant growth and further dependency upon its existing and planned intelligent transportation systems with the continued evolution of technology within the transportation industry, including connected and automated vehicles. Developing an understanding of needs that may be addressed with ITS solutions provides the basis for strategic recommendations and phasing that will best support the City's long-term vision and goals.

Safety and Mobility Needs

While safety and mobility are independently important considerations within transportation systems, the inherent relationship between the two adds complexity to isolated improvement efforts. Residents of Sandy Springs experience a variety of safety and mobility challenges every day such as long commute times, minor and major crashes, and road closures due to a work zone or crash.

Safety

Traffic incidents such as crashes can cause delay to travelers on the Sandy Springs transportation network and can result in severe injuries and fatalities. Improving the safety and reliability of the Sandy Springs transportation network will largely benefit motorists, bicyclists, pedestrians, and transit riders. Fewer incidents and quicker clearance of incidents enhance the safety of the area and reduce congestion.

As the state of Georgia continues to experience population growth, a higher demand on arterial and highway infrastructure is expected. Vehicle miles traveled (VMT) in the state increased by 12% from 2013 to 2016, resulting in the second highest rate nationally (TRIP, 2018). An increase in vehicles on the road can lead to greater delay, more congestion, and a higher risk of traffic incidents.

The City of Sandy Springs conducted a crash analysis for crashes occurring along City roadways during 2017. Sandy Springs reported 3,078 intersection crashes and 318 mid-block crashes, resulting in one fatality and 745 injuries. Each location was evaluated based on crash rate, crash cost/type, congestion, public sensitivity, and previously identified need. The City developed a scoring methodology and assigned a score to each criterion at each location to determine a total score. Locations with high crash rates can benefit from increased camera coverage and other potential technology solutions to improve safety. Camera coverage not only encourages safer driving habits, known as the "halo effect", but allows for constant monitoring of traffic conditions, which can be used by TMC's to proactively accommodate system needs. Other technology solutions like coordinated traffic signals facilitate consistent traffic patterns, while detection devices allow for effective real-time communication to road users, mitigating safety concerns.

Figure 7 shows the City's high crash locations and total score in 2017. There were five (5) locations identified to score above 100 are identified in red below; seven (7) locations scored between 100 and 75; 21 locations scored between 75 and 50; and 112 locations scored below 50.

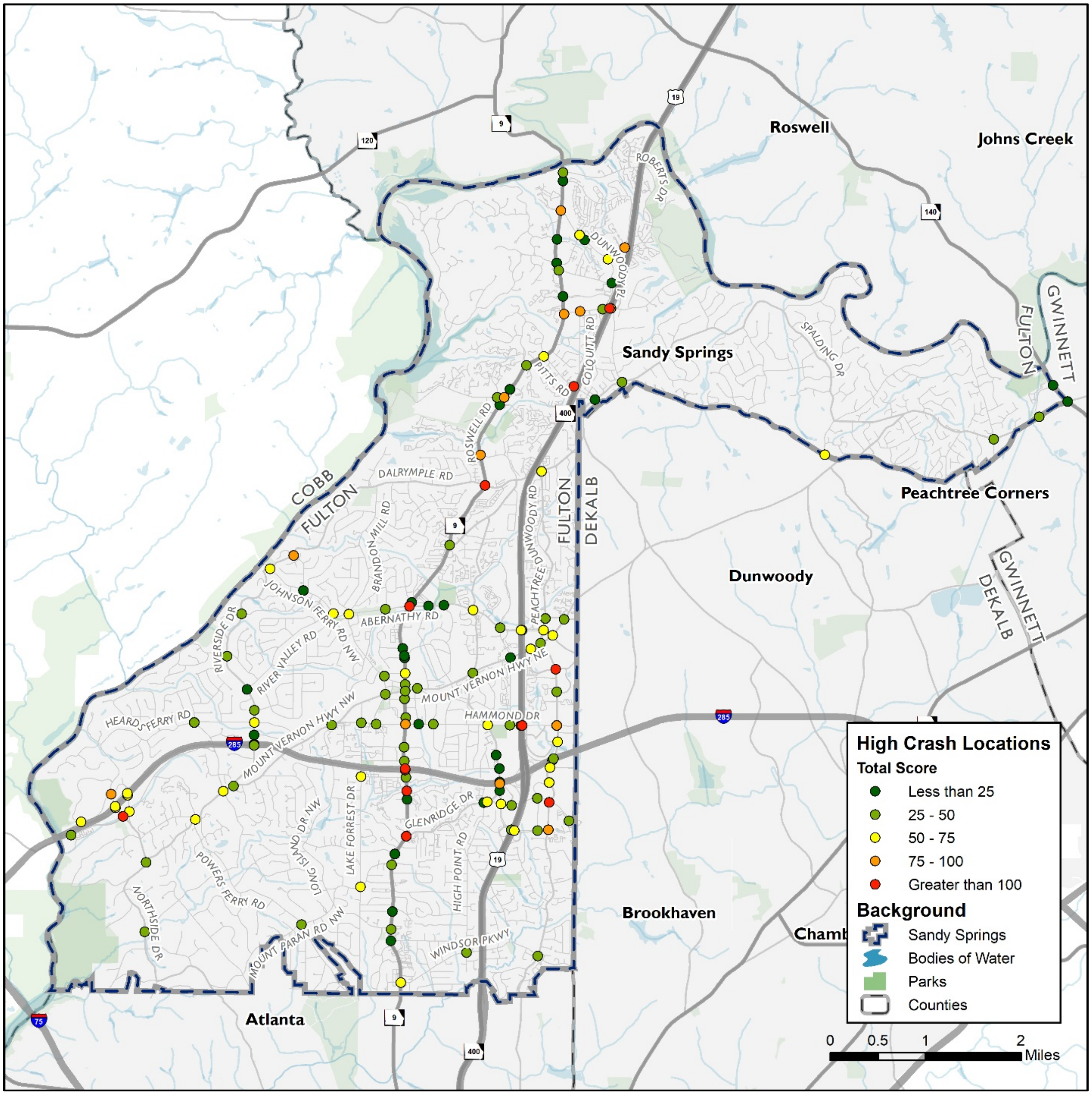


Figure 7: City of Sandy Springs High Crash Location Map

Mobility Needs

Sandy Springs mobility challenges impact residents, commuters, and the delivery of goods and services. Congestion levels are impacted by both recurring and non-recurring events. Recurring congestion accounts for more than half of congestion nationally and typically occurs during peak travel periods due to demand exceeding capacity (FHWA, 2017). Non-recurring events account for the remaining contributors to congestion and include disruptions such as severe weather, traffic incidents, and work zones. Nationally, the three main causes of non-recurring congestion are traffic incidents (25% of total congestion), work zones (10% of total congestion), and weather (15% of total congestion) as illustrated in Figure 8 (FHWA, 2017).

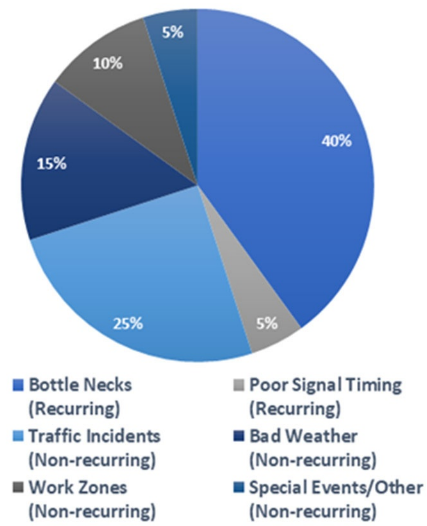


Figure 8: National Sources of Congestion (FHWA, 2017)

Congestion continues to increase annually as vehicle miles traveled (VMT) outpaces the growth of public road mileage (TTI, 2015). Georgia residents experience an average of 27.2 minutes commute daily, ranked the ninth highest in the nation (TRIP, 2018). Such delays cost the average traveler in time and wasted fuel. In addition to the financial costs related to safety and mobility challenges, research has shown a direct correlation between physical and mental wellbeing and congestion. Higher commute times have been linked to decreased energy, increased stress, and higher illness-related work absence. And those that experience congested driving have increased stress and frustrations. Transportation technology solutions, like real-time detection, advanced signal timing techniques, and system monitoring, offer significant safety and mobility benefits.

The data-driven transportation analysis platform, Regional Integrated Transportation Information System (RITIS), was used to portray congestion hot spots throughout the City. Weekday (Tuesday, Wednesday, and Thursday) traffic during peak morning (6:00 AM to 9:00 AM) and peak evening (3:30 PM to 6:30 PM) times was analyzed daily throughout 2018.

Figures 9a-9d display the average congestion during each 1-hour morning peak. The figures tell the story of how congestion grows during the morning peak hours. Understanding where the congestion begins during the morning peak hours, and how it grows, will help identify locations that can significantly benefit from transportation technology solutions.

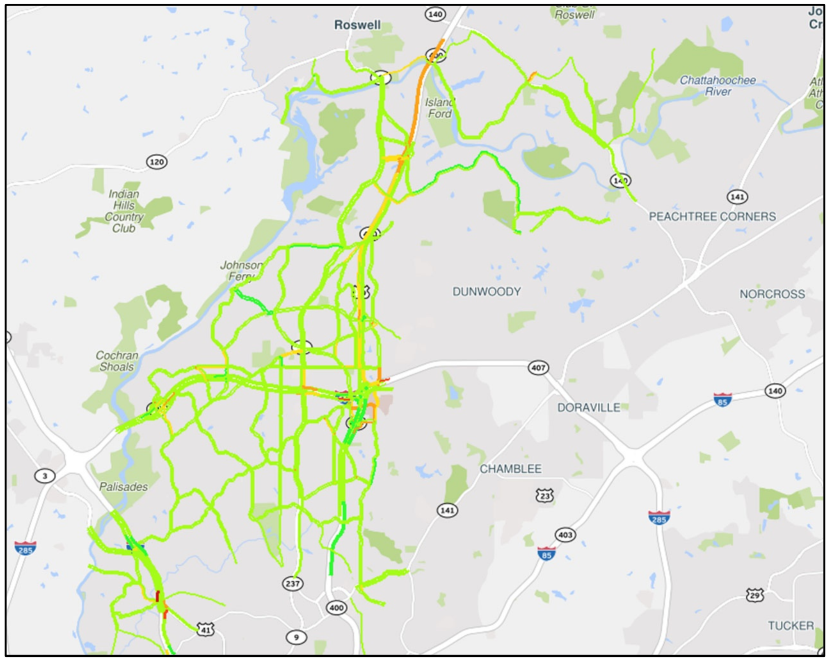


Figure 9a: Morning Peak – 6:00 AM

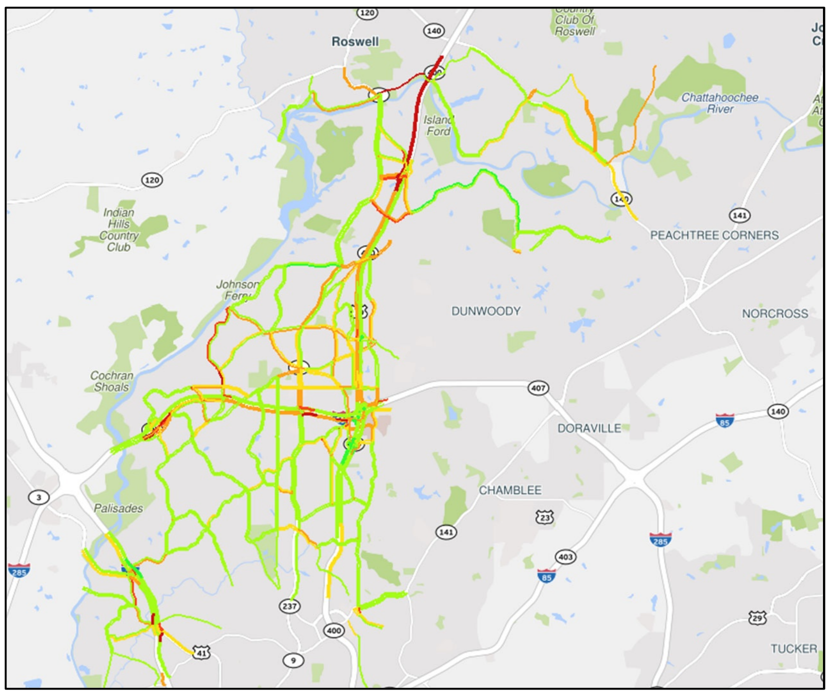


Figure 9b: Morning Peak – 7:00 AM

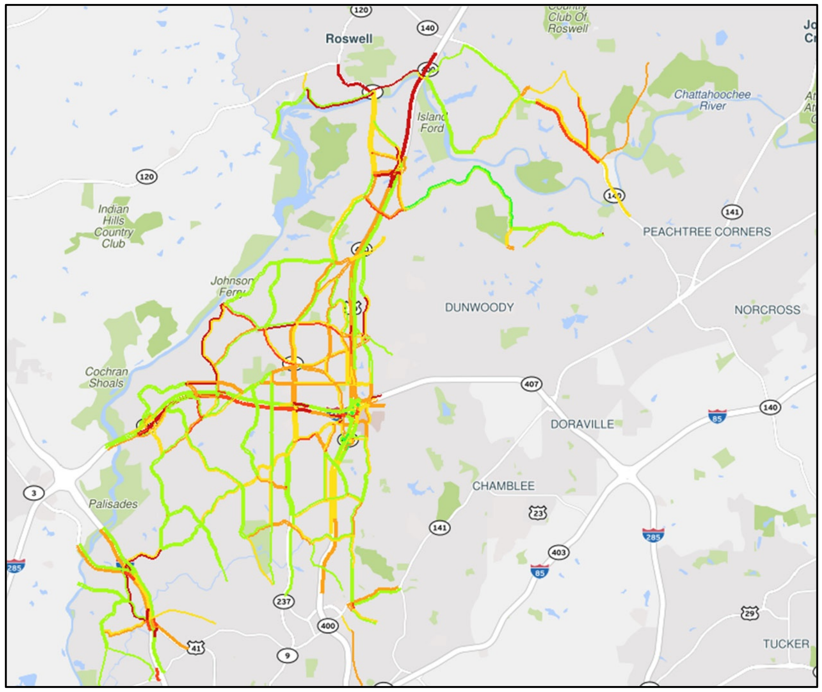


Figure 9c: Morning Peak – 8:00 AM

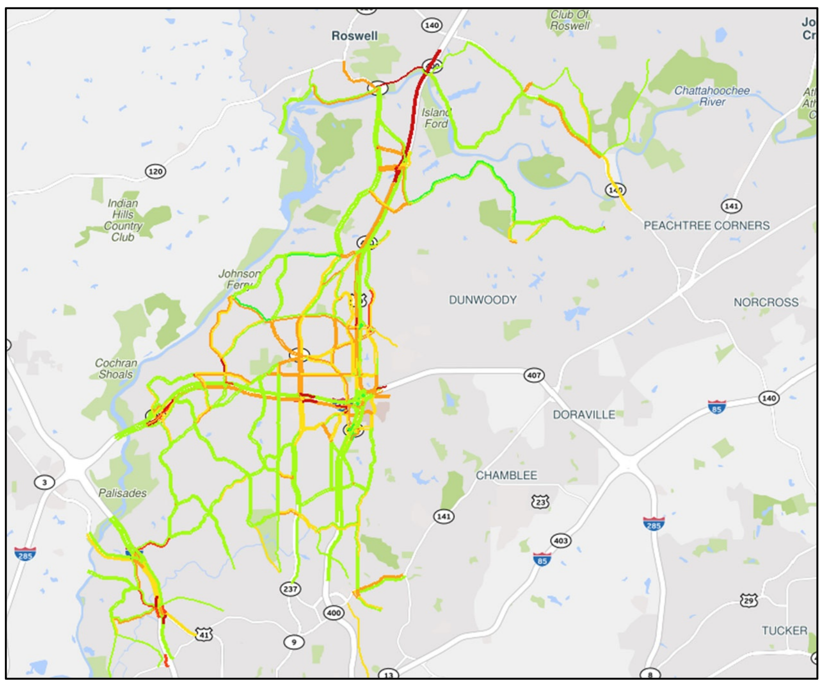


Figure 9d: Morning Peak – 9:00 AM

As shown in the congestion diagrams, the average 8:00 AM weekday peak hour displays the worst congestion. Congestion is worse near SR 400 and I-285 as commuters are entering and leaving the City. On the northern end of Sandy Springs SR 9 (Roswell Road), Azalea Drive, and Pitts Road show heavy congestion around SR 400. Near the center of the City, Abernathy Road, Peachtree Dunwoody Road, and Riverside Parkway show the worst congestion. On the southwest side of the City near I-285, Heards Ferry Road, and Johnson Ferry Road show the worst congestion.

Figures 10a-10d display the average congestion during each 1-hour evening peak. The figures tell the story of how congestion grows during the evening peak hours. Understanding where the congestion begins during the evening peak hours, and how it grows, will help identify locations that can significantly benefit from transportation technology solutions.

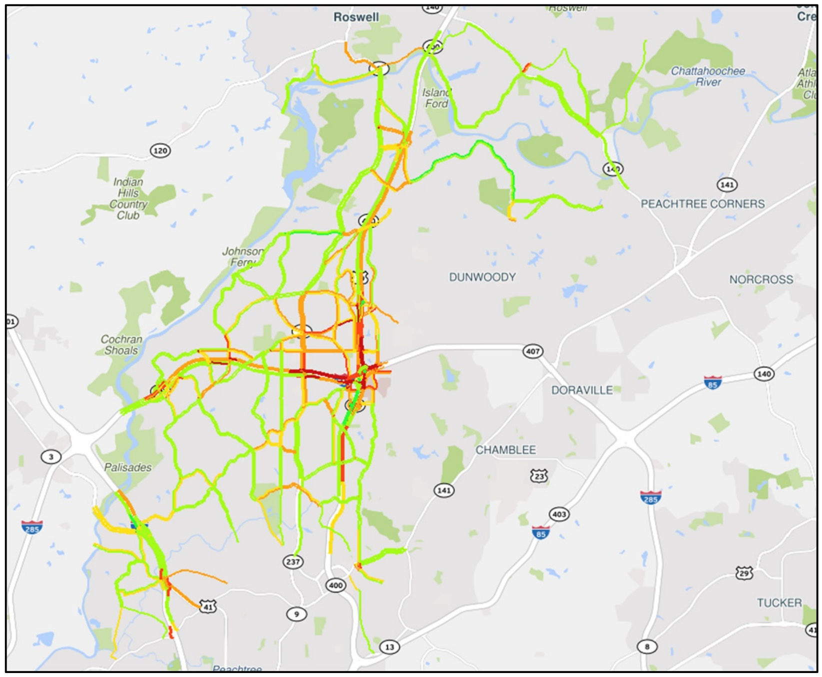


Figure 10a: Evening Peak – 3:30 PM

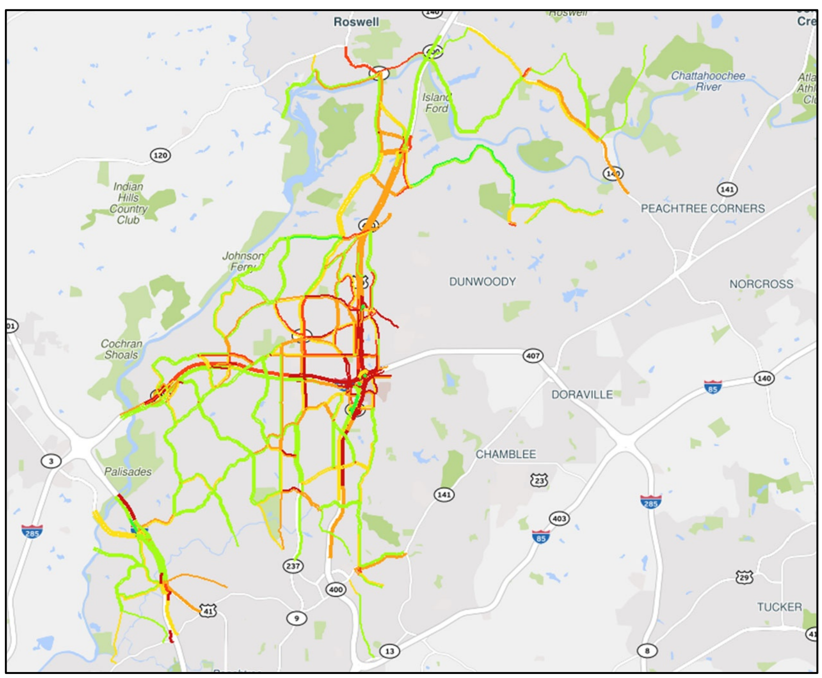


Figure 10b: Evening Peak – 4:30 PM

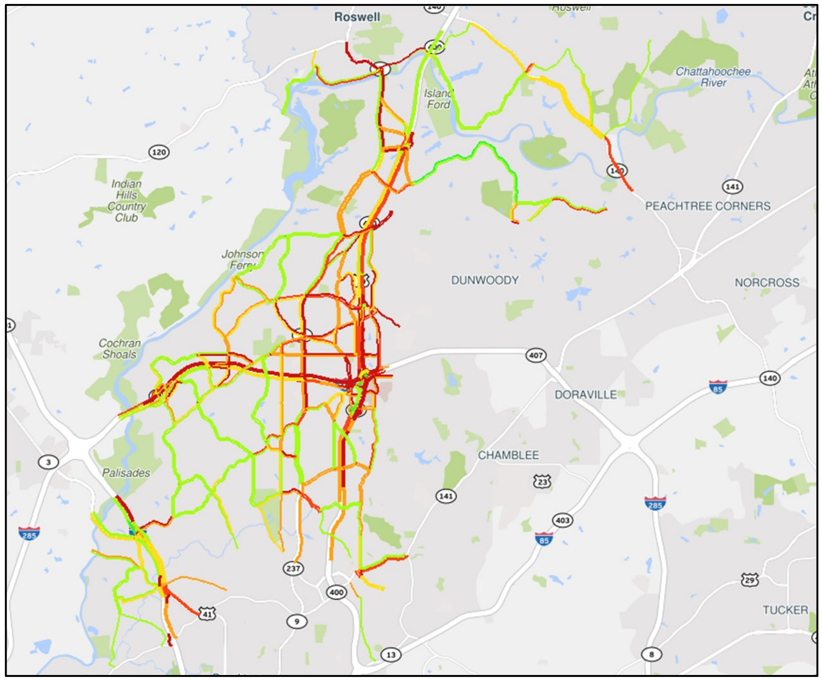


Figure 10c: Evening Peak – 5:30 PM

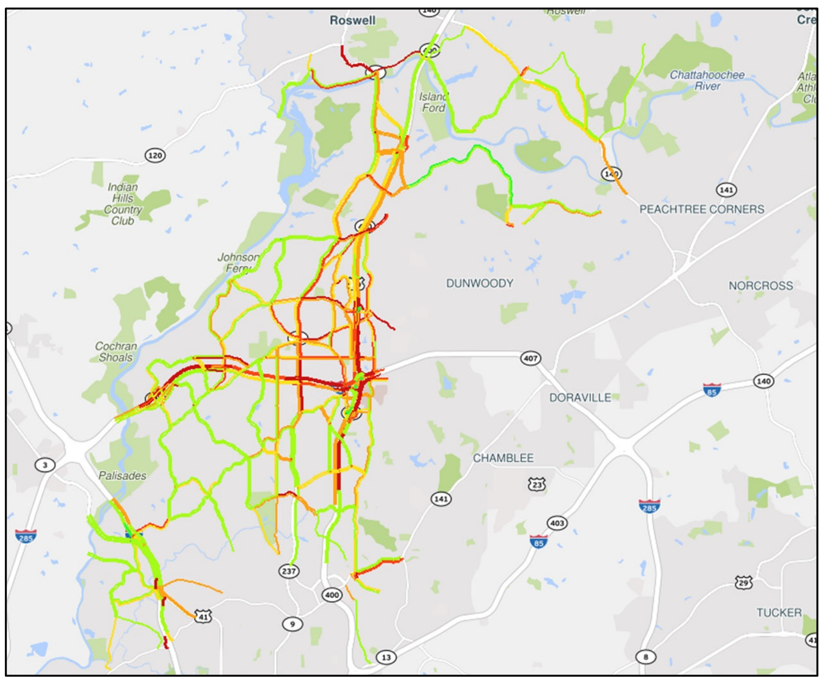


Figure 10d: Evening Peak – 6:30 PM

As shown in the congestion diagrams, the average 5:30 PM weekday peak hour displays the worst congestion. Congestion is focused near SR 400 and I-285 freeways. The heaviest congestion on the Sandy Springs network is primarily due to spillback from motorists trying to enter the congested freeways. The heaviest congestion is primarily on SR 9 (Roswell Road), Abernathy Road, Peachtree Dunwoody Road, Mount Vernon Highway, Hammond Drive, Johnson Ferry Road, and Heards Ferry Road. It is anticipated that congestion will continue to be a challenge within these areas and worsen over time as the City continues to grow and development increases in these areas. While there are several effective measures that jurisdictions use to maximize system mobility and safety, ITS is effective in harnessing the benefits of emerging technologies to achieve that end efficiently. The City of Sandy Springs recognizes the benefits of ITS operations and is committed to the inclusion of ITS into their suite of transportation initiatives.

ITS Field Device and Connectivity Needs

It is anticipated that the City will expand its current ITS field device infrastructure to better manage traffic; enhancing safety and mobility throughout the City. Currently planned deployments have been identified based on discussions with City staff and stakeholders. In addition, it is anticipated that future growth will necessitate additional deployments throughout the City. Table 2 provides the number of intersections with existing ITS device deployments.

Table 2: Existing ITS Devices

Device Type	Existing
Traffic Signal Controller	136
CCTV Camera	95
Bluetooth Devices	54
Video Detection	24*
Wireless Detection	73*
UPS/BBS	80
*Number of intersections with devices	

Fiber optic communications infrastructure supports the majority of the existing ITS field devices and is preferred over other types of communication due to its reliability, bandwidth capacity, and long-term costs. In the age of connectivity, this level of communications infrastructure is seen as a critical component to any future emerging technology deployment.

Traffic Signals

Communication between traffic signals and the City's TMC enhances the City's ability to manage and support signal timing, field equipment status, remote monitoring, emergency preemption, and transit priority. Currently, fiber optic cable is used to connect 103 of the 136 traffic signals in Sandy Springs. The signals that are presently on the City's fiber routes are grouped by local-area network (LAN) for communication between the TMC and each ITS device and traffic signal. Table 3 summarizes corridors and number of traffic signals currently located within each communication group connected via fiber.

Table 3: Existing Communication Groups

Communication Group (LAN)	Major Corridors	Number of Signals
1	Roswell Rd., Dunwoody Rd.	10
2	Roswell Rd., Abernathy Rd., Perimeter Center W.	17
3	Hammond Dr., Peachtree Dunwoody Rd., Mt. Vernon Hwy.	10
4	Glenridge Conn., Peachtree Dunwoody Rd., Hammond Dr.	27
5	Roswell Rd., Sandy Springs Cir., Hammond Dr.	16
6	River Valley Rd., Riverside Dr., Johnson Ferry Rd.	7
7	Northside Dr., New Northside Dr.	7
8	Roswell Rd.	9
	Total	103

There are 33 traffic signals that are not currently connected to the fiber communications network. These signals communicate to the TMC through cellular modems or wireless radios. Connecting the remaining ITS field devices via the fiber optic communications network can be based on a phased, strategic approach.

Sandy Springs is currently anticipating only one (1) future signal location. However, based on historic rates and anticipated future development, it is anticipated that the number of signalized intersections will grow by approximately 5% over the next five to eight years. It is also anticipated that some existing signals will be transitioned to the SCOOT system, in addition to the already planned 50 signals.

Battery Backup Systems

Currently, Sandy Springs utilizes IP/Ethernet UPS and BBS systems to sustain traffic operations during power interruption and power loss events. The City expects to continue to deploy these systems at existing and new traffic signal locations. The greatest need for these systems will be at high volume and crash rate locations, but it is expected that over time, they will be deployed at all signalized locations.

CCTV Cameras

The City of Sandy Springs currently operates and maintains 95 cameras and 38 additional locations are planned for near-term deployment. It is expected that additional cameras will be needed in the future to encourage safer driving as system demand increases. The greatest need for video coverage will be on high volume corridors and high crash rate areas. It has been assumed cameras will be added to all signalized locations in the future eight years where it makes sense for traffic and communications conditions considering topographic conditions.

The City of Sandy Springs currently has fiber communications to approximately 80 CCTV cameras. The remaining CCTV cameras are communicating to the TMC through cellular modems or wireless radios. Existing literature, along with input from City staff and stakeholders, identify the need to connect the remaining traffic signal controllers and CCTVs to the fiber network as a best practice, due to fiber's proven reliability, improved bandwidth, long-term cost effectiveness. Figure 11 shows the traffic signals and CCTVs not currently on the fiber network.

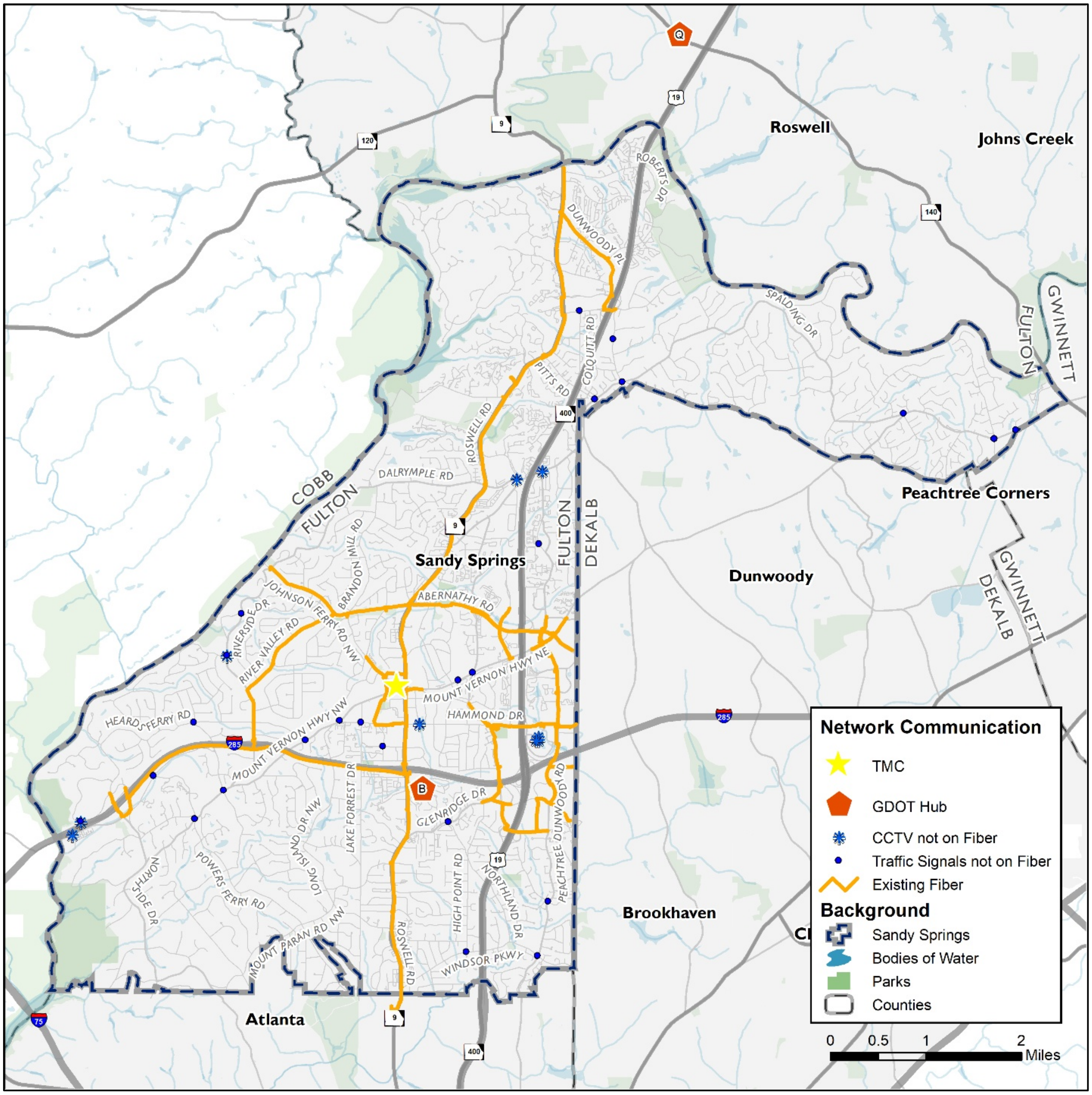


Figure 11: City of Sandy Springs Connectivity Map

Detection Devices

It is established that as roadways become increasingly congested and multi-modal, maximizing the efficiency of the system becomes increasingly critical. The evolving needs of roadways, and thus effective traffic signal control, suggest that advanced detection devices are needed. The City of Sandy Springs currently uses IP video detection cameras and IP based Sensys detection. The video detection devices are IP capable, allowing them to transmit video and data back to the TMC through field network switch connections. The Sensys detection is also IP capable, allowing them to transmit data back to the TMC through field network switch connections. The use of these advanced detection devices enables advanced signal timing deployments such as SCOOT (described in existing conditions). It is assumed that, to preserve consistency and reliability across the network, existing and planned intersections will use Sensys detection to communicate with the TMC in the future. Locations that implement SCOOT traffic signal control will require a greater number of detectors at each intersection location. It is assumed that each time-of-day signal will utilize an average of four detectors per intersection and that locations with SCOOT deployed will utilize and average of eight detectors per intersection. Sandy Springs expects there to be a limited number of intersections where the implementation of Sensys or video detection is not suitable, primarily intersections with constraining geography, limited need, or changing magnetic field issues stemming from proximity to power stations, lines, or light rail tracks. For those locations, Sandy Springs anticipates deploying microwave, inductive loop, or magnetic technology.

Bluetooth Readers

Sandy Springs anticipates maintaining the number of Bluetooth readers over the next five to eight years. These units will be used to provide archived travel time data to support operations and performance measurement as well as provide origin-destination information. It is assumed that the City will migrate to third-party probe data information sites over the next five to eight years as the probe data becomes more reliable and more reasonable in cost.

ITS Communications Network Needs

The ITS communications network is the basis for all field devices and supported systems that the City uses to manage and operate the transportation network. The need for a robust, resilient, and reliable network is critical to the current system and will become increasingly important as transportation systems' technological dependency, given the inability for capacity-oriented congestion mitigation, grows. IP/Ethernet communication protocol is the current best practice used for building a robust, reliable network; allowing for fast, reliable, and manageable communications.

The City uses IP/Ethernet communications within their signal system, detection, Bluetooth readers, and some of the cameras. There is a need to migrate the City's video to a completely IP/Ethernet, digital video network.

The IP/Ethernet communications network is used for two-way data communications between central computers and various types of field devices. As the City's fiber network continues to expand, developing a redundant and flexible network architecture will allow the City to evolve as the demand and usage requirements for the network also evolve. For example, should the City require significantly more fiber capacity in a particular area of the network, having a distributed Layer 3 architecture will allow for increased capacity without significant fiber upgrade investment. The current fiber optic communications infrastructure provides the foundation for a high bandwidth, fault-tolerant topology. Additional fiber installation, reconfiguration of splicing at key locations, and network hardware configurations are needed to facilitate this transition.

Network Topology and Redundancy

A network's topology is a representation of the physical and/or logical layout of the communications between devices and how they are connected. The four common communication topologies are bus, star, ring, and mesh. In most cases, networks use a combination of the four types.

A ***bus*** topology interconnects multiple devices along the same communications link or channel, similar to a multi-drop channel in a serial network. Bus topologies are rarely (if ever) used in newly deployed, IP/Ethernet networks. A ***star*** topology uses a point-to-point connection similar to a bus topology, but the network appears to radiate outward from a single point. A *ring* topology uses multiple-point, multiple-path connections between adjacent devices. A *mesh* topology uses multiple-point, multiple-path connections between devices. Each topology strikes a balance between resiliency and required communication links that correlate with cost.

ITS networks generally span large distances when compared with standard networks and are generally buried underground or hung aerially from utility poles in the public right of way. Fiber optic cable is the most capable, stable, and secure solution for ITS network design. However, the location of fiber infrastructure in the right of way does introduce vulnerability with construction activity as well as events such as vehicle hits and severe weather. To guard against this vulnerability, Sandy Springs will need to implement a network topology that provides redundancy to each field edge device. That is, each edge device will have a network connection to an upstream and a downstream network device in its communications group.

Edge devices deployed along fiber trunk routes will need to have a fault tolerant connection due to the path diversity achieved along trunk routes. Edge devices deployed along fiber spurs will have limited redundancy by implementing a folded loop (i.e. not path diverse). Fault tolerance will be provided from power or device failure, but the portion of fiber infrastructure along the spur will be folded and thus, susceptible to physical fiber cuts.

ITS communication networks are constructed and configured to provide various levels of redundancy. For example, where physical redundancy is constructed, it is possible to maintain communications even if a fiber cable is broken. In other examples, redundancy may be provided within the same cable but with use of additional fibers within the same cable.

A redundant communications network throughout the City will provide fault tolerance along the fiber communication paths, ensuring system dependability. The City's current fiber optic cable infrastructure provides a foundation for transition to a fault-tolerant topology. While the existing system does not have fault tolerance, an adaptation to the system can allow for the following situations:

- Loss of power or functionality for a single field edge switch would result in loss of connectivity in only that equipment cabinet, while the other devices in that particular communication group would maintain connectivity
- Loss of power or functionality for a single distribution layer network switch in the TMC would result in no loss of connectivity for field network equipment
- Loss of power or functionality for a single core layer network switch in the TMC would result in no loss of connectivity for field network equipment
- A fiber optic cable cut along a single corridor used by a communication group would result in no loss of connectivity for field network equipment on the corridor

There are two methods of redundancy deployment that would allow for the network to survive disruptions. One method is a folded loop with fiber following the same route from the TMC to the various devices and back to the TMC. This method ensures that a single switch malfunction will not cause the remaining switches on the fiber path to fail. An alternative method is a path diverse route where the fiber returns to the TMC following a different path. Utilizing a diverse route back to the TMC allows for communication to be uncompromised given a break in fiber at any point of the cable as the diverse path reaches each switch. These methods of redundancy create a ring topology that would require an increase in the fiber infrastructure as additional fiber is used to travel back to the TMC.

Given the importance of current and anticipated future reliance on the ITS communications network, construction of a redundant network is critical to ensure service at all times.

Interagency Connections

The City of Sandy Springs shares data and video with multiple partner agencies to better manage the transportation network at a regional level. In the future, Sandy Springs is open to working with partner jurisdictions to provide interoperability between systems to enhance the operations and maintenance in the region. Direct sharing of information and resources enhances the region's transportation systems. Additionally, fiber infrastructure share agreements may provide more efficient connection opportunities for remote signals. For example, sharing fiber infrastructure along Mount Vernon Road with the City of Dunwoody, may be an opportunity to more efficiently reach signals along Spalding Drive.

Video Sharing

Currently, Sandy Springs uses Genetec software residing on their TMC server, to monitor and view the CCTV cameras. Partner jurisdictions such as GDOT, City of Dunwoody, City of Brookhaven, City of Roswell, Gwinnett County, and Cobb County can have access to Genetec through license sharing agreements. Future, direct center-to-center communications between Sandy Springs and its partner agencies will provide agency interoperability and multi-jurisdictional signal coordination.

Coordination with partner transportation and law enforcement agencies for video sharing will not only enhance traffic monitoring and managing, but also build and strengthen relationships within the region. Consideration of expanding video sharing with various regional media companies is beneficial as it provides video data to traffic websites, mobile applications, and television stations to be broadcasted to travelers and improve their travel experience. While the City currently hosts a real-time traffic map on its website, the expansion of video sharing presents a greater regional travel impact.

Data Sharing

Automated Traffic Signal Performance Measure (ATSPM) is a traffic signal management program deployed by GDOT. ATSPM provides high-resolution data with the goal of improving safety, mobility, and efficiency at signalized intersections. This data is used to help traffic engineers identify locations which require field equipment maintenance and repairs, signal timing maintenance, operational improvement needs, or other potential projects. Access to real-time performance measures will assist the City and partner agencies identify where resources should be used to focus on improving safety and the quality of maintenance and operational practices.

GDOT uses Intelight's MaxView Advanced Traffic Management System Software to operate and maintain signals around the state. ATSPM pulls data straight from MaxView to report real-time and historical performance of individual signals. Sandy Springs is currently upgrading their traffic signal controllers to a Linux-based and NTCIP compatible software to be compatible with GDOT's MaxView ATSPM system.

Emerging Technologies Needs

The transportation industry is rapidly changing with the introduction of advanced emerging technologies. Sandy Springs anticipates incorporating technologies for Smart City, Internet of Things, and Connected and Automated Vehicles (CAV).

Autonomous vehicles are also being tested in the United States and throughout the world. While the concept is evolving, and long-term impacts are uncertain, vehicles with semi-autonomous features are available today and dense urban settings could begin to support autonomous vehicles within the next 20 years. As testing and research move forward, the industry will begin to understand the infrastructure requirements. As with the connected vehicles, autonomous vehicle infrastructure may need to be capable of huge amounts of data transfer. Whether these network services will be provided by public or private agencies remains to be determined.

Additional technologies such as 5G cellular networks and dedicated short range communications (DSRC) are emerging ITS technologies which support CAV. These allow for vehicle-to-vehicle and vehicle-to-infrastructure communications. The bandwidth requirements and application impacts are fairly unknown. The best way to plan for emerging technologies is to provide a robust, high quality network that is capable of expansion.

ITS deployments are also being used and explored in the transit industry. Transit Signal Priority (TSP) uses multiple techniques to reduce signalized intersection delay for transit vehicles. Transit agencies are also researching other ITS-based improvements for the transit industry, such as dynamic routing and operations and transit stop pedestrian warnings. MARTA plans to convert their Automatic Vehicle Location (AVL) system to sim cards which will provide more frequent GPS locations. This new system will provide opportunities for implementing Transit Signal Priority (TSP). TSP transmitter devices deployed onboard transit vehicles work with traffic signal controllers to determine if adjustments in the signal timing can be made to increase efficiency of the transit system by improving on-time performance. TSP could also operate across jurisdictions to provide interoperability across jurisdictions in the region.

Interagency Collaboration Needs

Public agency interviews and an interagency workshop was held to discuss current regional collaboration needs. Fostering a culture of collaboration is essential for integration and coordination of new technology deployments at a regional level. In addition, opportunities for increased efficiency of resources and funding may be identified and pursued.

The need for consistent collaboration was identified during interviews and the workshop. Coordination between agencies for work zone information, traveler information, and incident notifications will support the traffic management and operations for the region. Multijurisdictional communication is highly beneficial during emergency events as the sharing of information and coordination can lead to reduced response times and enhanced safety.

City collaboration with MARTA and SRTA to provide real-time information to users for transit arrival times, stop locations, and options of transit and routes can create a more efficient travel experience.

Local partner agencies such as Fulton County Schools and Fulton Aging Services have fleet vehicles which are equipped with GPS and automated systems which collect information on road closures, detours, and other traffic alerts. Increased coordination between these systems with the City could open up opportunities for providing updated traveler information directly to drivers to increase safety and efficiency of their systems. Additionally, coordination between Sandy Springs Public Works, Fire, and Police Departments to share video and traffic information could provide additional support to first responders to enable more efficient response and clearance times.

There is a potential need to provide real-time traveler information, work zone information, and incident notifications through an automated web- or application-based platform throughout the region. Creating a platform for data sharing between transit agencies, local jurisdictions, ride-share companies, signal systems, motorists, and other modes of transportation can provide valuable data for all users of the system.

Bandwidth and Latency Analysis

Bandwidth analysis is conducted to ensure that the central system and field network is sized to accommodate the anticipated needs of the network. If adequate bandwidth is not provided, the network may experience latency issues (i.e. network slowness), dropped packets or data, or even loss of connectivity. The primary generator of bandwidth demand for center-to-field links is video communications from CCTV cameras and vehicle detection to the TMC. Table 4 shows a summary of the categorical bandwidth required to support ITS devices and applications. Additionally, this bandwidth can be achieved by multiple forms of communication media, including wired and wireless options.

Table 4: ITS Device Bandwidth

Device	Bandwidth
HD CCTV Camera	3,500 Kbps
Video Detection (per intersection)	8,000 Kbps
Traffic Signal Controllers, Microwave Detection, Bluetooth Detection	100 Kbps
Wireless Detection	150 Kbps

Table 5 presents an overall summary of the aggregate bandwidth demand for the planned system. The entire planned enterprise is estimated to consume close to 5.7 gigabytes per second of bandwidth. Of this sum, the majority of the current demand is derived from traffic monitoring subsystems that are dominated by the video applications. It is anticipated that the future demand will be dominated by the use of connected vehicle (CV) deployments. There is not currently a defined plan for pulling data from roadside units (RSU), however, it has conservatively been assumed that future evolution and progression within emerging technologies will require significantly more bandwidth for high-resolution data as has been estimated below. This aggregate assessment is important for developing an understanding of center-to-center bandwidth needs for a future data sharing and gaining perspective on system bandwidth utilization.

Table 5: ITS Device Bandwidth

System Component	Device	Projected Number	Per Unit Bandwidth Demand (Mbps)	Bandwidth Demand (Mbps)
Traffic Management	Traffic Signal Controller	137	0.100	13.7
	UPS/BBS	137	0.020	2.7
	CMU/MMU	137	0.020	2.7
	CV RSU for EVP	137	27.00	3699.0
	TSP	54	27.00	1,458.0
Traffic Monitoring	SCOOT Intersection Detection	100	0.250	25.0
	Wireless / Radar Detection	37	0.150	5.6
	HD CCTV Camera	135	3.500	472.5
	Bluetooth Detection	54	0.100	5.4
		TOTAL		5670.9

* UPS (Uninterrupted Power Supply), BBS (Battery Backup System), CMU (Conflict Monitor Unit), MMU (Malfunction Management Unit, CV RSU (Connected Vehicle Roadside Unit), EVP (Emergency Vehicle Preemption), TSP (Transit Signal Priority)

In order to assess the demand of the system backbone for both existing and future fiber, the existing and future ITS and signal network was segmented into communication groups to represent a maximum density of devices. Groups represent a "channel" of devices, or a string of network switches connected directly together. Since devices are deployed in a multi-drop fashion along corridors, devices are arranged in communication groups to conserve fiber optic cable. Figure 12 shows a typical device grouping (with redundancy).

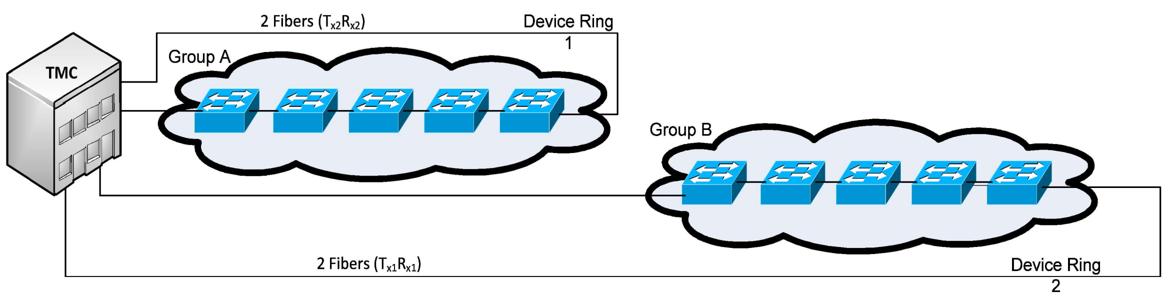


Figure 12: Typical Device Groups

For analysis of the bandwidth demands, groups were based on a maximum capacity of approximately 300 Mbps. This capacity allows for future expansion without overstressing the system. Additionally, even with future expansion, this capacity keeps the loading below the threshold of 60% of the theoretical maximum.

This 60% goal is used to account for two issues – first, to reserve space for network overhead (e.g., packet headers containing a packet's address), and secondly, to limit network congestion and facilitate applications that require limited packet retransmission (e.g., video).

1,000Mbps total – 400Mbps overhead = 600Mbps usable capacity

600Mbps usable ÷ 2 (100% spare) = 300Mbps

Traditionally, bandwidth capacity has been the limiting factor for field communication groups. However, within the past several years, optical transceiver technology has improved and as with any technology, prices for high bandwidth optical transceivers (such as Gigabit) have been reduced over time such that they are now feasible for ITS applications. Gigabit fiber optic transceivers are now the most commonly used technology for new deployments. Bandwidth capacity, while still important, has become a factor that is generally less limiting than it was with previous technology (100 Mbps communication groups). However, latency continues to be a prominent concern and limiting factor particularly for time-sensitive transmission of video traffic. Network latency is generally introduced in Layer 1 and is impacted by:

- Type of communication media
- Physical distance of communication over various media types
- The number of times a frame is received and forwarded through a network device interface
- The amount of time it takes each network device to receive and forward the frame through interfaces

The most prominent factor for introduction of latency in an ITS network environment is often the number of network switches per communication group. General testing and consensus in an ITS environment have provided a latency rule-of-thumb suggesting that the number of field network devices be limited to approximately 25 devices per communication group. To allow for future expansion within communication groups, it is recommended that initial grouping of network devices include approximately 15 devices (+/-) per group. Figure 13 shows the current communication groups. Several groups are more than 15 switches; communication group 4, for example, has 27 switches. To date, latency has not been a problem with these groups. However, it is recommended that these groups be modified as appropriate during design and construction of the future redundant system. The ultimate design and layout of the system will be driven by the existing architecture in place during the deployment of the specific project and the migration plan to the future system architecture.

Emerging Technologies Considerations

Rapid technology advances in the industry indicate the importance of accounting for growth. Not only is there the expected growth of the existing ITS inventory, but there are a number of technologies breaking into the market that could be included in the City of Sandy Springs ITS inventory in the not-so-distant future. In addition, the City of Sandy Springs has a somewhat unique network in that multiple municipal agencies, such as fire, police, etc. share the same physical network infrastructure. Therefore, the fiber capacity recommendations are conservative in nature, understanding that potential future growth is not only limited to emerging transportation technologies.

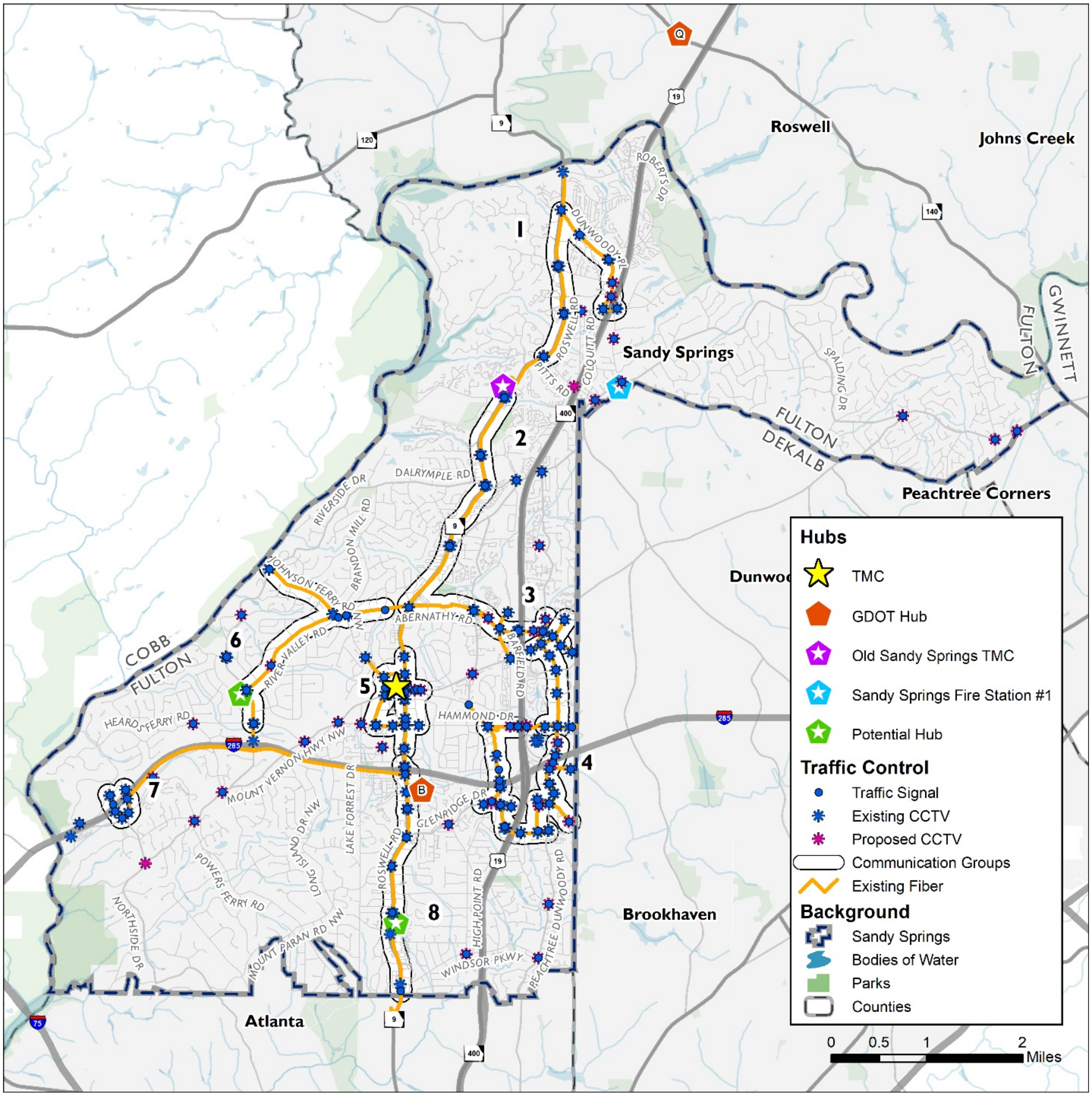


Figure 13: Existing Communications Groups

Recommendations

The following project recommendations have been developed based on the existing and needs analysis, stakeholder input, current industry expertise, and national best practices. These recommendations support the City of Sandy Springs ITS Master Plan's established vision of *utilizing Intelligent Transportation Systems (ITS) to enhance safety, mobility, connectivity, efficiency, throughout all modes of travel; using technology to improve the quality of life for the residents of Sandy Springs*. Existing ITS projects and recommendations from this plan have been provided to ARC who is currently in the process of completing the Regional ITS Architecture update. This will ensure that the proposed projects are consistent with the regional architecture and satisfy the federal requirement to be as such.

Recommendations have been categorized by recommended ITS Initiatives, ITS Network, and System. High-level cost estimates have been developed for planning and programming purposes. Each recommended fiber construction route was considered to determine a reasonable estimate for underground vs. overhead construction. Underground construction was assumed as the preferred method of construction unless it was determined that the likely soil type or other limiting factors would require aerial construction. Cost estimate assumptions have been provided in the Appendix. It is anticipated that costs will be refined prior to deployment for more accurate representation of current market conditions.

ITS Initiatives

The City recognizes the importance of collaboration and coordination with intradepartmental as well as external partner agencies. These partnerships are becoming increasingly more important. As systems and networks become more complex and fully integrated, leveraging opportunities across jurisdictional boundaries can provide further return and value to the City's investments. Likewise, the dependency upon documentation, which communicates the structure, configuration, and allocation of the integrated networks and systems, is also becoming increasingly more critical. Several ITS Initiatives have been recommended to enhance and strengthen existing partnerships and to provide a framework for documentation.

Collaboration efforts typically involve minimal capital investment and are sometimes easier to implement with focused effort and commitment of staff resources. It is recommended that the following initiatives be instituted:

- Bi-annual Partner Agency Meeting – Key stakeholders throughout the region from GDOT, MARTA, county, neighboring jurisdictions, intra-departmental, and other relevant partners meet to discuss opportunities to support and facilitate the optimization of the transportation network and discuss current challenges and develop solutions.
- Outreach – Materials explaining the City's commitment and value received from investment in ITS solutions should be distributed to communicate and educate partners.
- Standard Operating Procedures (SOP) – Standard operating procedures should be documented and implemented such that consistency and a high level of quality may be maintained. In addition, documentation will provide a method of retaining knowledge as staffing changes may occur. The following SOPs are recommended:
    - TMC Operations

- Work Zone (particularly GDOT)
- Traveler Information

- Asset Management Procedures – Standard procedures to manage ITS assets should be developed and implemented. The following asset management SOPs are recommended:
  - GIS documentation of ITS assets
  - NexusWorx documentation of ITS infrastructure assets
- Performance Management – Performance targets should be set and tracked using performance metrics. It is recommended that the existing Automated Traffic Signal Performance Measures (ASTPM) metrics be used and expanded as required for the City's needs.

ITS Network Recommendations

The ITS Network is the critical foundation of the ITS devices and systems, existing and planned. Given the importance of current and anticipated future reliance on the ITS communications network, strategic expansion and construction of a redundant network is critical to ensure service at all times. The following ITS Network recommendations are focused on establishing:

- Communications to all signals and CCTV cameras, with a primary focus on fiber communications infrastructure wherever reasonably possible
- Network redundancy, including core redundancy
- Network scalability through network architecture topology and construction of strategic field distribution layer 3 routers (hubs)

The ITS Network recommendations have been developed by considering the existing infrastructure and optimal communication routing to provide increased redundancy at a feasible cost. Figure 14 shows the ring structure for the City of Sandy Springs. Physical fiber design will involve the following components:

- A two-fiber pair is connected to a distribution layer network device at the TMC
- From the TMC, the same two-fiber pair traverses a fiber trunk route to reach the 1st edge Ethernet switch in the communication group
- A two-fiber pair connects the 1st edge Ethernet switch in the communication group with each subsequent switch in the same communication group, in a multi-drop configuration
- The last edge Ethernet switch in the communication group will have a two-fiber pair connection over a path-diverse fiber trunk route back to the TMC
- The two-fiber pair connects a second distribution layer network device at the TMC

This fiber-rich topology will include a physical two-fiber circuit from the TMC, to each field communication group, and back to the TMC over diverse fiber trunk routes, creating a ring topology. This network architecture will support the use of IP routing protocols at the distribution network layer, thus eliminating the need for IEE open standard Rapid Spanning Tree Protocol or similar proprietary Layer 2 redundancy protocol. Instead, Sandy Springs will utilize a virtual gateway protocol, such as Virtual Redundancy Router Protocol (VRRP) or similar proprietary protocol, to achieve redundancy between the two distribution network devices supporting each field communication group.

The recommended topology will allow all core and distribution network equipment to be centrally located in the Sandy Springs TMC. In addition, Figure 14 shows the recommended core and distribution network recommendations. It is recommended that fire stations and additional data hubs be used along the trunk route for location of distribution layer 3 network equipment. The distribution layer network devices provide an opportunity for aggregation, resulting in lower fiber counts along fiber optic trunk routes, allowing for scalability of the network in the future.

The use of field distribution layer 3 routers (hubs) enhances the scalability for future expansion and provides redundancy at the distribution network tier. An additional core network device is recommended to be deployed at a back-up data center, located at Fire Station #1 to provide an architecture with core tier redundancy. Location of Layer 3 network devices in any location other than a secured data center should be considered closely. Sandy Springs would maintain the network devices in a locked, access restricted, conditioned room in Fire Station #1.

This system will benefit from use of network management software, as it will provide staff the ability to proactively monitor bandwidth, device failure, and IP address usage. In addition, active management of the network within software will ultimately provide the most accurate and reliable documentation for use with modifications or additions to the network.

In general, network configuration can be performed by a network administrator via SSH/SSL or via a web interface from the TMC for all field devices. Device maintenance requiring physical access to devices will require field visits for any device in the access layer (field Ethernet switches in cabinets) as well as distribution layer 3 devices. It is further recommended that cabinet locks be replaced with unique keys so that the City can better manage access and security within the edge space.

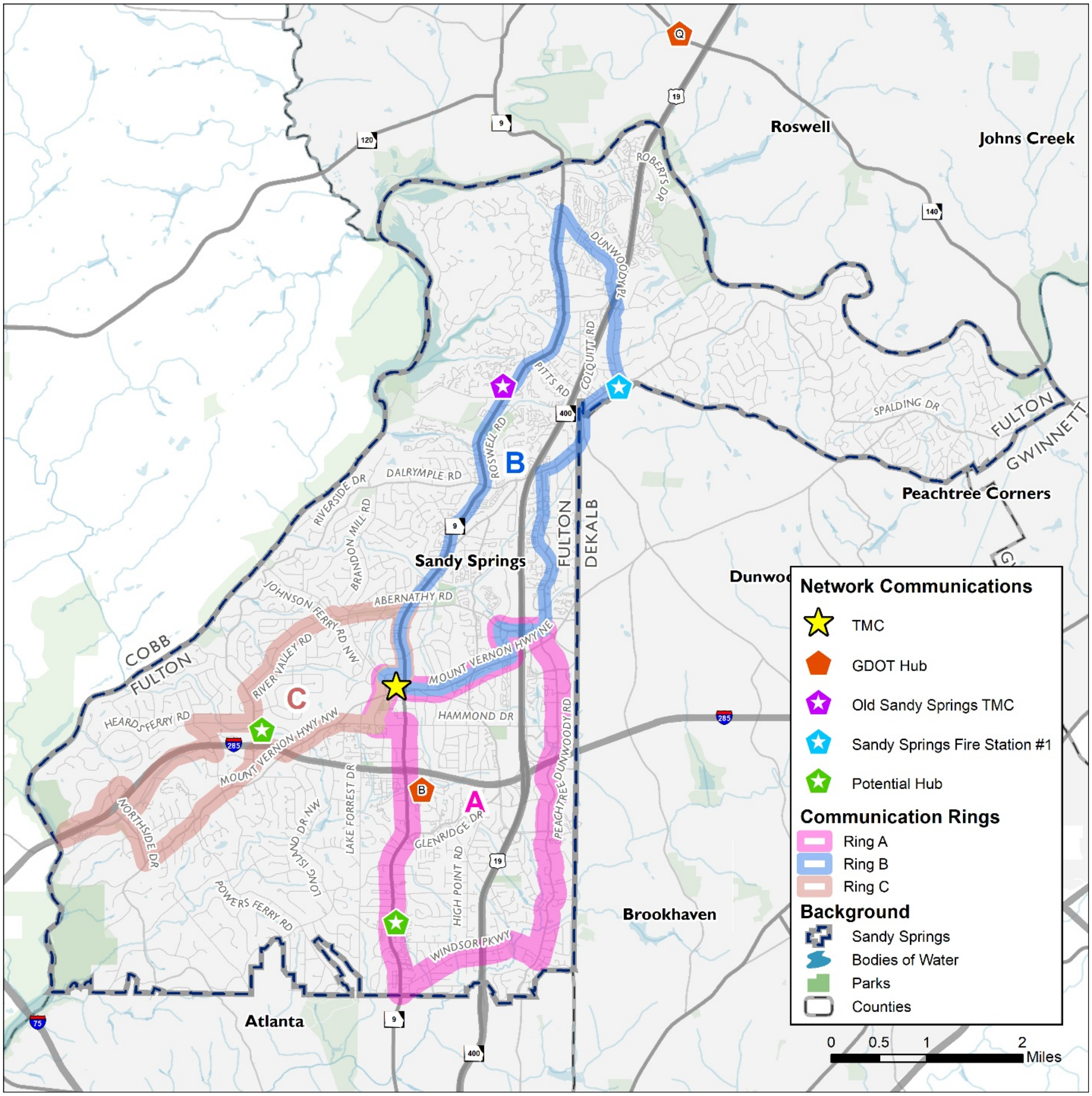


Figure 14: Proposed Communication Rings

Projects were developed within each of the three Rings to provide redundant communications to all traffic signals, CCTV cameras, and ITS devices. Figure 15 shows an overview of the projects identified for each of the rings. It is recommended that Rings A and B be constructed as a 144-count cable. It is not anticipated that the entire capacity will be utilized for future ITS purposes. However, understanding that the City currently shares fiber infrastructure resources among many departments, that Rings A and B are in more prominent areas, and that the cost variance between a smaller and larger count cables is minimal, it is recommended that the additional capacity be constructed. It is recommended that Ring C be constructed as a 48-count cable ring; minimizing the need for upgrades to existing fiber routes. However, for locations where new fiber is constructed, it is recommended that 144-count cable be installed.

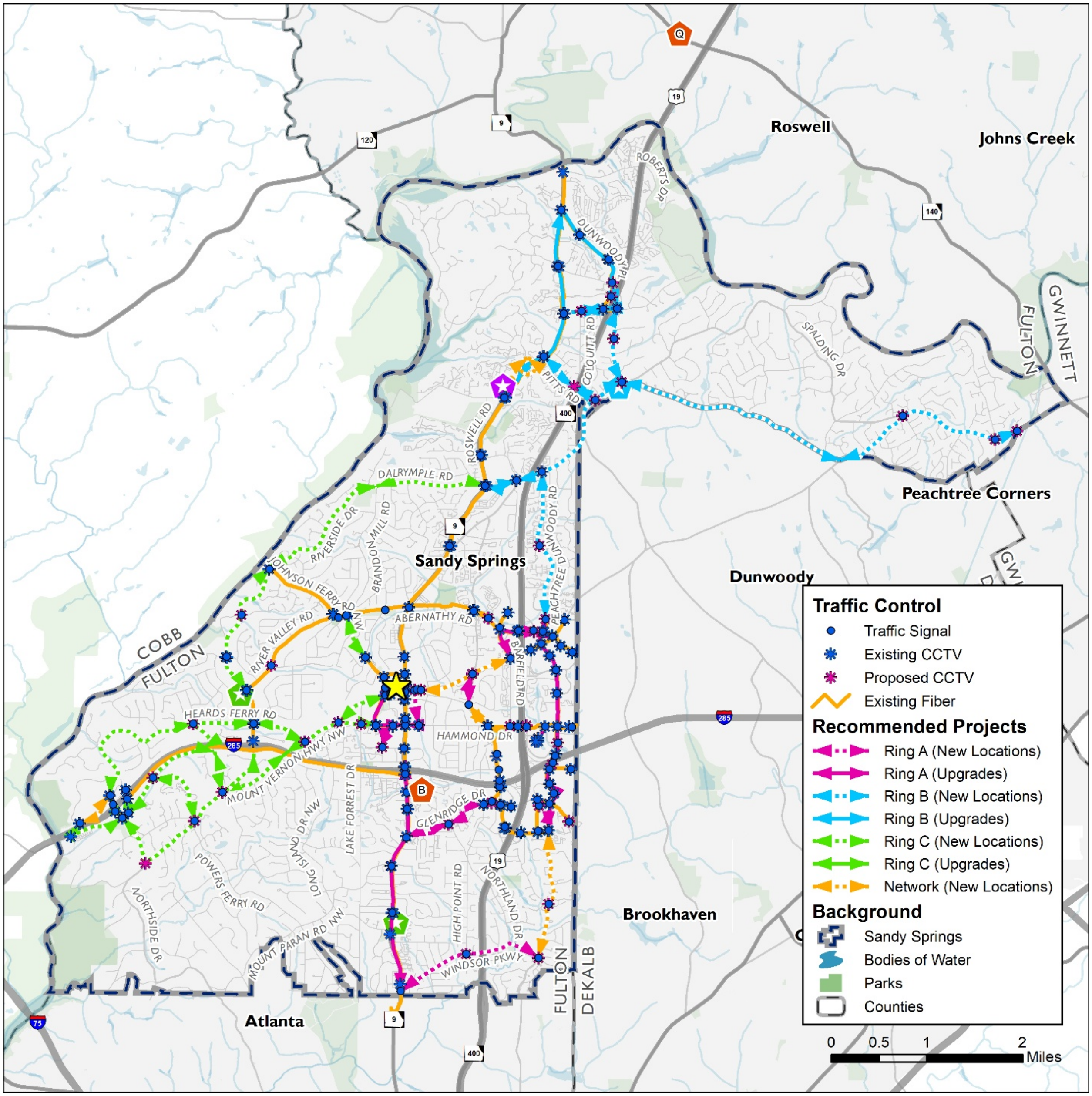


Figure 15: Proposed Network Projects

The following Ring project sheets show a detailed image of each ring's identified projects and associated project descriptions, design and construction costs for Rings A, B, and C respectively. More detailed project descriptions and information can be found in the Appendix.

RING A: PROJECTS

PROJECT FOCUS

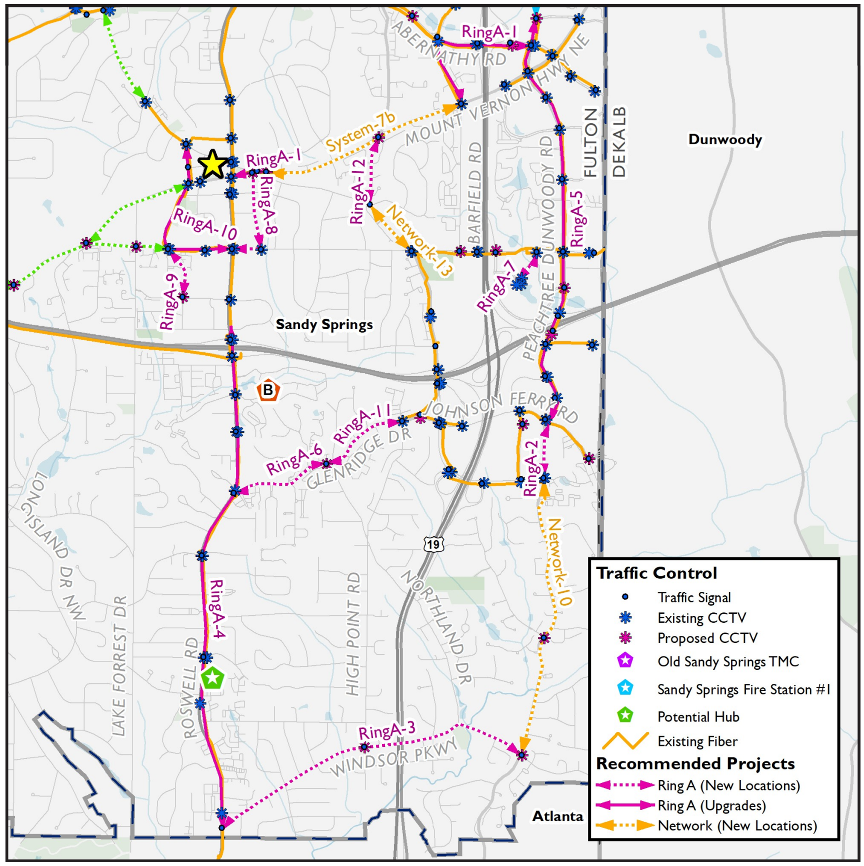
Ring A projects are primarily focused on:

1. New fiber construction along the ring path such that physical path redundancy is provided to those communication groups within Ring A
2. New fiber construction to those signals and cameras not currently on fiber
3. Fiber upgrades along the ring path to provide 144-count fibers for existing and future use

Projects are designated as short or long term depending on their relative immediate benefit to the network.

PROJECT BENEFITS

The communications network is the basis for all field devices and supported systems used to manage and operate the transportation network. The need for a robust, resilient, and reliable network is critical to the current system and will become increasingly important as transportation systems' technological dependency strengthen. Ring A projects create a physical path diverse ring which will provide redundancy to the communication groups within the highest congested areas, minimizing or negating any downtime within the area.



TERM	PROJECT	DESCRIPTION	DESIGN COST	CONSTRUCTION COST
SHORT-TERM (Network 1a-d)	RingA-1	Upgrade existing fiber cable along Mt Vernon Hwy, Abernathy Rd, and Barfield Rd	$13,000	$86,000
	RingA-2	Install new fiber cable along Peachtree Dunwoody Rd	$14,000	$92,000
	RingA-3	Install new fiber cable along Windsor Pkwy	$54,000	$359,000
	RingA-4	Upgrade existing fiber cable along SR 9 (Roswell Rd)	$16,000	$106,000
	RingA-5	Upgrade existing fiber cable along Peachtree Dunwoody Rd	$17,000	$110,000
	RingA-6	Install new fiber cable along Glenridge Dr	$18,000	$120,000
	RingA-7	Install new fiber cable to Concourse CCTV cameras	$8,000	$51,000
	RingA-8	Install new fiber cable along Boylston Dr and Hammond Dr	$18,000	$116,000
	RingA-9	Install new fiber cable along Sandy Spring Cir and Hammond Dr	$11,000	$70,000
	RingA-10	Upgrade existing fiber cable along Hammond Dr and Sandy Springs Cir	$11,000	$68,000
	TOTAL SHORT-TERM COSTS		**$180,000**	**$1,178,000**
LONG-TERM (Network 2a-d)	RingA-11	Install new fiber cable along Glenridge Dr	$17,000	$107,000
	RingA-12	Install new fiber cable along Glenridge Dr	$14,000	$92,000
	TOTAL LONG-TERM COSTS		**$31,000**	**$199,000**
OVERALL COSTS			**$211,000**	**$1,377,000**

RING B: PROJECTS

PROJECT FOCUS

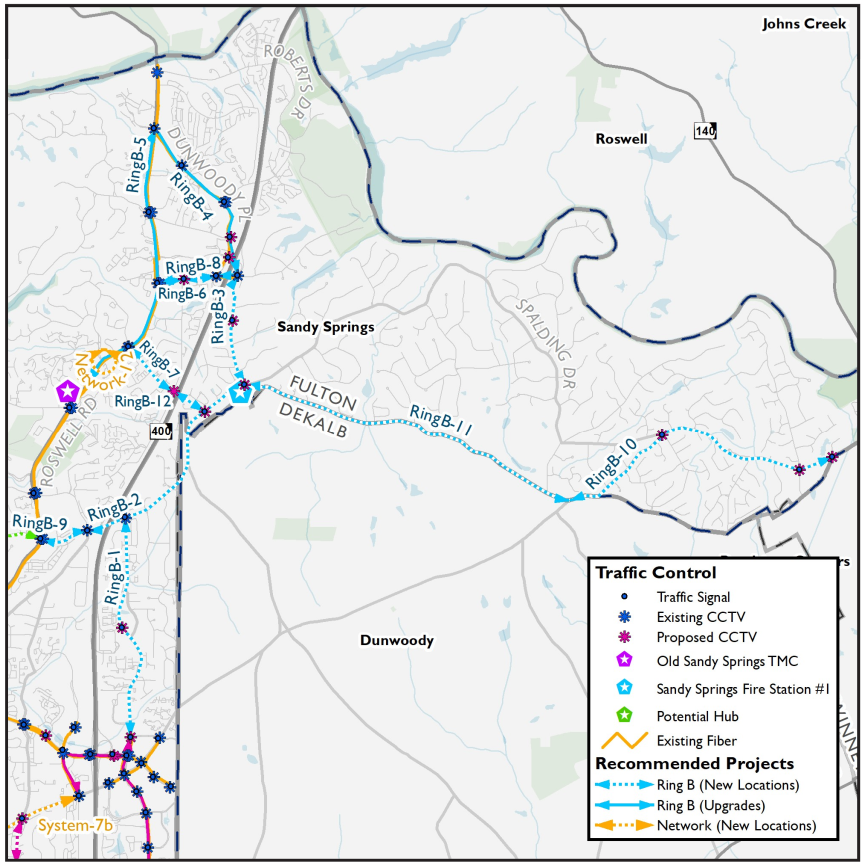
Ring B projects are primarily focused on:

1. New fiber construction along the ring path such that physical path redundancy is provided to those communication groups within Ring B
2. New fiber construction to those signals and cameras not currently on fiber
3. Fiber upgrades along the ring path to provide 144-count fibers for existing and future use

Projects are designated as short or long term depending on their relative immediate benefit to the network.

PROJECT BENEFITS

The communications network is the basis for all field devices and supported systems used to manage and operate the transportation network. The need for a robust, resilient, and reliable network is critical to the current system and will become increasingly important as transportation systems' technological dependency strengthen. Ring B projects create a physical path diverse ring which will provide redundancy to the communication groups within the highest congested areas, minimizing or negating any downtime within the area.



TERM	PROJECT	DESCRIPTION	DESIGN COST	CONSTRUCTION COST
SHORT-TERM (Network 3a-c)	RingB-1	Install new fiber cable along Peachtree Dunwoody Rd	$52,000	$346,000
	RingB-2	Install new fiber cable along Spalding Dr	$60,000	$398,000
	RingB-3	Install new fiber cable along Roberts Dr	$30,000	$200,000
	RingB-4	Upgrade existing fiber cable along Northridge Rd and Dunwoody Pl	$11,000	$71,000
	RingB-5	Upgrade existing fiber cable along SR 9 (Roswell Rd)	$15,000	$100,000
	RingB-6	Install new fiber cable along Northridge Rd	$10,000	$65,000
	RingB-7	Install new fiber cable along Pitts Rd	$18,000	$114,000
	TOTAL SHORT-TERM COSTS		**$196,000**	**$1,294,000**
LONG-TERM (Network 4a-b)	RingB-8	Install new fiber cable along Northridge Rd	$8,000	$49,000
	RingB-9	Install new fiber cable along Spalding Dr	$7,000	$46,000
	RingB-10	Install new fiber cable along Spalding Dr, Mt Vernon Rd, and Dunwoody Club Dr	$82,000	$545,000
	RingB-11	Install new fiber cable along Dunwoody Club Dr	$80,000	$530,000
	RingB-12	Install new fiber cable along Pitts Rd	$8,000	$49,000
	TOTAL LONG-TERM COSTS		**$185,000**	**$1,219,000**
OVERALL COSTS			**$381,000**	**$2,513,000**

RING C: PROJECTS

PROJECT FOCUS

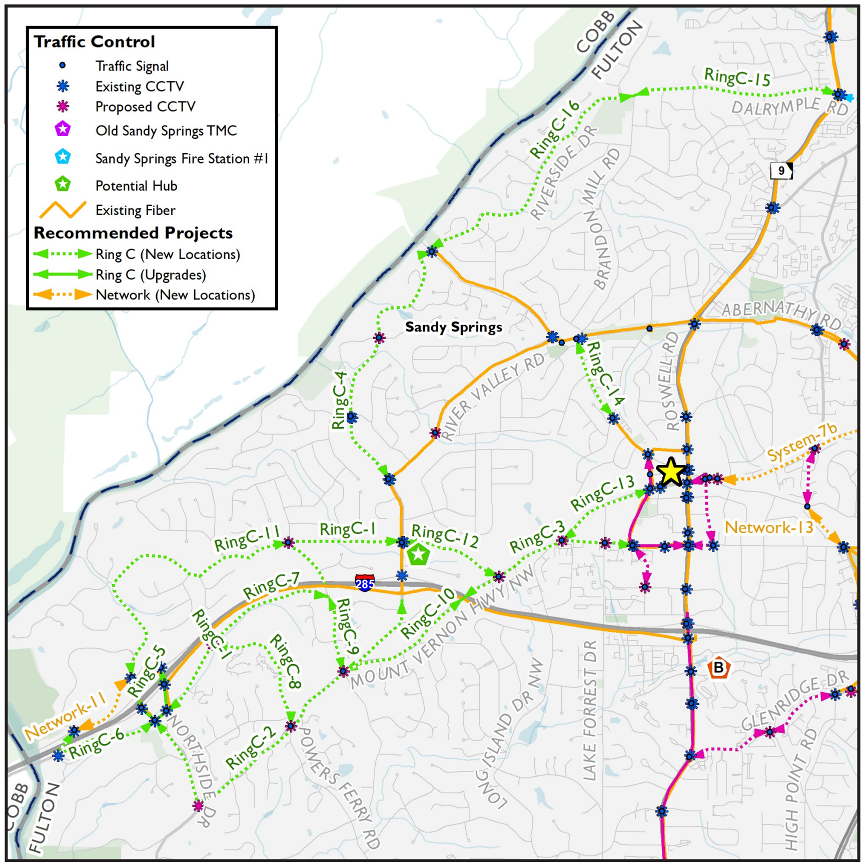
Ring C projects are primarily focused on:

1. New fiber construction along the ring path such that physical path redundancy is provided to those communication groups within Ring C
2. New fiber construction to those signals and cameras not currently on fiber
3. Fiber upgrades along the ring path to provide 144-count fibers for existing and future use

Projects are designated as short or long term depending on their relative immediate benefit to the network.

PROJECT BENEFITS

The communications network is the basis for all field devices and supported systems used to manage and operate the transportation network. The need for a robust, resilient, and reliable network is critical to the current system and will become increasingly important as transportation systems' technological dependency strengthen. Ring C projects create a physical path diverse ring which will provide redundancy to the communication groups within the highest congested areas, minimizing or negating any downtime within the area.



TERM	PROJECT	DESCRIPTION	DESIGN COST	CONSTRUCTION COST
SHORT-TERM (Network 5a-b)	RingC-1	Install new fiber cable along Heards Ferry Rd, Raider Dr, and I-285 EB to the intersection of Powers Ferry Rd at Dupree Dr	$23,000	$153,000
	RingC-2	Install new fiber cable along Riverside Dr, Mt Vernon Hwy, and Northside Dr	$76,000	$502,000
	RingC-3	Install new fiber cable along Mt Vernon Hwy and Hammond Dr	$48,000	$320,000
	TOTAL SHORT-TERM COSTS		**$147,000**	**$975,000**
LONG-TERM (Network 6a-b)	RingC-4	Install new fiber cable along Riverside Dr	$54,000	$358,000
	RingC-5	Upgrade existing fiber cable along New Northside Dr, Powers Ferry Rd, and Northside Dr	$6,000	$34,000
	RingC-6	Install new fiber cable along Powers Ferry Rd and under I-285	$43,000	$281,000
	RingC-7	Install new fiber cable along Powers Ferry Rd	$36,000	$234,000
	RingC-8	Install new fiber cable along Dupree Dr	$24,000	$158,000
	RingC-9	Install new fiber cable along Raider Dr/Powers Ferry Rd	$14,000	$92,000
	RingC-10	Install new fiber cable along Mt Vernon Hwy	$23,000	$152,000
	RingC-11	Install new fiber cable along Northside Dr/Heards Ferry Rd	$51,000	$334,000
	RingC-12	Install new fiber cable along Heards Ferry Rd	$18,000	$120,000
	RingC-13	Install new fiber cable along Mt Vernon Hwy	$19,000	$126,000
	RingC-14	Install new fiber cable along Johnson Ferry Rd	$15,000	$98,000
	RingC-15	Install new fiber cable along Dalrymple Rd	$34,000	$224,000
	RingC-16	Install new fiber cable along Riverside Dr	$46,000	$302,000
	TOTAL LONG-TERM COSTS		**$383,000**	**$2,513,000**
OVERALL COSTS			**$530,000**	**$3,488,000**

ITS Network Recommendations Overview

The City's ITS Network will continue to be the foundation of the City's future field infrastructure and systems that allow the City to effectively and efficiently manage and operate the transportation network. Table 6 provides an overview of the ITS Network recommendations.

Table 6: ITS Network Recommendations

Project ID	Project Description	Project Cost
Network-1a	Ring A – Design	$ 180,000
Network-1b	Ring A – Build – Phase 1	$ 537,000
Network-1c	Ring A – Build – Phase 2	$ 387,000
Network-1d	Ring A – Build – Phase 3	$ 254,000
Network-2a	Ring A – Design (long-term)	$ 110,000
Network-2b	Ring A – Build (long-term)	$ 722,000
Network-3a	Ring B – Design	$ 196,000
Network-3b	Ring B – Build – Phase 1	$ 346,000
Network-3c	Ring B – Build – Phase 2 & 3	$ 948,000
Network-4a	Ring B – Design (long-term)	$ 185,000
Network-4b	Ring B – Build (long-term)	$ 1,219,000
Network-5a	Ring C – Design	$ 147,000
Network-5b	Ring C – Build	$ 975,000
Network-6a	Ring C – Design (long-term)	$ 383,000
Network-6b	Ring C – Build (long-term)	$ 2,513,000
Network-7	Back up data center – *design, construction, and integration to be located at Fire Station #1*	$ 500,000
Network-8	Cabinet lock replacement	$ 25,000
Network-9	Field Distribution Layer 3 Routers (Hubs) – *design and installation of 3 field distribution layer 3 routers (hubs)*	$ 90,000
Network-10	Peachtree Dunwoody Rd new fiber installation *Part of other City project*	$ -
Network-11	Interstate N Pkwy new fiber installation to connect existing CCTVs *Install new fiber along Interstate N Pkwy* *Install wireless radio bridge across I-285*	$ 150,000
Network-12	New Traffic Signal at Grogans Ferry / SR 9 (Roswell Rd) *Part of other City project*	$ -
Network-13	Glenridge Dr new fiber installation from Hammond Dr to Johnson Ferry Rd / Glenairy Dr (T-0054)	$ 18,000

System Recommendations

System recommendations are provided to expand and enhance the existing systems. In addition, advanced and emerging technologies have been recommended to strategically support the progression of the City's use of technology to optimize the transportation network. These recommendations include device deployments, advanced signal operations, connected vehicle deployments, and additional system upgrades or enhancements.

Device Deployments

It is recommended that Sandy Springs continues to invest in upgrading their existing legacy ITS devices and execute planned expansions of new devices. Communication to signals is a fundamental way to more efficiently manage traffic. Fiber is the preferred method of communication, however, fiber construction can sometimes be challenging if a signal is isolated. For those locations that are not currently communicating to the TMC, it is recommended that cellular modems be deployed until fiber construction is feasible. In addition, connected cameras allow staff to monitor intersections remotely. Table 7 describes each of the device deployment recommendation projects.

Table 7: Device Deployment Recommendations

Project ID	Project Description	Project Cost
System-1	Bring analog Cameras to digital – 17 Remaining Analog CCTV Cameras to be upgraded to digital	$ 100,000
System-2	Cameras – *15 Remaining Fiber locations for CCTV*	$ 129,000
System-3	Short-term solution Signal to wireless *Install cellular or wireless communication systems to signals not currently online*	$ 118,000
System-4	Spalding Dr / Dalrymple Rd & Towbridge Rd CCTV *Part of other City project*	$ -
System-5	School Beacon Replacement / School Flasher Retrofit *Replacing or upgrading all remaining school flashers / beacons*	$ 120,000
System-6	Radar Speed Feedback Sign on Spalding Dr, just south of Dalrymple Rd *Part of other City project*	$ -

Advanced Signal Operations

To continue to improve traffic signal operations in the City of Sandy Springs, it is recommended the City expand its adaptive signal system and implement an Automated Traffic Signal Performance Metrics (ATSPM) system. Table 8 describes the advanced signal operations project recommendations.

Table 8: Advanced Signal Operations Recommendations

Project ID	Project Description	Project Cost
System-7a	Adaptive Migration – ATMS 3 (T-0054) *Install SCOOT system and wireless detection at approximately 30 signalized locations*	$ 1,500,000
System-7b	Adaptive Migration – ATMS 4 (TS 107) *Install SCCOT system and wireless detection at approximately 20 signalized locations* *Install new fiber along Mt. Vernon Hwy from SR 9 (Roswell Rd) to Barfield Rd*	$ 1,600,000
System-8	ATSPM Extension *Development of Sandy Springs interface and integration with GDOT's ATSPM System*	$ 150,000

Emerging Technologies

The City of Sandy Springs is committed to utilizing progressive techniques and emerging technologies to increase the safety, mobility, and efficiency of the transportation system. Table 9 describes the emerging technologies project recommendations. Additionally, Atlanta Regional Commission (ARC) and GDOT are currently investing in connected vehicle deployments throughout the region. The City is an active stakeholder in these discussions and it is anticipated that future opportunities will be available to leverage the City's investment and commitment to innovation.

Table 9: Emerging Technologies Recommendations

Project ID	Project Description	Project Cost
System-9	Emergency Vehicle Preemption *Install Preemption devices at 111 signalized intersections and in 28 emergency vehicles*	$ 700,000
System-10	Transit Signal Priority (upgrade controllers) *Deploy ITS devices and upgrade controllers at signalized intersections along MARTA routes*	$ 350,000
System-11	CAV Pilot Application Deployment: Bike/Ped/other *Development of application to work with existing CAV information to include bicyclists, pedestrians, and other users*	$ 200,000
System-12	Autonomous Shuttle *Autonomous shuttle from MARTA Station to Glenlake area businesses on shared-use path*	$ 340,000

Project ID	Project Description	Project Cost
System-13	Traveler Information Kiosks / Transit Curbside Management *Design and installation of pilot project at one of Sandy Springs MARTA Stations*	$ 200,000
System-14	Information Sharing: Aging Services and/or Fulton County Schools *Development of automated system for sharing information and streamline alerts and notifications*	$ 50,000
System-15	Traveler Information coordination with hospitals and Perimeter CID *Development of automated system for sharing information and streamline alerts and notifications*	$ 50,000
System-16	Video Sharing – GDOT fiber connection to Sandy Springs TMC for video access *Provide sharing access to Cobb County, Gwinnett County, City of Brookhaven, City of Dunwoody, City of Atlanta, City of Roswell*	$ 3,000
System-17	Pilot TSMO Project	$ 250,000

Implementation Plan

The City of Sandy Springs recognizes the importance and value of implementing ITS strategies and projects to *enhance safety, mobility, connectivity, and efficiency throughout all modes of travel.* It is recommended that ITS recommendations, described in the previous sections, be implemented in a prioritized, efficient manner.

The following implementation plan has been developed based on consideration of needs identified and discussed throughout stakeholder engagement (i.e. workshops, interviews, staff meetings, and survey); existing programmed work and present opportunities; estimated annual capital budget of $300,000 to $500,000; dependency of the project in relation to other deployments and systems; how the recommendation supports the stated goals of the City; and professional experience and best practices. It is anticipated that operations and maintenance will continue to grow at the current rate even with future deployments. This is primarily because the recommended deployments are largely focused on further optimization and redundancy. For example, when a fiber cable is cut today, loss of communication to signals can occur and requires immediate attention. After construction of a redundant ring a future cut will not require critical resources and can be addressed on a more relaxed, convenient schedule.

A high-level prioritization process was developed to help objectively guide project programming. Projects were prioritized based on five criteria which align with the stated ITS vision. Each of the five criteria were scored and weighted to create a final score for each project:

1. Dependencies and opportunities – raw score ranges from 10 (supports a significant number of systems) to 0 (no or minimal dependencies supported).
    a. Category is weighted by 50%.
2. Safety - raw score ranges from 3 (green), high safety impact, to 1 (orange), low safety impact.
    a. Category is weighted by 18%.
3. Mobility – raw score ranges from 3 (green), high mobility impact, to 1 (orange), low mobility impact.
    a. Category is weighted by 18%.
4. Connectivity and efficiency – raw score ranges from 3 (green), high connectivity and efficiency impact, to 1 (orange), low connectivity and efficiency impact.
    a. Category is weighted by 10%.
5. Innovation – raw score ranges from 3 (green), highly innovative, to 1 (orange), minimal innovation, i.e. system is existing and established technology.
    a. Category is weighted by 4%.

Table 10: Prioritization Considerations

Dependencies and Opportunities	10 - 1
Safety	
Mobility	
Connectivity and Efficiency	
Innovation	

Implementation recommendations have been made in the following horizons: Fiscal Years 2020, 2021, 2022, 2023, 2024, 2025, and Long Term. The recommended horizon schedule does not align directly with the prioritization rankings. This is based on the anticipated fiscal year capital budget and an understanding of reasonable management of deployments. Table 11 provides the recommended implementation plan for the ITS recommendations.

Table 11: Implementation Plan

Project ID	Project Description	Cost	D&O	Safety	Mobility	C&E	Inn.	Rank	Fiscal Year
System-1	Bring analog Cameras to digital (17 Remaining Analog CCTV Cameras to Upgrade)	$ 100,000	10					1	FY20
System-4	Spalding/Dalrymple & Towbridge CCTV (TS 103)	$ -	10					1	FY20
System-7a	Adaptive Migration - ATMS 3 (T-0054)	$1,500,000	9					3	FY20
System-7b	Adaptive Migration - ATMS 4 (TS 107)	$1,600,000	9					3	FY20
System-9	Emergency Vehicle Preemption	$ 700,000	10					5	FY20
System-5	School Beacon Replacement/School Flasher Retrofit	$ 120,000	10					6	FY20
System-6	Radar Speed Feedback Sign	$ -	10					7	FY20
Network-12	New Traffic Signal at Grogans Ferry/Roswell Rd (TS 105)	$ -	10					8	FY20
System-16	Video Sharing (GDOT Connection to TMC for video access)	$ 3,000	10					9	FY20
Network-13	Glenridge Dr new Fiber Installation (T-0054)	$ 18,000	10					12	FY20
Network-10	Peachtree Dunwoody new Fiber Installation (TS 109)	$ -	10					10	FY20
Network-11	Interstate N Pkwy New Fiber Installation to connect existing CCTVs	$ 150,000	10					10	FY20
System-17	Pilot TSMO Project	$ 250,000	10					12	FY20
								FY20 Total:	$4,441,000
System-2	New Cameras (15 Remaining Fiber Locations for CCTV)	$ 129,000	7					14	FY21
System-3	Short-term solution Signal to wireless	$ 118,000	6					15	FY21
Network-1a	Ring A - Design	$ 180,000	6					16	FY21
								FY21 Total:	$ 427,000
Network-1b	Ring A - Build - Phase 1	$ 537,000	6					16	FY22
								FY22 Total:	$ 537,000
Network-1c	Ring A - Build - Phase 2	$ 387,000	6					16	FY23

Project ID	Project Description	Cost	D&O	Safety	Mobility	C&E	Inn.	Rank	Fiscal Year
System-8	ATSPM Extension	$ 150,000	3					23	FY23
Network-8	Cabinet lock replacement	$ 25,000	1					28	FY23
								FY23 Total:	$ 562,000
Network-1d	Ring A - Build - Phase 3	$ 254,000	6					16	FY24
System-13	Traveler Information Kiosk	$ 200,000	1					30	FY24
								FY24 Total:	$ 454,000
Network-3a	Ring B - Design	$ 196,000	5					20	FY25
System-11	CAV Pilot Application Development: Bike/Ped/other	$ 200,000	1					29	FY25
								FY25 Total:	$ 396,000
Network-3b	Ring B - Build - Phase 1	$ 346,000	5					20	Long-Term
Network-3c	Ring B - Build - Phase 2 & 3	$ 948,000	5					20	Long-Term
System-10	Transit Signal Priority (Upgrade Controllers)	$ 350,000	3					23	Long-Term
Network-7	Back-up Data Center	$ 500,000	4					25	Long-Term
Network-5a	Ring C – Design	$ 147,000	4					26	Long-Term
Network-5b	Ring C – Build	$ 975,000	4					26	Long-Term
Network-2a	Ring A - Design (long-term)	$ 110,000	1					31	Long-Term
Network-4a	Ring B - Design (long-term)	$ 185,000	1					31	Long-Term
Network-6a	Ring C - Design (long-term)	$ 383,000	1					31	Long-Term
System-14	Information Sharing: Aging Services and/or Fulton County Schools	$ 50,000	1					31	Long-Term
System-15	Traveler information coordination w/ hospitals + Perimeter CID	$ 50,000	1					31	Long-Term
Network-2b	Ring A - Build (long-term)	$ 722,000	1					36	Long-Term
Network-4b	Ring B - Build (long-term)	$1,219,000	1					36	Long-Term
Network-6b	Ring C - Build (long-term)	$2,513,000	1					36	Long-Term
Network-9	Field Distribution Routers	$ 90,000	1					39	Long-Term
System-12	Autonomous Shuttle	$ 340,000	1					39	Long-Term
								Long-Term Total:	$8,928,000