Concept of Operations:

State Road 200 from Martin Luther King Jr. Ave to SW 60th St (Tartan Rd)

Traffic Signal Corridor Improvements

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**Document Approval Status**

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## Scope

This document addresses the system engineering needs for the State Road 200 Traffic Signal Corridor Improvements. The signal system will make use of Intelligent Transportation Systems and Advanced Traffic Management Systems to manage traffic flow, reduce congestion, reduce delay and provide motorists with information to make better route choices. Technologies include adaptive traffic signal coordination which will allow for automated real time adjustment of traffic signal timings in response to varying traffic demand; transit priority to facilitate timely transit routing, bluetooth wi-fi data collection which will allow remote collection of traffic origin and destination information and corridor travel times; variable message signs used to disseminate emergency management route guidance information; traffic monitoring cameras used for real time viewing of traffic along the corridor and signal operation troubleshooting; and traffic signal cabinet electronic security key upgrades along the corridor depicted in the illustration below.

 **Figure 1 corridor map**

This Concept Of Operations explains, at a high level, how the system will operate and defines the relative roles and responsibilities of the various participants in the system at each stage in the development of the project. The intended audience for the document includes both public and private sector partners responsible for planning, design, implementation, operations and maintenance of the system. This document is also intended to provide the required information for Federal and Florida Department of Transportation approval. Finally the document is expected to be used by the selected vendors as guidance for system requirements design and implementation.

## User-Oriented Operational Description

### Overview

Data collection, traffic monitoring, transit priority and adaptive traffic signal control technologies make use of sensors, communications and a control systems to enable monitoring and development of traffic signal timings to be in accordance with the variation in traffic flow. The system will also provide better support for public transit by minimizing disruption to coordination along the corridor in the event of a priority call. The overall effect of applying the technology will be to improve the reliability of travel times experienced through the corridor, reduce fuel consumption, reduce emissions and improve the driver experience by reducing the number of stops. Variable message signs will used to display pertinent real time traffic information to motorists utilizing information culled from a variety of sources including traffic monitoring cameras.The traffic signal cabinet electronic security keys provide an improved level of security for the field equipment while providing the ability to manage, control and log cabinet access. The figure below shows a high level architecture description of the system.

Traffic monitoring cameras

Adaptive traffic signal technology

Traffic signal cabinet

Transit priority

Variable message signs

Traffic signal cabinet electronic security keys

 **Figure 2 High Level System Architecture**

The implementation will make use of existing traffic control hardware in order to preserve previous investments in capital equipment and minimize implementation costs. Each intersection is currently equipped with the following legacy equipment:

 Figure High Level System Architecture

* NEMA TS2 Type 1 Controller
* Conflict monitor
* Bus Interface Units
* Load switches
* Loop or Video Detection
* Fiber Interconnect
* Traffic monitoring cameras (nine intersections: MLK Jr. Ave, SR 464, SW 27th Ave, SW 32nd Ave, I-75 East, I-75 west, SW 43rd St Rd, SW 48th Ave and SW 60th St)
* Variable message signs (one intersection: SW 43rd St Rd)

These devices will be supplemented through the acquisition of special purpose control hardware designed to support data collection, traffic monitoring, transit priority, adaptive traffic signal control and the installation of traffic sensors at suitable locations along the corridor. Traffic signals will be controlled by on street controllers which in turn will be linked back to the City of Ocala Traffic Management Center. This will allow traffic conditions to be monitored remotely from the City of Ocala Traffic Management Center. Changes and incidents will be managed through operator intervention at the City of Ocala Traffic Management Center.

## How the Existing System Works

The current system is connected back to the City of Ocala Traffic Management Center via fiber optic interconnect allowing equipment monitoring and also plan selection. The current traffic signal timing control strategy for the City system is accomplished through the use of Time of Day plan selection based on data collected when the intersections were retimed. Under the auspices of this control strategy, different timing plans are selected based on the current time of day. The timing plans were developed based on snapshot traffic counts and do not reflect evolving traffic conditions. There are nine traffic monitoring cameras that are used to monitor traffic along this corridor of 16 signalized intersections. There is also one variable message sign is also in use along this corridor as part of our I-75 Emergency Management Route.

## Network Characteristics

The State Road 200 consists of 16 signalized intersections. The existing road network is classified as an arterial with a major intersections at State Road 464, SW 27th Ave, I-75 and SW 38th Ct. Land use along the corridor is primarily commercial.

Table 1 provides a summary of the signalized intersections being addressed by the project.

Table 2 provides a summary of the distances between intersections.

**Table 1 List of Intersections**

|  |
| --- |
| Intersection |
| SR 200 and MLK |
| SR 200 and SW 17th St |
| SR 200 and SW 17th Rd |
| SR 200 and SW 20th St |
| SR 200 and SW 27th Ave |
| SR 200 and SW 26th St |
| SR 200 and SW 32nd Ave |
| SR 200 and SW 34th Ave |
| SR 200 and SW 35th Terr |
| SR 200 and I-75 East |
| SR 200 and I-75 West |
| SR 200 and SW 38th Ct |
| SR 200 and SW 43rd St Rd |
| SR 200 and SW 44th Ct |
| SR 200 and SW 48th Ave |
| SR 200 and SW 60th St (Tartan Rd) |

**Table 2 Distances Between Intersections**

|  |  |  |
| --- | --- | --- |
| From Intersection | To Intersection | Miles |
| SR 200 and MLK Jr Ave | SR 200 and SW 17th St | 0.57 |
| SR 200 and SW 17th St | SR 200 and SW 17th Rd | 0.39 |
| SR 200 and SW 17th Rd | SR 200 and SW 20th St | 0.21 |
| SR 200 and SW 20th St | SR 200 and SW 27th Ave | 0.13 |
| SR 200 and SW 27th Ave | SR 200 and SW 26th St | 0.39 |
| SR 200 and SW 26th St | SR 200 and SW 32nd Ave | 0.29 |
| SR 200 and SW 32nd Ave | SR 200 and SW 34th Ave | 0.21 |
| SR 200 and SW 34th Ave | SR 200 and SW 35th Terr | 0.21 |
| SR 200 and SW 35th Terr | SR 200 and I-75 East | 0.31 |
| SR 200 and I-75 East | SR 200 and I-75 West | 0.08 |
| SR 200 and I-75 West | SR 200 and SW 38th Ct | 0.16 |
| SR 200 and SW 38th Ct | SR 200 and SW 43rd St Rd | 0.29 |
| SR 200 and SW 43rd St Rd | SR 200 and SW 44th Ct | 0.39 |
| SR 200 and SW 44th Ct | SR 200and SW 48th Ave | 0.39 |
| SR 200 and SW 48th Ave | SR 200 and SW 60th St | 1.01 |
|   | Total corridor length | 4.64 |

## Traffic Characteristics

This section of SR 200 is a heavily traveled arterial, with variable traffic flows. It features directional peaks, bidirectional midday and weekend traffic peaks, transit routes and heavy event traffic requiring a sophisticated approach to signal coordination and traffic management. There are significant left turn movements at SW 17th St, SW 27th Ave, SW 35th Terr, I-75 East, I-75 West and SW 38th Ct. The corridor intersects the SR 464 coordinated corridor.

## Signal Grouping

The intersections are sufficiently close that they may be coordinated together under most traffic conditions and there are no groups of intersections that are separated by a sufficiently large distance that they will never be coordinated together.

## Operating Agencies

The City of Ocala will be the operating and maintaining agency for the traffic signal related equipment along the SR 200 Corridor. The signal control equipment along the corridor is connected using existing fiber optic interconnect back to the City of Ocala Traffic Management Center. The relationship between the proposed system and the Central Florida Regional ITS Architecture is described in the following section. The City of Ocala will troubleshoot, operate and maintain all the equipment and connectivity to the 16 city maintained signalized intersections along this corridor.

## Existing Architecture and Infrastructure

The following table summarizes the functions and interfaces supported by the City of Ocala Traffic Management Center.

**Table 3 Functions and Interfaces**

|  |
| --- |
| Coordinate emergency traffic signal control with the county EOC/warning points |
| Coordinate traffic information and traffic control with the City of Ocala TMC |
| Coordinate traffic information with the City of Ocala TMC |
| Operate traffic signal systems, including CCTVs, signals, and sensors, for City of Ocala TMC |
| Information Dissemination for City of Ocala TMC |
| Coordinate emergency plans, incident responses, and resources with the county EOC/warning points |
| Coordinate evacuation and reentry plans with the county EOC/warning points |
| Provide traffic information to travelers using private companies; city public information systems; and the media |
| Receive AMBER Alerts and other wide area alert information from the county EOC/warning points |
| Incident Management (Traffic and Maintenance) for City of Ocala TMC |
| Perform network monitoring for detection and verification of incidents on City roads, and send traffic/incident information and traffic images to city and county fire/EMS/sheriff agencies, the FHP, the county EOC, and local fire/EMS/police agencies |
| Provide incident information to travelers using traffic information devices on city roads, and through local ISPs, Web sites, and the local media |
| Receive incident information, incident response status, and resource requests from the county EOC/warning points |

The following block diagram shows how this system will fit within the Central Florida Regional ITS Architecture and the interfaces that are supported.

Counties and cities

Marion County Traffic Division

SunTran

FDOT Statewide

FDLE

FDOT D5 RTMC

Local media and venue promoters

MCSO MCFR

TPO

OPD/OFR

ISPs

City of Ocala field equipment

County

County EOC

City of Ocala TMC

**Figure 3 Fit with Central Florida Regional ITS Architecture**

Note that the gray box labeled “City of Ocala field equipment” is where the system will reside within the overall Central Florida Regional ITS Architecture. The operation of the traffic signals will be managed from the City of Ocala Traffic Management Center with maintenance activities supported by the City of Ocala Traffic Division.

## What are the Limitations of the Existing System?

Traffic signal control hardware along the corridor is perfectly serviceable. However, due to variable traffic conditions, including I-75 incidents, sporting events and transit timeliness disrupted by these conditions, it is necessary to implement equipment and technologies that allow for advanced data collection, management, control and observation of traffic. The corridor has been retimed several times in the recent past and yet corridor progression, data collection, the ability to monitor traffic and the ability to maintain transit timeliness is still limited. The variation in demand for movements throughout the corridor requires a more sophisticated solution. The current system cannot support such a solution without the purchase of additional hardware and software.

##  How the System will be Improved

In broad terms, the general approach to improving the system is through the introduction of hardware to collect traffic data, monitor traffic in real time, adaptive traffic signal timings that change in response to traffic demands to minimize delay and maximize throughput along the corridor. This is to be achieved through the procurement of additional hardware and software that will work with the existing system to provide the additional capability to more thoroughly manage transportation within the corridor.

##  Statement of Objectives for the Improved System

This section is focused on describing the operational objectives that will be satisfied by the envisioned adaptive operation.

Operational objectives for the signals to be coordinated are as follows:

1. Smooth the flow of traffic along coordinated routes and improve travel time reliability
2. Maximize the throughput along the corridor by making the best use of available green time
3. Manage queues, to prevent excessive queuing from reducing efficiency
4. Preserve the legacy hardware and software to protect previous investment in capital equipment
5. Enable traffic signal timings to be better aligned with variations in traffic flow
6. Minimize installation cost for adaptive control strategies through the reuse of existing hardware and software
7. Maximize the efficiency of the corridor under emergency situations through minimization of transition periods and the selection of the appropriate post emergency situation traffic movements
8. The system must incorporate frequent pedestrian operation into routine adaptive operation
9. Operator training will be provided to enable effective and efficient operations and management of the system from the City of Ocala Traffic Management Center
10. Provide traffic and operational data
11. Equipment failure management

### Smooth Flow

This objective seeks to provide a green band or pipeline along the corridor. For this particular corridor it is particularly important to achieve directional coordination and to accommodate extreme variable traffic flows. The corridor traffic exhibits directional peaks and considerable variability. This will be achieved by ensuring that the relationship between the intersections and signal timings are such that once a platoon starts moving it rarely slows or stops. This may involve holding a platoon at one intersection until it can be released and not experiencing downstream stops. It may also involve operating non-coordinated phases at a high degree of saturation (by using the shortest possible green), within a constraint of preventing or minimizing phase failures and overflow of turn bays with limited length, and with spare time in each cycle generally reverting to the coordinated phases.

### Maximize Throughput

This objective seeks to provide a broad green band along an arterial road, both directions, to provide the maximum throughput along the coordinated route without causing unacceptable congestion or delay side streets.

### Manage Queues

The adaptive traffic signal control algorithm should also take into account queue management requirements. This is particularly important due to the short distances between a number of intersections in this corridor.

One of the primary objectives is to ensure that queues do not block upstream. This often requires constraints on phase lengths to ensure that a large platoon does not enter a short block if it must be stored within that block and wait for a subsequent green phase. The adaptive algorithm should have the ability to manage queues in such a manner without creating side street cycle failures.

### Preserve legacy hardware and software

Existing hardware and software for traffic signal control is perfectly serviceable and does not require to be replaced. However the current configuration cannot support adaptive coordinated traffic signal control. The desired implementation will make maximum use of existing hardware and software and superimpose appropriate capabilities to support adaptive traffic signal control. This will ensure that the cost of installation for adaptive traffic signal control is minimized.

### Enable traffic signal timings to be better aligned with variations in traffic flow

The primary objective in implementing adaptive traffic signal control along this corridor is to better align traffic signal timings with variations in traffic flow. There are significant variations in traffic control along the corridor over the course of the day. Time-of-Day control strategies do not have the flexibility to optimize traffic signal control along the corridor.

### Minimize installation costs

It is essential that previous investment in traffic signal control equipment along the corridor is preserved. Therefore it is an important requirement of the project that existing hardware for traffic signal control be utilized in the new solution.

### Maximize the efficiency of the corridor under public transit priority situations

To accommodate future implementation of public transit vehicle priority equipment. This enables emergency and public transit vehicles to call for priority at each intersection. Under the current traffic signal control architecture, this introduces a loss of available green time due to the recovery period after priority has been granted. The objective is to minimize transitional green time losses.

### Incorporate Frequent Pedestrian Calls

The system is to accommodate the incorporation of frequent pedestrian calls at any of the intersections.

### Operator training will be provided to enable effective and efficient operations and management of the system from the City of Ocala Traffic Management Center.

Training will be provided to enable operators to conduct the following activities:

* Troubleshooting the system
* Preventive maintenance and repair of equipment
* System configuration
* Administration of the system
* System calibration
* Thorough explaination of how the timing works

Training delivery shall include: printed course materials and references, electronic copies of presentations and references and delivered to the City of Ocala Traffic Management Center.

### Provide traffic and operational data

One of the major advantages of an adaptive coordinated traffic control system using the latest technology is the ability to collect a range of valuable data and the ability to monitor traffic in real time. This data can be used for operational management of the traffic signal system and also be used as input to a performance management system. The system will be expected to provide a range of traffic monitoring and operational data as specified in the requirements.

### Equipment Failure Management

The system will be expected to support a range of equipment failure management features. These will include failure of the adaptive processor, failure of the communication system and failure of other hardware and software. Failure management features will be expected to comply with those specified in requirements. The City of Ocala Traffic Division will be responsible for the collection, receipt and correction of system failure alerts for the 16 City of Ocala maintained signalized intersections.

##  Description of Strategies to be applied by the Improved System

This section describes the adaptive coordination and control strategies that may be employed to achieve the operational objectives.

### Provide a Pipeline or Green Wave in both directions

Providing a pipeline along a coordinated route will support the two objectives of minimizing stops along a route and maximizing throughput along the route. The provision of a pipeline along a coordinated route can be achieved by a system based on a common cycle length, and also by a system that provides coordination bands toward and away from a critical intersection without using a common cycle length. A non-cycle-length-based or non-sequential system is preferred. This will define the bandwidth of the pipeline to match the phase length of the coordinated phases at the critical intersection within a group. Then the phasing at other intersections will be timed so that green is provided on the coordinated route to accommodate the pipeline.

### Distribute Phase Splits

To provide access equity, the demand for all phases will be handled equitably by serving all movements regularly and not providing preferential treatment to coordinated movements to the extent that delays and stops of other movements are significantly increased. To do this, the system will be optimizing an objective function that seeks to balance individual vehicle delays or some surrogate measure proportional to delays.

### Manage Queues

To manage queues, the system will allow the offsets between intersections to be set in a fashion that allows queues to be cleared at the end of each phase in blocks that are required to store queues during a subsequent phase. It will provide a means to control the locations where queues are allowed to form.

##  Operational Needs

At the highest level the operational needs can be defined as follows:

* Increased efficiency
* Higher customer service
* Improved Safety
* Smooth the flow of traffic along the coordinated routes and improve travel time reliability
* Manage queues to prevent excessive queuing from reducing efficiency
* Preserve the legacy hardware and software to protect existing capital equipment investments
* Enable traffic signal timings to be better aligned with variations in traffic flow
* Minimize installation cost for adaptive control strategies through the use of existing hardware and software
* Maximize efficiency of the corridor under public transit priority situations through minimization of transition periods and the selection of the appropriate post priority traffic movements
* Incorporate frequent pedestrian operation into routine adaptive operation
* Operator training to enable effective and efficient operations and management from the Ocala Traffic Management Center
* Provide traffic and operational data
* Equipment failure management

Each of these operational needs to be defined in more detail as follows:

### Efficiency

Efficiency is defined in terms of reduction in number of stops and the reduction in the average trip time through the corridor. Note that the objective here is not to speed traffic but rather disposed traffic flow. Therefore this need will also be measured through a reduction in the number of stops achieved by better traffic signal coordination and better matching of signal timings to existing traffic flows.

### Customer Service

The customer service operational need is defined in terms of an improvement for the overall customer service experience with the corridor. This could be measured in terms of reduction in number of stops and reduction in delay. It can also be measured subjectively by surveying opinions of travelers who use the corridor, developing a satisfaction rating based on the survey results.

### Safety

Safety needs can be defined in terms of reduction in the number of accidents and the reduction in the severity of the accident still remaining.

##  Measuring Progress Towards Needs Satisfaction

The following table summarizes the performance measures that have been identified for measuring progress towards satisfying the needs described above. Note that some of the measures identified wil not be measured directly, but inferred through the use of simulation modeling software such as Synchro.

**Table 4 Performance Measures**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Needs |  |  |  |
| Performance measures | **Efficiency** | **Customer Service** | **Safety** |
| No. of low severity accidents |  |  |  |
| No. of stops |  |  |  |
| Arterial delay |  |  |  |
| Side-street delay |  |  |  |
| Total network delay |  |  |  |
| Average travel time |  |  |  |
| Variability in travel time |  |  |  |
| Total emissions |  |  |  |
| Total fuel consumption |  |  |  |

##  System Overview

The proposed implementation forms a component within a regional traffic signal management system operated the City of Ocala . The larger system consists of a number of on-street traffic controllers linked through a fiber optic network to the City of Ocala Traffic Management Center. The system is currently operated using pre-determined Time-of-Day plans. This involves the creation of a number of predetermined timing plans which are activated for periods of time based on a set calendar.

The proposed implementation will build on the foundation of the current Time-of-day plans by adding further sophistication in the form of adaptive control. This will obviate the need for the development and maintenance of pre-determined timing plans. The traffic sensors will provide a continuous stream of data regarding traffic conditions and the special-purpose algorithms built into the firmware within the new hardware to be fitted the controllers will determine the appropriate traffic signal timings and communicate those to the controller. The overall system operation will be operated and monitored from the City of Ocala Traffic Management Center via a fiber optic link. This will allow the opportunity to intervene to override automated signal timings should an emergency or special event occur.

##  Adaptive Operational Environment

This section describes the physical operational environment in terms of facilities, equipment, computing hardware, software, personnel and operational procedures necessary to operate the deployed system. It describes the personnel in terms of their expected experience, skills and training, typical work hours, and other activities that must be or may be performed concurrently.

 To begin, the relative roles and responsibilities of each participant are defined. The matrix below summarizes roles and responsibilities for these participants at the various stages in the development of the project.

**Table 5 “Who Does What Matrix”**

|  |  |
| --- | --- |
| Responsibility | Participant |
| Planning | City of Ocala Traffic Division |
| Design | Vendor and City of Ocala Traffic Division |
| Implementation | Vendor and City of Ocala Traffic Division |
| Operations | City of Ocala Traffic Division |
| Maintenance | City of Ocala Traffic Division |

 Figure 4 Adaptive Operational Environment (Field)

Vehicle detection

New Adaptive Control processor

New Equipment Panel

Existing Traffic controller

Fiber or radio communication

Keyboard

(For Programming)

Monitor

(For Programming)

The figure above depicts the adaptive operational environment in terms of the new hardware and software to be installed within the overall context of the field legacy system.

The system will be procured and operated by the City of Ocala, with system maintenance provided by the City of Ocala staff. The City of Ocala Traffic Division has the staff necessary to maintain and operate the traffic signal control system software and hardware equipment. The City of Ocala Traffic Division will incorporate the use and operation of the traffic signal system equipment into their daily operational and preventative maintenance procedures. Equipment will be utilized until the end of its functional service life and will be replaced as part of the City of Ocala’s signalized intersection preventative maintenance program.

The operation of the traffic signal system equipment will be supported from the City of Ocala Traffic Management Center. This is an established traffic management center already conducting management and supervision for 126 signalized intersections. The new system will be operated under the auspices of the City of Ocala Traffic Division. Therefore the system will be required to support a single interface from the field to the City of Ocala Traffic Management Center to facilitate system operations and management.

##  Operational Scenarios

To illustrate the operation of the system a number of operational scenarios have been defined. The overall operation of the system under each of the scenarios will be described as a means of illustrating the technical and organizational operational concept for the system. This will indicate how the hardware and software will operate and also illustrate the respective roles and responsibilities for each of the major participants in system operation and maintenance.

The following operational scenarios have been identified:

* Normal routine operating conditions
* Business Hours Operation
* Off-Peak Period Operation
* Major Events
* Minor Incident
* Major Incident
* Maintenance and Failure Scenarios

Each of these operational scenarios are described in more detail as follows

### Normal routine operating conditions

It is expected that the system will operate under these conditions for the majority of the time. Under this scenario signal timings are automatically created and applied making use of the hardware and software enabling adaptive traffic signal control. While the operation of the automated system will be monitored remotely from the City of Ocala Traffic Management Center it is anticipated that there will be no requirement to intervene in system operations.

Normal routine operating conditions can also be subdivided into a number of more detailed scenarios as described below.

### Peak Periods – Unsaturated Conditions

During typical peak periods (and other periods when traffic volumes are high), the system will select phases that minimize delay to all movements at all intersections. The system will compare the volumes traveling in each direction, and provide coordination in both directions. The coordination will be implemented in a manner that provides balanced progression as far as possible in the two directions.

Where leading and lagging left turn phases are used, the system will determine the optimal phase sequence in order to provide the best coordination. This would be linked to the direction of offset, such as providing a lagging left turn in the heavy, coordinated direction. If the green time required for a left turn phase is longer than the time required to service a queue fully occupying the left turn bay, the queue would overflow and block the adjacent lane, the operator will be able to specify the phase to operate twice per cycle in order to avoid queue overflow.

The entire corridor may be set by the operator to operate as one coordinated group, or the system may have the freedom to operate it as one group subject to user-specified criteria, such as volume of traffic in the peak direction exceeding a threshold.

### Peak Periods – Oversaturated Conditions

During peak periods when one or more intersections are oversaturated, the primary objective of the system will be to maximize the throughput along the corridor in the peak direction. The system will determine the direction with peak flow and provide the maximum bandwidth possible. This will be subject to user-specified constraints, such as allowable phase sequences, and minimum and maximum phase times. As described in the unsaturated peak description, phase sequence of lead-lag phases, and the operation of left turn phases will be determined by the system. The entire corridor may be set by the operator to operate as one coordinated group, or the system may have the freedom to operate it as one group subject to user-specified criteria, such as similar required cycle lengths in different parts of the corridor are similar or the volume of traffic in the peak direction exceeds a threshold.

### Business Hours Operation

During business hours, there will be two separate but complementary objectives: select signal timings that ensure all movements at all intersections are accommodated equitably, while providing reasonable coordination in both directions.

### Off-Peak Period Operation

During early mornings, evenings and parts of the weekends when traffic is lighter than during the business hours, the coordination objectives will be similar to the business hours, although shorter green times may be applicable. If there are green times that would provide good two-way progression and accommodate all movements at all intersections equitably, but cannot accommodate all pedestrian movements on all phases and stay in coordination, the system will allow shorter green times through the following actions.

If protected/permitted left turn phasing is in operation, the protected phase can be omitted under user-specified conditions, such as very light volume or short queue lengths (determined by detector logic). The maximum green time may be set lower than the sum of pedestrian walk and clearance times, and still allow the pedestrian phase to operate by extending the green time when necessary without throwing the system out of coordination.

During normal weekend traffic conditions, the system may operate in the same manner as the business hours or as the off-peak periods.

### Major Events

For this scenario it is assumed that a special event such as a sporting event is taking place requiring special traffic signal timings and traffic handling be applied. In this case the City of Ocala Traffic Division staff will adjust the time between green waves. The effect on traffic will be monitored making use of the sensors in the corridor and traffic data will be relayed back to the City of Ocala Traffic Management Center to confirm the effectiveness of the timings and strategies being applied.

During major events, the traffic characteristics are often similar to the peak periods, either oversaturated or unsaturated. The system will behave in a similar fashion to those periods, and data from the detection system will determine whether unsaturated or oversaturated conditions prevail. If there is heavily directional traffic before or after an event, the system will determine the predominant direction and coordinate accordingly, with an appropriate green times and offsets. If the event traffic is not as heavy as peak hours, but the traffic on the corridor is still highly directional, then the system will recognize this and provide coordination predominantly in the heaviest direction, even though the green times may be similar to business hours (with balanced flows) green times.

The entire corridor may be set by the operator to operate as one or more coordinated groups under this condition, or the system may have the freedom to operate it as one or more groups subject to user specified criteria, such as similar required green times in different parts of the corridor or the volume of traffic at key locations exceeds a threshold.

### Minor Incident

Under the auspices of this scenario it is assumed that a minor incident has occurred along the corridor. This is defined as a traffic incident that is not severe enough to require a lane closure but is of such significance that traffic conditions have been affected along the corridor, for example a minor vehicle collision or a stalled vehicle. In this scenario it is expected that the automated traffic control system will be able to manage the signal timings automatically with the operation of the system being monitored remotely at the City of Ocala Traffic Management Center.

### Major Incident

When a major incident occurs on I-75 or SR 200, or at a location along the corridor, the traffic on the corridor will change in a manner that is difficult to predict, and the response required of the system will vary depending on the time of day, day of week and the current traffic conditions at the time the incident occurs. The system will detect any increase in traffic volume and take the following action. If the incident occurs at times of higher traffic volumes, green times will incresease in order to continue to accommodate all movements at all intersections, but only up to the maximum permitted by the operator. If the diverted traffic results in a change in the balance of the direction of the traffic on the corridor, the progression will be changed to match the traffic. Typically the result of these actions will be to increase certain green times and provide a wide progression bandwidth in the direction of the diverted traffic. However, if the incident occurs at times of lower overall traffic volumes, and it does not result in oversaturated conditions on the corridor, the result may be that the system mimics a typical peak pattern or business hours pattern.

This type of incident will typically not result in a uniform increase in traffic in one direction for the entire length of the corridor. Therefore, it is expected that the response of the system will be different in each section of the corridor, depending on the location, nature and time of day of the incident. The architecture of the system will allow each section of the system to respond independently but in a consistent manner during incidents.

##  Failure Scenarios

A number of system failure scenarios have been defined as follows:

### Detector Failure

Detector reliability is a very important part of successful adaptive operation. The system will recognize a detector failure and take appropriate action to accommodate the missing data. For a local detector failure, the local controller will place a soft recall or maximum recall (to be user-specified) on the appropriate phase, and issue an alarm. For a detector that influences the adaptive operation (e.g., a system detector), the system will use data from an alternate (user-specified) detector, such as in an adjacent lane or at an appropriate upstream or downstream location. If the number of detector failures within a specified group exceeds a user-specified threshold, the system will cease adaptive operation and go to a fallback mode of time-of-day operation or free operation. The fallback mode will be specified by the user based on location and time of day. All detector failure alarms will be automatically transmitted to maintenance and operations staff at the City of Ocala Traffic Management Center for appropriate attention.

### Communication Failure

Communications failures will have varying effects on the operation of the system. If a communication failure prevents the adaptive system from continuing to control one or more intersections within a defined group, all signals within the group will revert to an appropriate, user-specified fallback mode of operation, either time-of-day operation or free operation. The fallback mode will be specified by the user based on location and time of day. All communication failure alarms will be automatically transmitted to the City of Ocala Traffic Management Center for appropriate attention.

### Adaptive System Failure

There are two possible types of adaptive system failures: failure of the server or equipment that operates the adaptive algorithms; and inability of the adaptive algorithms to accommodate current traffic conditions. If the equipment that operates the adaptive algorithms fails, the system will recognize the failure and place the operation in an appropriate, user-specified fallback mode, either time-of-day operation or free operation. The fallback mode will be specified by the user based and time of day.

The adaptive system will make its decisions based largely on detector data. Occasionally, as the result of an incident or other event outside the control of the system and outside the area covered by the system, congestion will propagate back into the adaptive control area and the measured traffic conditions will be outside the range of data that can be processed by the system. In locations where this is likely to occur, the intersection detectors, or queue detectors installed specifically for this purpose, will measure increased occupancy. In such cases, when user-specified signal timing and detector occupancy conditions are met, the system will recognize that its response to the input data may not be appropriate, and it will revert to an appropriate, user-specified fallback mode, either time-of-day operation or free operation. The fallback mode will be specified by the user based and time of day.

All adaptive system failure alarms will be automatically and immediately transmitted to the City of Ocala Traffic Management Center operator for appropriate attention.

**Equipment Failure**

Equipment failure can have varying effects on the operation of the system. Systems monitoring and reporting will ensure equipment failures are detected and addressed in a timely and safe manner. User specified fallback modes will prevent unwanted consequences and actions when equipment malfunctions occur.