U.S. DOT, FL DOT, MIAMI-DADE EXPRESSWAY AUTHORITY, CITY OF SWEETWATER, FIU

University City Prosperity Project

http://UC.FIU.edu

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Principal Investigator: Dr. Naphtali Rishe

Informed Traveler Program and Applications

Plan for Phase 1 – Design and Development
Abstract

The Informed Traveler Program and Applications (ITPA) software is an advanced traffic management package to be developed by Florida International University's High Performance Database Research Center (HPDRC) and partners under the umbrella of National Science Foundation's Industry-University Cooperative Research Center for Advanced Knowledge Enablement at FIU (NSF I/UCRC CAKE, http://CAKE.FIU.edu). It will provide customized real-time and predictive information about multimodal and intermodal traffic in the UniversityCity region to individual customers, and also make available innovative decision support for parking and transportation providers. ITPA will enable the individual user to make optimum route and mode choices, and will also enable the service providers to manage individual traffic, transit and parking more effectively.

This document describes the first phase of ITPA design and development. After a general introduction on the system's scope and the underlying assumptions (Section 1) the functional requirements to the software are listed (Section 2). This is followed by an overview on the general architecture and the utilized technologies and processes (Section 3), and descriptions of the goals of the three major design and development phases (section 4). Section 5 lists roles in ITPA's design and development process. Appendix A provides background details.
1 Introduction

The 2013 TIGER Discretionary Grant-awarded UniversityCity Prosperity Project consists of:

1. A major development effort, including parking and transit infrastructure on Florida International University's (FIU) Modesto A. Maidique Campus (MMC), a pedestrian bridge connecting MMC and the neighboring City of Sweetwater, and the development of a pedestrian-oriented Sweetwater Memorial Plaza and "Main Street"
2. Preparation of an extended choice of transit modes, including community transit buses
3. The Informed Traveler Program and Applications (ITPA) software, which will offer innovative solutions to manage and optimize individual traffic, transit and parking

This document describes the work planned to design and develop the ITPA Phase 1 software on schedule and on budget.

ITPA is an advanced traffic management and customer-oriented navigation software which will provide customized real-time and predictive information about multimodal and intermodal traffic in the UniversityCity region to customers, recommend trip segment choices that optimize travel, and make available innovative decision support for transportation providers. The ITPA software will primarily address individual (motorized and un-motorized) traffic, public transit, and parking management. It will enable individual users to make optimum route and mode choices, and also enable service providers to manage individual traffic, transit and parking more effectively. ITPA is therefore aiming to provide best possible solutions both from a local and global point of view, rising both efficiency and effectiveness of individual traffic, public transit and parking, and will thus yield a significant economic benefit derived from very efficient travel decisions and large-scale transportation demand management as applied to the UniversityCity.

ITPA Phase 1 is the first installment of ITPA, funded by the 2013 TIGER Discretionary Grant.

ITPA Phase 1 Scope

ITPA Phase 1 will focus on providing parking availability information and management support, as well as transit information and management support. To accomplish this, it will display to individual users' smart-phones, to service providers' operations centers, and to dynamic message signs at bus stops and parking garages various customized views of the:

1. Estimated real-time and predicted future parking occupancy in UniversityCity's parking garages and parking lots
2. Real-time transit vehicle locations, routes, and estimated times of arrival
It will also be able to broadcast event and other information from service providers to smartphone users and available dynamic message signs at bus stops and parking garages.

One of its most innovative features will be the option for some of the community transit vehicles to deviate from their schedule to fulfill transit requests from its users. For this, transit requests entered via the smartphone app will be collected; optimized routes and schedules will be calculated and provided to the respective vehicles. The system will also enable service providers to dynamically reroute the community transit buses for loosely scheduled express trips which are envisioned to connect University City to the Miami Intermodal Center (MIC) or Metrorail’s Palmetto Station so as to maximize ridership and avoid congestion-based trip delays. Another innovative feature is the estimation of real-time and future parking availability based on crowd-sourced and historic data acquired from sensors; we will also examine how this innovation might be applied community transit.

ITPA Phase 1 will serve as a platform to develop and lay a foundation for additional functions in future phases, such as navigation to available parking, extended dynamic transit routing based on real-time user demand, and more overall decision support with redundancies for transit and parking management and operations, decrease of cost of operation of transit, increase passenger convenience and satisfaction, increase percentage of commuters option for transit vs private vehicles, indirectly decrease congestion and cost of operation of the road system. To that effect, development during Phase 1 will have an immediate deliverable as specified herein and will also produce software modules beneficial to later phases.

ITPA Phase 1 software design and development will start in September 2014 and end in March 2018. According to section 6.9 of the ITPA Phase 0 Background Discussion (see appendix A) the net amount allocated to these software development tasks is $1,100,000 over the course of three and a half years, within a total budget of $2,368,836 (see table 1).

<table>
<thead>
<tr>
<th>ITPA Phase 1</th>
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</thead>
<tbody>
<tr>
<td><strong>Budget Categories</strong></td>
</tr>
<tr>
<td>Parking implementation guidance by FIU faculty</td>
</tr>
<tr>
<td>Software development</td>
</tr>
<tr>
<td>Evaluation (Independent Evaluator)</td>
</tr>
<tr>
<td>IBM senior software engineer and consulting</td>
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<tr>
<td><strong>Total Labor Costs</strong></td>
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<tr>
<td>Other Materials and Supplies</td>
</tr>
<tr>
<td>Software IBM</td>
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TIGER ITPA PHASE 1 PLAN 2014-09-15
<table>
<thead>
<tr>
<th>Software Pirouette</th>
<th>$100,000</th>
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</thead>
<tbody>
<tr>
<td>Sensor-based Parking and DMS</td>
<td>$160,000</td>
</tr>
<tr>
<td>APTS Equipment (9 vehicles) – procured through separate SDG</td>
<td>$0,000</td>
</tr>
<tr>
<td>Equipment (ÁLTA/Bluetooth devices) and deployment</td>
<td>$50,000</td>
</tr>
<tr>
<td>Equipment (computers, servers, etc.) and deployment</td>
<td>$50,000</td>
</tr>
<tr>
<td><strong>Total Direct Costs</strong></td>
<td><strong>$1,969,776</strong></td>
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<tr>
<td>Indirect Costs @ 27% of MTDC ($1,503,020)</td>
<td>$399,060</td>
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<tr>
<td><strong>TOTAL COSTS</strong></td>
<td><strong>$2,368,836</strong></td>
</tr>
</tbody>
</table>

*Table 1: Budget, as further explained in Appendix A, section 6.9. All costs include the functional testing of the developed individual components and their integration.*

**Pre-requisites**

This document makes several assumptions whose prior fulfillment is essential for the completion of the ITPA Phase 1 software according to schedule and budget. Efforts to fulfill these pre-requisites are therefore not part of the work described in this document.

1. Transit and parking management and operations will be provided by the UniversityCity Transportation Management Association (TMA), which will be established by mid-2015 by the City of Sweetwater.

2. FIU Department of Parking and Transit (P&T) will use $160k out of the TIGER match budget to provide camera-based data acquisition modules for FIU’s parking garages and parking lots. P&T will co-operate with NuPark or a similar provider, which will make available to the ITPA software a stream of real-time data on parking availability. P&T is also installing TransLoc technology for its transit vehicles and ITPA will be designed and installed so as to be intraoperative or otherwise compatible with such technology or establish a system improvement thereof.

3. UniversityCity TMA will install vehicle interaction modules on FIU and Sweetwater transit vehicles by mid-2015. While customization work on on-board sensors or cameras, information and communications equipment and software will be funded by TIGER, the devices themselves will be acquired under the 2014 FDOT Service Development Grant “UniversityCity Transit Improvements” or by other means.
4. The FHWA-approved vendor Pirouette Software will deliver a working prototype of its parking availability estimation module by the end of 2014 and a finished product by the end of 2015.

5. Miami-Dade Transit (MDT) will make available to the ITPA software a stream of the real-time position of its vehicles by mid-2015. Only information about vehicles with streamed real-time positions can be included into the ITPA software.

6. The UniversityCity TMA, in coordination with FIU and Sweetwater, will seek to secure an IOT software license and support from IBM in order arrange for an examination of its capabilities when compared to ITPA functionalities with the intent to integrate these products for optimum results, use IOT as a back-up to ITPA or use IOT as a related program serving unmet UniversityCity TMA, FIU and Sweetwater needs.
2 Functional Requirements

1. ITPA shall provide management support for an UniversityCity Advanced Public Transportation System (UCAPTS)
   
a. UCAPTS shall track transit vehicles and process diverse data
      i. UCAPTS shall process data on transit vehicle positions
      ii. UCAPTS shall process data on passenger load and other relevant data
      iii. UCAPTS shall process data on special events reported by drivers
   
b. UCAPTS shall provide schedule and route information via a smart-phone app and web page
      i. UCAPTS shall provide an UniversityCity smart-phone app and web page
      ii. UCAPTS shall detect user position
      iii. UCAPTS shall provide transit information on a map-based view
      iv. UCAPTS shall provide information on transit routes and schedules
      v. UCAPTS shall provide current transit vehicle positions
      vi. UCAPTS shall provide estimated transit vehicle arrival times for each bus stop
      vii. UCAPTS shall provide a list of next available transit vehicles for each bus stop
      viii. UCAPTS shall provide event messages from the transit operations center
      ix. UCAPTS shall provide an option for users to request community transit
      x. UCAPTS shall provide transit information to available dynamic message signs at bus stops
   
c. UCAPTS shall provide management support for a transit operations center
      i. UCAPTS shall report vehicle positions on a map-based view
      ii. UCAPTS shall report schedule adherence
      iii. UCAPTS shall report dwell times at bus stops and traffic lights
      iv. UCAPTS shall report passenger load and transit usage statistics
      v. UCAPTS shall provide route recommendations for express transit
      vi. UCAPTS shall try to fulfill feasible community transit requests by considering dynamic rerouting of community buses
      vii. UCAPTS shall report system usage statistics
viii. UCAPTS shall include playback facilities

2. ITPA shall provide management support for an UniversityCity Advanced Parking Information System (UCAPIS)
   a. UCAPIS shall track parking availability and collect diverse data
      i. UCAPIS shall process data on vehicles entering and leaving parking garages
      ii. UCAPIS shall process data on vehicles entering and leaving parking lots
   b. UCAPIS shall provide parking availability information via a smart-phone app and web page
      i. UCAPIS shall provide an UniversityCity smart-phone app and web page
      ii. UCAPIS shall provide parking availability information on parking garages
      iii. UCAPIS shall provide parking availability information on parking lots
      iv. UCAPIS shall provide estimates of parking availability
      v. UCAPIS shall provide parking availability information to available dynamic message signs at parking garages
   c. UCAPIS shall provide management support for a parking operations center
      i. UCAPIS shall report parking availability on a map-based view
      ii. UCAPIS shall report usage statistics for parking garages and parking lots
      iii. UCAPIS shall report system usage statistics
      iv. UCAPIS shall include playback facilities

3. ITPA shall meet other requirements as outlined in this section
   a. The UC app shall allow for a single log-on to all of its components
   b. The UC app shall allow users to provide feedback

3 Architecture and Technologies Overview

While the detailed composition of ITPA Phase 1's modules will be designed at the start of development, a plan for its general architecture is already in place. ITPA Phase 1 design and development will leverage the technologies of HPDRC TerraFly, IBM Worklight, Pirouette StreetSmart, Spring Framework, and will establish an agile software development process.

General architecture
The ITPA Phase 1 software will consist of front-end and back-end modules, and will interact with stationary data acquisition modules and vehicle interaction modules on board of transit vehicles. A computational transportation research team will design the complex algorithms for its more advanced requirements.

**Front-end** – The front-end will consist of the smart phone application and the operations center module.

The smart phone app will run on most popular devices and will not be restricted to one single platform like Android or iOS. It will display customized information to individual users and will allow them to interact with the system. Most of its functions will also be made available by a web page.

The operations center module will run on a regular work station, typically also connected to two wall-mounted screens. It will display customized information to operators and will allow them to interact with the system.

**Back-end** – The back-end software will run on a dedicated server or will utilize cloud computing services. It will consist of a number of modules, connected by a module integration bus. These will include a parking availability module, a transit tracker module, a responsive transit module, and also service modules for user interaction, vehicle interaction, parking management interaction, system usage statistics and database services.

**Research** – Several features in the areas of parking availability estimation and management, and transit analysis and management require advanced and computationally complex models and algorithms. A computational transportation research team will research and design those models and algorithms.

**Technologies**

ITPA Phase 1 will utilize a set of technologies and products.

**HPDRC TerraFly** – While the back-end will utilize TerraFly’s geospatial databases and moving object tracking technology, the front-end will utilize its methods to display aerial imagery and
street maps, including the platform-neutral next-generation viewer currently under development.

**IBM Worklight** – By utilizing a framework like PhoneGap or IBM Worklight major parts of the front-end code can be re-used on several mobile platforms: Worklight supports iOS, Android, Blackberry OS, Windows Phone, Ubuntu, Firefox OS and most web browsers. Using one of these frameworks, many parts of the actual smart-phone and operations center applications are coded in non-proprietary programming technologies, i.e. JavaScript, HTML5 and CSS3.

**Pirouette StreetSmart** – StreetSmart is a crowd-sourced parking availability estimation software currently in development by Pirouette Software. It will enable ITPA to provide users and service providers with parking availability information for UniversityCity's parking lots and on-street parking based on historical availability and real-time data.

**Spring Framework** – Utilizing an enterprise application framework like Spring Framework will enable efficient back-end development. It provides extensive services in areas like user authentication, remote access, transaction management and testing.

Other technologies to be used include CSS3, HTML5, Java 7 Enterprise Edition, JavaScript, JSON, MySQL, and SQLite.

**Processes**

An agile software development process will be established for ITPA Phase 1 software design and development. This group of software development methods is especially suitable for complex projects in which requirements and solutions evolve as new information is gathered and the project's environment changes. Their way to control complexity is to promote adaptive planning, evolutionary development, early delivery, continuous improvement and to encourage rapid and flexible response to change. They focus on delivering working software with the minimum amount of work.

As user feedback is very important in the context of an agile software development process, the ITPA team has agreed with the Honors College at FIU to recruit a significant number of Honors College students as pioneer audience and testers throughout the duration of the project. As the success of the project relies on good user response, significant attention will be devoted to user feedback from the Honors College and will used to guide further feature development. The Honors College will thus also serve as a launch pad to market the ITPA Phase 1 software to the broader student body.

**4 Design and development phases**

Work on ITPA Phase 1 will consist of three design and development phases (Phase 1A, 1B and 1C) and a wrap-up period. At the successful completion of Phase 1A, ITPA will be a viable basic
product informing a pioneer audience on real-time parking and transit. It will be used to support management and operations of FIU’s parking garages and of the UniversityCity TMA's bus fleet, which is currently envisioned to commence operation in the first half of 2016. At the successful completion of Phase 1B, ITPA will include estimates on future parking availability and basic responsive transit support. At the successful completion of Phase 1C, the whole range of Phase 1 requirements will be covered. At the successful completion of the wrap-up period all ITPA Phase 1 related documentation will be complete.

<table>
<thead>
<tr>
<th><strong>ITPA Phase</strong></th>
<th><strong>Planned Start</strong></th>
<th><strong>Planned End</strong></th>
<th><strong>Planned Duration</strong></th>
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<tr>
<td>Phase 1A</td>
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<td>31.12.15</td>
<td>15 month</td>
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<tr>
<td>Phase 1B</td>
<td>01.01.16</td>
<td>31.12.16</td>
<td>12 month</td>
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<tr>
<td>Phase 1C</td>
<td>01.01.17</td>
<td>31.12.17</td>
<td>12 month</td>
</tr>
<tr>
<td>Phase 1 Wrap-up</td>
<td>01.01.18</td>
<td>31.03.18</td>
<td>3 months</td>
</tr>
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</table>

**ITPA Phase 1A**

ITPA Phase 1A will result in a viable product which satisfies a significant subset of ITPA’s functional requirements as stated in section 2. This product will be tested, documented and ready to ship to a pioneer audience. It will enable users to navigate on a map of the UniversityCity area, which also yields information about bus routes, bus stops, current position of buses and expected times of arrival (ETAs) at the respective next bus stops. It will include basic information on the availability of parking in some FIU parking garages and Sweetwater on-street parking.

The schedule for Phase 1A assumes – as stated above – that UniversityCity TMA will install vehicle interaction modules on FIU and Sweetwater buses in parallel with this effort and that MDT publishes or delivers the real-time position of its vehicles. It also assumes that at least one parking garage will have a sensor-based data acquisition module by the end of 2014, and that Pirouette Software delivers a working prototype of its parking availability estimation module by the end of 2014.

At the successful completion of ITPA Phase 1A the smart-phone app will:

- Allow users to create an account and log in to the system
- Show a map of the user’s surroundings
- Show the user's position on the map
- Allow for scrolling of the map
- Show the current position of UniversityCity TMA buses
- Show the current position of MDT buses
- Show ETAs of UniversityCity TMA buses
• Show UniversityCity TMA bus routes
• Show MDT bus routes
• Show bus stop locations
• Show parking garages color-coded according to occupancy
• Show parking lots color-coded according to occupancy
• Send the user's position to ITPA server
• Show messages from the operations center module

At the successful completion of ITPA Phase 1.A, the server will:

• Administrate user account data
• Deliver map data requested by apps
• Deliver bus route and bus stop data requested by apps
• Deliver UniversityCity TMA bus positions requested by users
• Deliver MDT bus positions requested by users
• Deliver parking garage occupancy data requested by users
• Deliver parking lot occupancy data requested by users
• Track the user's position and movement
• Track position of UniversityCity TMA buses
• Track position of MDT buses
• Administrate parking garage occupancy data provided by NuPark servers
• Administrate parking lot occupancy data provided by Pirouette Software servers
• Compute ETAs of UniversityCity TMA buses
• Administrate messages for users from the operations center module
• Collect statistic data on ITPA system usage

At the successful completion of ITPA Phase 1.A, the operations center module will:

• Show a map of UniversityCity area
• Show the current position of UniversityCity TMA buses
• Show the current position of MDT buses
• Show UniversityCity TMA bus routes
• Show MDT bus routes
• Show schedule adherence of UniversityCity TMA buses
• Show statistical data on UniversityCity TMA buses
• Show parking garages color-coded according to occupancy
• Show parking lots color-coded according to occupancy
• Show the estimated number of available slots in parking garages
• Show the estimated number of available slots in parking lots
• Show the position of individual ITPA users (anonymously)
• Show statistical data on ITPA system usage
• Allow for messages to be sent to a smart-phone app

At the successful completion of ITPA Phase 1.A, the vehicle interaction modules will:
- Track the vehicle's current position
- Send the vehicle's current position to the ITPA server via mobile data

**ITPA Phase 1B**

As the best design options covering the more advanced functional requirements will only become fully understood in the course of designing, developing, and evaluating the ITPA Phase 1A product, the feature sets of phases 1B and 1C are not closely specified yet.

ITPA Phase 1B will result in a viable product which will be ready to be deployed to UniversityCity TMA. In addition to the ITPA Phase 1A feature set it will include basic support for responsive community transit and route recommendations for express transit. It will also provide estimations on future parking availability both in parking garages and parking lots. It will include an interface to broadcast transit information to available dynamic message signs at bus stops, and parking availability information to dynamic message signs at parking garages and parking lots.

The feature set will be fully specified at the beginning of this phase.

**ITPA Phase 1C**

ITPA Phase 1B will result in a viable product which satisfies the complete set of functional requirements stated in section 2. It will be ready to be deployed to UniversityCity TMA.

Its feature set will be fully specified at the beginning of this phase.

**ITPA Phase 1 Wrap-up**

ITPA Phase 1 Wrap-up will result in a complete documentation of ITPA.
5 Personnel

To complete the stated features in the time frame of ITPA Phase 1 the software design and development team will consist at least of the following personnel:

<table>
<thead>
<tr>
<th>Role</th>
<th>Part time/full time</th>
<th>Qualifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <strong>TIGER P.I. and ITPA Project</strong></td>
<td>part</td>
<td>Expertise in directing large Federally-funded R&amp;D projects in the areas of geospatial data management and computational transportation; Director of NSF I/UCRC CAKE and HPDRC, Professor of Computer Science.</td>
</tr>
<tr>
<td>• <strong>TIGER ITPA Project Manager</strong></td>
<td>part/full</td>
<td>Significant experience in project management, team management, design and development technologies, object-oriented design and design patterns (industry professional level).</td>
</tr>
<tr>
<td>• <strong>Team Lead/Architect</strong></td>
<td>part</td>
<td>Significant experience in research management, team management, design and development technologies, object-oriented design and development, design patterns, data structures and complex algorithms (post-doctoral or industry professional level).</td>
</tr>
<tr>
<td>Back-end design/development:</td>
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<td></td>
</tr>
<tr>
<td>• <strong>Senior Software Engineer</strong></td>
<td>full</td>
<td>Significant experience in enterprise application development, database management, object-oriented design and development, knowledge of design patterns, data structures and complex algorithms (industry professional level).</td>
</tr>
<tr>
<td>• <strong>Junior Software Engineer</strong></td>
<td>part/full</td>
<td>Experience in enterprise application development, object-oriented design and development, data structures and standard algorithms (comp. science graduate level).</td>
</tr>
<tr>
<td>• <strong>Assistant Developer</strong></td>
<td>part/full</td>
<td>Knowledge in object-oriented design and development (comp. science student level).</td>
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<tr>
<td>Front-end design/development:</td>
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<td></td>
</tr>
<tr>
<td>Role</td>
<td>Contact</td>
<td>Experience</td>
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<tr>
<td>-------------------------------------------</td>
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<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Senior Smart-phone Application/Website Developer</td>
<td>full</td>
<td>Significant experience in mobile application development, web development, deep knowledge of design patterns (industry professional level).</td>
</tr>
<tr>
<td>Junior Smart-phone Application/Website Developer</td>
<td>part/full</td>
<td>Experience in mobile application development, web development (comp. science graduate level)</td>
</tr>
<tr>
<td>Interaction Designer/Graphic Designer</td>
<td>part</td>
<td>Significant experience and deep knowledge in graphic design for web sites and mobile devices, experience in interaction design for mobile devices and corporate identity creation (industry professional level).</td>
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**Research and Expertise – Public Transit:**

<table>
<thead>
<tr>
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<th>Contact</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Computational Transit Researcher</td>
<td>part</td>
<td>Significant experience and deep knowledge in computational transportation research, especially transportation modeling, simulation and optimization, general computer science, data structures and complex algorithms, academic writing (at least post-doctoral level).</td>
</tr>
<tr>
<td>Computational Transit Researcher</td>
<td>Full</td>
<td>Deep knowledge in transit modeling, simulation and optimization, general computer science, data structures and standard algorithms (at least PhD student level).</td>
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**Research and Expertise – Parking:**

<table>
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<tbody>
<tr>
<td>Researcher</td>
<td>Full</td>
<td>Deep knowledge in parking modeling and management, data science, data structures and standard algorithms (at least PhD student level).</td>
</tr>
</tbody>
</table>
Appendix A:

Background Discussion

UniversityCity Prosperity Project – Informed Traveler Program and Applications Component
1. Introduction

1.1 Background

The UniversityCity Prosperity Project (UniversityCity or project) has been awarded a TIGER Discretionary Grant to address transportation and parking issues facing Florida International University (FIU) and the City of Sweetwater (Sweetwater) based upon a TIGER Discretionary Grant (TIGER/UniversityCity) grant submittal dated June 3, 2013.\(^1\) The TIGER Award Agreement was fully executed by Florida International University (FIU), U.S. Department of Transportation (US DOT), and the Florida Department of Transportation (FDOT) on June 5, 2014\(^2\) and the FDOT issued to FIU a Notice to Proceed on June 20, 2014.\(^3\)

In addition, on May 20, 2014 a Public Interest Finding was accepted by the Federal Highway Administration (FHWA) authorizing Force Account and Sole Source Contracting of IBM and Pirouette Software Consulting as part of the Informed Traveler Program & Application (ITPA) project component\(^4\).

The project will link the Sweetwater and FIU’s Modesto A. Maidique Campus (MMC) through a number of parking, transit, local mobility, and transportation demand management improvements that constitute enhanced pedestrian-oriented transit access infrastructure and intelligent transportation systems (ITS) aimed at improved pedestrian, bicycle, moped, and feeder bus access to express bus services. By this

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\(^1\) See [http://cake.fiu.edu/TIGER2013/drop/Narrative.pdf](http://cake.fiu.edu/TIGER2013/drop/Narrative.pdf).


means, ITPA is expected with infrastructural pedestrian-oriented transit access improvements to increase transit ridership, reduce per capita vehicle miles traveled, shorten trip times and avoid traffic congestion.

The TIGER/UniversityCity grant award encourages the beneficial integration of Sweetwater residents and businesses with a thriving and rapidly expanding FIU community. For this reason, UniversityCity improvements will be a useful response to the rapid growth of FIU, increases in transportation demands, and changing conditions.

By this means, UniversityCity, in the context of being but one of many regionally significant South Florida communities, can develop as a safe, resilient, self-sufficient, healthy, prosperous, just, intelligent and sustainable places that grow an economy to the size of Singapore on a narrow isthmus that is securely connected to the most powerful nation on Earth.

Among the planned improvements, UniversityCity includes a new TIGER funded signature pedestrian-oriented shared-use bridge to span across US 41 (also identified as SW 8th Street) to connect MMC with Sweetwater’s main street at SW 109th Avenue. This will create an attractive and safe pedestrian and bicycle route between two currently disconnected areas (i.e., the nine lanes of busy US 41 traffic creates a real barrier that separates FIU and Sweetwater). Completion of the bridge is expected in December 2017.

This signature pedestrian-oriented shared use bridge will also help to link Sweetwater with FIU express transit stops planned for east of Parking Garage 5 (PG 5/Market Station) and MDT or other transit services north of Parking Garage 6 (PG-6). PG 5 is an existing seven level, mixed use parking garage with classrooms, offices and a food court built into the first and second floors. PG6 is a nearly identical seven level, mixed-use parking garage under construction at MMC. PG6 has been designed so it can serve as a multi-modal station on the north side of campus upon its completion in 2015.
TIGER funds will be used to construct a sheltered bus platform immediate on the northern edge of the PG6. In addition, an express bus stop pavilion will be constructed east of PG5 across SW 108th Avenue using TIGER funds. Over time, it is expected that express bus stops configured with other intermodal and multimodal station improvements will extend along US 41 from PG6 to Parking Garage 4 (PG4/Red Parking Garage) to PG5/Market Station and these transit improvements are collectively referenced as an Advanced Intermodal and Multimodal Station (AIMS).

Pedestrians, bicyclists, community transit passengers, express bus passengers, and those individuals arriving by private vehicles will be provided before and when arriving at AIMS with information that will guide them to effortlessly access various modes of transit to desired destinations remote from UniversityCity as well as to local UniversityCity destinations. As to smart parking areas, when arriving by car or truck, empty parking spaces will be identified and the optimum routing to access that parking spot will be provided along with opportunities to be planned for in the future providing for reserved parking on request. Similar optimized routing information will be provided to bus drivers who are driving buses to or departing from AIMS and station stops. Such travel guidance will be based on the information, expert analysis, and predictive capabilities built into the Informed Traveler Program and Applications (ITPA).

ITPA is the subject of this Work Plan. When it is designed, developed and deployed, ITPA will provide advanced intermodal and multimodal guidance to optimize each trip by reducing travel times and costs through existing and new ITS technologies, communications and software.

The ITPA software is planned to be predictive in nature, allowing users to make better travel decisions when using transit before as well as after ITPA users decide to get into their private or other vehicles. It also offers the potential for faster parking in smart garages as a major time saver. ITPA will work on any smart phone. It will include audio and visual capabilities similar to standard in-vehicle navigation systems,
but ITPA will also use intelligence that considers user needs, situational conditions, safety concerns and a fuller understanding of actual multimodal options.

The first generation ITPA that will help UniversityCity-affiliated subscribers of ITPA to travel to and from UniversityCity faster, easier and more enjoyably with a focus on access to:

- Pedestrian-oriented transportation alternatives (i.e., walking, biking, and use of electric mopeds)
- Community transit providing feeder bus services
- Access to express transit to the Miami Intermodal Center (MIC), Miami International Airport (MIA), and Metrorail’s Palmetto Station
- Smart parking at FIU and Sweetwater.

Once developed and in operation, ITPA will be expanded upon so as to address all traveler needs within the Southeast Florida region; increasing the geographic scope and reach of ITPA and applying its predictive capabilities to greater numbers of available modes of transport.

The north side of campus is a major vehicle entrance due to its proximity to four major regional traffic arteries, US41, SW/NW 107th Avenue, the Homestead Extension of Florida’s Turnpike and SR836 (Dolphin Expressway). The signature pedestrian-oriented shared-use bridge along with community transit, plazas and complete street improvements will turn SW 109th Avenue into the main pedestrian transit corridor between FIU and Sweetwater. This US 41 crossing will also be improved by wide crossing strips and pedestrian activated traffic signals that provide improved at grade walking conditions on both the east and west sides of the SW 109th Avenue intersection with US 41.

Further, UniversityCity and a related FDOT Service Development Grants (SDG) expected to be awarded in 2014 will provide for the increased frequency of community transit crossing US 41 along the SW 109th Avenue corridor should pedestrians and bicyclists want to cross US41 by community transit.
The expected increase in pedestrian, transit and private vehicle traffic underlines the need for a fully operational ITPA aimed at:

- Dispersing traffic to less congested areas
- Encouraging transit ridership and non-motorized traffic modes
- Improving timely access to available parking, and providing informed travelers with useful trip scheduling alternatives.

When fully operational, ITPA will represent a large-scale electronic transportation demand management system that can optimize travel within the Southeast Florida region. By making improvements to the built, natural and electronic environments, UniversityCity will better prepare FIU and Sweetwater to compete in the world marketplace as a prosperous 22nd century community.

The need to develop an ITPA was fully recognized by the TIGER/UniversityCity grant submittal dated June 3, 2013 and the TIGER Award Agreement in the allocation of a significant portion of the funds towards its development. Thus, following the TIGER directive and FHWA regulation, FIU will exploit its existing resources in terms of both available installations and highly relevant expertise towards the cost-effective creation of this ITS system. The TIGER grant announcement mentions that this implementation will be unique and innovative and can serve as a model for other communities around the nation.\(^5\)

Because the development of a first phase of the ITPA was always to be a major component of UniversityCity, this document reports on the development of the work plan of the ITPA system as part of a Miami-Dade Expressway Authority (MDX) task authorization that directed ITPA plan development to begin last February 10, 2014.

1.2 Phase 1 Scope

The TIGER funds allocated for the Phase 1 of the ITPA will used to develop an initial prototype system. This prototype will focus on creating a parking, transit and traffic data acquisition and integration system, along with a user-friendly smartphone application having three primary capabilities:

- Display of real-time parking occupancy;
- Display of real-time transit vehicle locations, routes, and estimated times of arrival;
- Display of real-time travel-related conditions such as traffic congestion, traffic accidents, weather conditions, road construction, and road hazards

The prototype will serve as a platform for development of additional functionalities, such as navigation to available parking, dynamic transit routing based on real-time user demand, and overall decision support for transit and parking management and operations.

The system will be prepared to monitor the real-time position and passenger occupancy of UniversityCity Transit vehicles which will consist of a fleet of 10 community transit, trolley, and CATS vehicles from Sweetwater and FIU identified: i) as a FIU CATS Shuttle vehicle as shown at http://cake.fiu.edu/TIGER2013/drop/post_submittal/201407081300OU_ServiceDevelopmentGrant.UniversityCityCommunityTransit.PostSubmissionRevisions.pdf; and, ii) at least the nine vehicles as identified in the SDG filed with FDOT last June 6, 2014 and awarded as of the September 12, 2014 FDOT notice. See http://cake.fiu.edu/TIGER2013/drop/post_submittal/201407081300OU_ServiceDevelopmentGrant.UniversityCityCommunityTransit.PostSubmissionRevisions.pdf and http://cake.fiu.edu/TIGER2013/).

The system will display this information seamlessly to ITPA users, along with schedules, fares, estimated times of arrival, and other relevant information. It will also display, where available, the real-time position of other buses and trains in the broader Miami area that have stops at or adjacent to the UniversityCity
area. This will raise user awareness of transit options and timely intermodal options so as to facilitate increased usage of the transit system.

The system will be prepared to allow for real-time route and schedule optimization in response to user demand in the FIU and Sweetwater areas by UniversityCity Transit vehicles. This will encourage greater UniversityCity Transit use and use of other transit services linked with the UniversityCity Transit stop and destinations (especially at AIMS) by making the overall system adaptable to changing needs of specific ITPA users to reach their desired destinations from their identified locations.

The system will be prepared for smart transit management to support the efficient and effective operations of UniversityCity Transit vehicles within UniversityCity and as to UniversityCity Transit trips taken to the MIC, MIA and Palmetto Station; suggesting the best route given known and predictable traffic conditions and additional stops to optimize passenger loads. ITPA will acquire valuable data to identify, in the aggregate, user behaviors and usage that define success metrics and guide development of future ITPA development stages.

The system will be prepared for supporting traffic signalization that favors transit vehicles (Transit Signal Priority) and other transit priority improvements to reduce traffic delays within the FIU campus and along US 41 and SW /NW107th Avenue to the Homestead Extension of the Florida Turnpike and Dolphin Expressway.

The total amount allocated to the Phase 1 of ITPA development is $2,368,836 ($2,156,832 from USDOT and $212,004 from FIU). This document reports on all the aspects of the development of phase 1 of the ITPA system developed initially as part of a Miami-Dade Expressway Authority (MDX) task order.
1.3 Goals and Objectives

The goal of this document is to provide a comprehensive plan for the development and implementation of the ITPA system closely following a systems engineering approach. The objectives of this plan are:

- Identification of the existing conditions and needs
- Identification of the functional requirements to meet the needs
- Identification of portions of the regional ITS architecture that need to be implemented to support the functional requirements
- Identification of applicable ITS standards and testing procedures
- Identification of stakeholder agencies roles and responsibilities
- Analysis of alternative system configurations and technology options to meet requirements
- Identification of implementation, procurement, operations, and evaluation plans of the system

2. Existing conditions, Issues and Needs
2.1 Overview

This section presents a review of existing conditions related to the focus areas of this project: smart transit and smart parking. It then discusses issues associated with the existing conditions. The materials presented are based on review of recent studies and documents, review of agency websites, and field observations.

2.2 Existing and Planned FIU Parking

Despite the extensive parking system at the FIU’s MMC, there is a parking shortage and traffic congestion during peak traffic periods. The MMC parking system can accommodate as many as 11,500 cars. About 60% of the parking capacity consists of open parking lots, while the remaining 40% are parking garages. Congestion is caused not by lack of spaces, but by crowd behavioral patterns where drivers tend to cluster on the same spaces. The parking spaces are categorized as administrator, faculty, student, and visitor spaces. Students, administrators, and faculty pay a fee for using parking, while visitor parking areas are metered.

The high demand for parking during peak hours coupled to crowd-behavioral patterns of drivers looking for parking spaces during typical weekdays leave many parking users circulating around looking for open spaces, causing significant congestion and delays. FIU has a growing student population that has surpassed 54,000 students; the vast majority of which, along with over 4200 faculty and staff members, drive their personal vehicles to MMC each day.

To address the parking shortages, FIU has conducted comprehensive analyses of its parking and transportation systems and has produced a campus master plan. 6

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Both structured parking garages and surface parking lots are available at the FIU MMC. There are currently five large parking garages with a sixth garage (PG6) under construction and scheduled to be completed in January 2015. Large surface street parking is primarily located along the northern and western edges of MMC and along the southern perimeter adjacent to Tamiami Park and Miami-Dade Youth Fair and Exposition. Among the existing parking garages, three garages and two open parking lots are of particular interest to the ITPA Phase 1 project due to their proximity to the City of Sweetwater. These garages are PG4, PG5, and PG6 and the two open parking lots in the northern edge of the MMC as shown on Fig. 2.2.1. When PG6 is fully constructed in 2015, it is expected to act as a multi-modal transit hub for express vehicles as well as providing approximately 2000 structured parking spaces. PG4 and PG5 can accommodate 1,441 and 1,950, parking spaces, respectively. Over time, all three parking garages are expected to, with liner buildings, form an AIMS for large scale transit access to and from University City.

The addition of the Public Health, Nursing & Health Sciences buildings (i.e., AHC1, AHC2 and AHC3), construction of the Academic Health Center Building #4 (AHC4), the PG4/Red Parking Garage and the PG5/Market Station Parking Garage are becoming critical to FIU operations as the Academic Health Science Center Master Plan is effectuated7 in the context of the FIU Campus Master Plan.

It should be noted that, due to the limited availability of parking in the new student high-rise buildings in Sweetwater, these students will be parking in the FIU parking garages; presenting FIU with additional challenges given the expected FIU student population growth in Sweetwater. As the downtown Sweetwater mixed-use district grows and additional student housing towers are built, new parking opportunities will need to be located in Sweetwater. In addition to street parking, Sweetwater parking

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7 See [http://facilities.fiu.edu/projects/BT877_StempelComplex_AHSC_MasterPlan_Information.pdf](http://facilities.fiu.edu/projects/BT877_StempelComplex_AHSC_MasterPlan_Information.pdf)
expansions are likely to be planned at the City Hall Intelligent Plaza and Parking Area (CHIPPA). The following figures show the locations and pictures of the major plan components; identifying the parking at FIU most proximate to Sweetwater and associated with UniversityCity transit access improvements.

Figure 2.2.1 - Parking Facilities at FIU

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8 See initial CHIPPA study by Ramon Trias at http://cake.fiu.edu/TIGER2013/drop//CHIPPA_SweetwateFundedStudy-Ramon_Trias.pdf.

Figure 2.2.2 - PG4 (Red Parking Garage)

Figure 2.2.3 - PG5 (Market Station Garage)
Figure 2.2.4 - PG6 (Under Construction)

Figure 2.2.5 - PG4, PG5, PG6 Parking Locations
The ground floor of the PG5/Market Station Parking is used for classrooms, offices, and restaurants, resulting in additional pedestrian activities in the vicinity of the garage and conflicting with the vehicular traffic. In addition, there are high volumes of pedestrian traffic associated with parking and the new buildings in the area, including the academic health center and the chemistry and physics building.

Due to the scarcity of available land for expansion on campus, it will be useful if ITPA could increase the efficiency of using the existing parking garages and lots. It is estimated that the parking capacity utilization is reduced by 10% due to users circulating for parking.

2.3 Sweetwater Parking

There are limited parking opportunities in Sweetwater with only few dedicated parking spaces. Most of the existing parking of cars and trucks occurs at curbs that are not marked for parking. Sweetwater has received recommendations that it should designate areas of the Sweetwater right-of-way for metered parallel parking spaces and is currently considering expanding the dedicated parking spaces available so that it can start charging for such parking using advanced parking fee system.

By this means, the additional metered street parking could start generating revenues need to help finance CHIPPA development. CHIPPA design and feasibility is expected to be examined as part of the UniversityCity Sub-Area Mobility Study (UniversityCity SAMS) efforts that will be undertaken in 2015 using federal funds available through FDOT and local match funds supplied by Sweetwater and FIU.

Given the rapidly growing population of FIU students residing in Sweetwater, is will be useful to both maximize the number of available street and structured parking spaces in Sweetwater and to develop a guidance system for Sweetwater visitors and FIU students to find available parking.
2.4  **FIU, Sweetwater, and MDT Transit Systems**

The transportation segment of the Department of Parking and Transportation at FIU is managed and monitored by a Transportation Coordinator who oversees the Golden Panther Express (GPE), CATS Shuttle, Panther Mover, and Panther Safety Tram. Sweetwater provides Circulator/Trolley services. The GPE is operated by Academy Bus Company (Academy) through a transportation contract signed by the University and the carrier. Miami-Dade Transit (MDT) also provides service within the University City area including an FIU Bus Terminal for several Metrobus routes at SW 107th/108th Avenue.

The transit services in the FIU/Sweetwater area include:

- GPE
- FIU CATS Shuttle
- MDT Transit Buses
- Sweetwater Circulator/Trolley
- FIU Panther Movers
- FIU Panther Safety Tram

The GPE buses are motor coaches that provide transportation between MMC and the FIU Biscayne Bay Campus (BBC) during weekdays. There is a $2.50 fee (one-way trip) for the service. The drivers use a ticketless system, which allows a student FIU One Card to be automatically deducted. One problem is that the equipment utilized to scan the cards frequently malfunctions. There are two 61-passenger buses and two 55-passenger buses which are wheelchair equipped. Two of the buses are of the 2007 MCI D model and the other two are of the 2005 VanHool model with restrooms. These buses are contracted through Academy; a private sector transit provider. The GPE is monitored by a dispatch crew hired and paid by Academy to oversee their operation. They use telephones for communication between drivers and dispatchers.
In the future, the four charter buses are expected to be replaced with new buses. The next two figures show the GPE buses and their routes. The next table shows the schedule. As the primary route has recurrent congestion, the GPE operators seek alternative routes during the congested hours of the day. Examples of these routes are taking the Turnpike through the Golden Glades Interchange. Another route is taking the Palmetto Expressway to the Golden Glades Interchange. Currently, there are no ITS equipment such as automatic vehicle location (AVL) systems or Automatic Passenger Counters (APC) on these buses.

![FIU GPE coach bus](image)

**Figure 2.4.1 - FIU GPE coach bus**

**Table 2.4.1 - FIU GPE 2013/2014 Schedule**

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<th>Depart MMC</th>
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* Service not available Friday evenings and during semester breaks

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**Figure 2.4.2 - GPE primary (Blue) and alternate routes (Red)**

The **FIU CATS Shuttle** is a free service that transports students and faculty between the Engineering Campus (EC) and MMC. There are a total of six buses. There are two 25-passenger buses (Blue and Gold
Buses) in full operation and four buses that are used for support and events. Three of the buses were purchased in 2012. The funding for these buses comes from the operational budget for the Department of Parking and Transportation at FIU. There is a Passio GPS tracking system on two CATS buses. The FIU Division of Parking and Transportation is planning to install Wi-Fi and a more advanced GPS tracking systems on the CATS buses.

The drivers for the CATS shuttle or the events shuttles also use their telephones as the main method to communicate between managers and drivers. Currently, FIU Parking and Transportation does not have any documentation for work rules for the CATS drivers. The following tables and figures show the CATS Shuttle and routes.

<table>
<thead>
<tr>
<th>FIU Number</th>
<th>Year</th>
<th>Make</th>
<th>Engine Type</th>
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<td>5010</td>
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<td>Ford E350, Diesel 6.0 Liter</td>
<td>10 Passengers w/disable Lift</td>
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<td>5011</td>
<td>2007</td>
<td>Ford E350, Diesel 6.0 Liter</td>
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<td>5012</td>
<td>2010</td>
<td>Ford E350-Diesel 6.0 Liter</td>
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<td>2012</td>
<td>Ford E350-Gas 5.4 Liter</td>
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<td>5015</td>
<td>2012</td>
<td>Ford E350, Gas 5.4 Liter</td>
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<tr>
<td>5016</td>
<td>2012</td>
<td>Ford E350, Gas 5.4 Liter</td>
<td>25 Passenger without Lift</td>
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Figure 2.4.3 - FIU CATS Shuttle
Figure 2.4.4 - FIU CATS Shuttle
### Table 2.4.3 - CATS Schedule

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*Service not available during semester breaks*

The next tables show the CATS ridership for the fiscal years 2012 through 2014. Currently, no ridership information is provided for the 4th quarter of fiscal years 2013 through 2014.
Table 2.4.4 - Fiscal Year 2012-2013 CATS Ridership

<table>
<thead>
<tr>
<th>Fiscal Year 2012-2013 CATS Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Quarter</td>
</tr>
<tr>
<td>2nd Quarter</td>
</tr>
<tr>
<td>3rd Quarter</td>
</tr>
<tr>
<td>4th Quarter</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 2.4.5 - Fiscal Year 2013-2014 CATS Ridership

<table>
<thead>
<tr>
<th>Fiscal Year 2013-2014 CATS Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Quarter</td>
</tr>
<tr>
<td>2nd Quarter</td>
</tr>
<tr>
<td>3rd Quarter</td>
</tr>
<tr>
<td>4th Quarter</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Miami-Dade Transit (MDT) also offers transit service in the vicinity of FIU and Sweetwater. The map below shows the current MDT bus routes in the UniversityCity area, as well as the current GPE bus route in the same area inclusive of the MDT Route 212 (Sweetwater Circulator). For further details on MDT bus schedules and regional routes see the MDT Metrobus website at: http://www.miamidade.gov/transit/metrobus

us.asp and the 212 Sweetwater Circulator at http://www.miamidade.gov/transit/routes
detail.asp?route=212

Figure 2.4.5 - MDT & GPE Routes
The Sweetwater Circulator/Trolley buses are managed by the Sweetwater. The Circulator buses run in the morning and the Trolleys run in the afternoon and have a 21-person to 32-person capacity (depending on the vehicle used). The Trolleys are vintage-style, ADA accessible, and air-conditioned with a 32-person capacity. The following figure shows the Sweetwater Trolley. The trolley and circulator bus service are free and open to the public and run from 8:00 am to 7:00 p.m. Monday through Friday and from 8:30 am to 5:30 p.m. Saturday and Sunday. The trolley service does not run on Thanksgiving and Christmas days and runs from 8:30 am to 5:30 pm on other legal holidays.

Figure 2.4.6 - Sweetwater Trolley
Sweetwater is considering outsourcing this service to a private company in the future and has begun a dialogue with FIU and the Citizen’s Independent Transportation Trust (CITT) regarding the creation of a
University City transportation management association (TMA) to operate both the FIU CATS and Sweetwater Circulator/Trolley services.

The next table shows the Sweetwater Trolley/Circulator schedule.

**Table 2.4.6 - Sweetwater Trolley/Minibus Schedule**

<table>
<thead>
<tr>
<th>Transit Routes (last updated January 2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1701 NW 110 Ave - City of Sweetwater Maintenance and transit Dept.</td>
</tr>
<tr>
<td>1701 NW 112th Avenue - Sweetwater Code Enforcement and Building and Zoning</td>
</tr>
<tr>
<td>11401 NW 12th St - DOLPHIN MALL</td>
</tr>
<tr>
<td>Entry #8 Trio</td>
</tr>
<tr>
<td>Entry #7 Bloomdales' - The Outlet Store</td>
</tr>
<tr>
<td>Burlington Coat Factory</td>
</tr>
<tr>
<td>Entry #5 Dolphin Mall</td>
</tr>
<tr>
<td>Marshall / Home Goods</td>
</tr>
<tr>
<td>Entry #4 - Sacks Fifth Avenue Outlet.</td>
</tr>
<tr>
<td>ROSS</td>
</tr>
<tr>
<td>Main Entrance Texas Brazil and Cheesecake Factory</td>
</tr>
<tr>
<td>Entry #2 - Old Navy.</td>
</tr>
<tr>
<td>Bass Pro Shop.</td>
</tr>
<tr>
<td>DOLPHIN MALL Miami-Dade Main Bus Stop</td>
</tr>
<tr>
<td>1801 NW 117th Avenue – IKEA</td>
</tr>
<tr>
<td>11698 NW 25th St - US Postal Service</td>
</tr>
<tr>
<td>11411 NW 25th St - Our Lady of Mercy Catholic Cemetery</td>
</tr>
<tr>
<td>10730 NW 25th St La Covacha</td>
</tr>
<tr>
<td>2390 NW 107th Avenue – Midas</td>
</tr>
<tr>
<td>1890 NW 107th Avenue - BP gas station/ MD bus stop</td>
</tr>
<tr>
<td>1500 NW 107th Avenue - County Federal Credit Union</td>
</tr>
<tr>
<td>1414 NW 107th Avenue - MD bus stop</td>
</tr>
<tr>
<td>1390 NW 107th Avenue - MD bus stop</td>
</tr>
<tr>
<td>500 NW 107th Avenue - MD bus stop</td>
</tr>
<tr>
<td>318 NW 107th Avenue - MD bus stop</td>
</tr>
<tr>
<td>200 NW 107th Avenue - MD bus stop</td>
</tr>
<tr>
<td>10701 NW W. Flagler - Mobil / Food Star</td>
</tr>
<tr>
<td>10910 W. Flagler - My Pueblo Restaurant</td>
</tr>
<tr>
<td>10983 SW 4th Street - MD bus stop</td>
</tr>
<tr>
<td>110th Avenue SW 5th St - MD bus stop</td>
</tr>
<tr>
<td>500 SW 109th Avenue - City of Sweetwater</td>
</tr>
<tr>
<td>City Hall, POLICE Department and MD Clerk of Courts</td>
</tr>
<tr>
<td>512 SW 109th Avenue - City of Sweetwater Passport Office</td>
</tr>
<tr>
<td>7th SW 110th Avenue - Stop sign</td>
</tr>
<tr>
<td>7th Tr SW 110th Avenue - Stop sign</td>
</tr>
<tr>
<td>Location</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>7th Tr SW 113th and 114th Avenue</td>
</tr>
<tr>
<td>11495 W. Flagler - Social Security / Robles / Villa Hermosa</td>
</tr>
<tr>
<td>117th Avenue SW 1st St – Corner</td>
</tr>
<tr>
<td>11490 SW 2nd St - MD bus stop</td>
</tr>
<tr>
<td>4th Tr NW 110th Avenue</td>
</tr>
<tr>
<td>7th NW 113th Avenue</td>
</tr>
<tr>
<td>606 NW 112th Avenue - MD bus Stop</td>
</tr>
<tr>
<td>112th Avenue NW 2nd Tr - MD bus stop</td>
</tr>
<tr>
<td>11200 W. Flagler - Tower Plaza / MD bus stop</td>
</tr>
<tr>
<td>7th Tr SW 113th and 114th Avenue</td>
</tr>
<tr>
<td>115th SW 2nd Street - Stop sign</td>
</tr>
<tr>
<td>11388 W. Flagler - MD bus stop</td>
</tr>
<tr>
<td>11180 W. Flagler - MD bus stop</td>
</tr>
<tr>
<td>10780 SW Flagler Madrono Restaurant</td>
</tr>
<tr>
<td>50 SW 108th Avenue - MD bus stop</td>
</tr>
<tr>
<td>10500 SW W. Flagler – MacDonald</td>
</tr>
<tr>
<td>10198 W. Flagler - Sunoco Gas Station / MD Bus stop</td>
</tr>
<tr>
<td>99ct W. Flagler - MD bus stop</td>
</tr>
<tr>
<td><strong>9825 W. Flagler - Ruben Dario Park</strong></td>
</tr>
<tr>
<td>99ct W. Flagler - MD bus stop</td>
</tr>
<tr>
<td>102nd Avenue SW 4th St. - Stop sign</td>
</tr>
<tr>
<td>300 SW 107th Ave - Continental National Bank of Miami</td>
</tr>
<tr>
<td>10899 SW 4th St - MD bus stop</td>
</tr>
</tbody>
</table>

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The Panther Mover, shown in the next figure, is a free program at FIU that shuttles students and faculty/staff from the Panther Parking Garage to Primera Casa (PC) with stops along the way. These motorized cart shuttle vehicles fits seven 7 passengers. The shuttle runs on weekdays from 8:00 am through 7:00 pm during the fall and spring semesters.
The Panther Safety Tram Program provides escorts around campus at the MMC and BBC campuses each evening. Students, faculty and staff wanting an escort simply can call the Visitor Information Center and specify which campus and where the escort is requested. The following figure shows the Panther Safety Tram. On the MMC campus, the shuttle runs on Monday through Thursday from 7:00 pm through 1:00 am during the fall and spring semesters and Monday through Friday from 7:00 pm through 11:00 pm during the summer semester.

![Figure 2.4.9 - Panther Safety Program](image)

There are also plans using TIGER UniversityCity grant funds for FIU to rebuild, repair and enhance a small hybrid-electric rubber tire trolley and repair a circulator bus owned by Sweetwater that is currently used as a backup vehicle. The following figures show the small hybrid rubber tire trolley and one of the
Sweetwater back-up vehicles. Upon the award of the pending FDOT Service Development grant, these repairs and enhancements will be extended to 9 vehicles.\(^\text{10}\)

The small rubber-tire electric trolley would operate on traffic-calmed streets as well as mixed-mode corridors and transit greenways in MMC and elsewhere. Designed for speeds of 25 mph and less it is a worthy alternative to golf cart vehicles for use in pedestrian oriented public space. This vehicle is sized between the shuttle vehicles and golf carts and can work within pedestrian oriented built environments. It is expected that when enhanced it will include solar power collection and use with its on-board battery array. All vehicles will be smarter through easy access by drivers and passengers to ITPA information, greener though changes to fuels used and other improvements, and more operationally reliable through various mechanical repairs.

2.5 Other Existing Related ITS Components

This section discusses other related existing ITS technologies that affect the project. All limited access facilities in Miami-Dade County are managed utilizing advanced traffic and incident management systems implemented by FDOT District 6, MDX, and Florida Turnpike Enterprise. These systems include detectors installed at 0.3 to 0.5 miles apart and closed circuit television cameras.

The HPDRC and FIU-CAKE centers, as mentioned in Chapter 1, conduct research in joint academia-industry and academia-government projects on advanced database management systems, advanced geo-spatial and moving objects analytics, advanced analytics tools and software, big data mining, parallel processing and development of front-end platforms allowing high traffic database queries. These centers are therefore a cost-effective existing platform on which to develop and manage the front-end for ITPA and the back-end analytics-intensive ITPA modules. As stated in Chapter 6, these centers will be responsible for developing the smart parking solution, community transit optimization modules, and the front-end applications.
The HPDRC has developed an NSF sponsored geo-referenced platform, TerraFly\(^{11}\), which has achieved significant attention from both the public and private sectors. ITPA will leverage the existing platforms to include ITPA features such as real-time and predicted traffic and parking information and real-time and predictive bus tracking and route information. It will also display real-time and predictive scheduling and bus route optimization. This document will hereinafter refer to both the HPDRC and FIU-CAKE centers as simply “FIU-CAKE”.

The IITS has exchanged data and video from various facilities in Southeast Florida. The IITS center has developed data analytics and modeling tools to analyze archived and real-time transportation system data to support transportation agency decisions. These existing tools have been developed under a number of contracts with FDOT in the past few years and are currently being further developed and integrated under an on-going contract to meet Transportation System Management and Operation needs in Florida. These tools have been developed to support multi-facility, multi-mode transportation management support, including the prediction of system performance under different performance regimes and different recurrent congestion, weather, incident, and construction conditions.

The traffic signals in Miami-Dade County, including those in the vicinity of the FIU campus and on the route of GPE and the route most typically to be used for Express transit between University City and MIC, MIA and Palmetto Station are controlled by the Miami-Dade County Public Work traffic operation center. Currently, these signals are coordinated semi-actuated signals, but it is planned to replace the signals on SW 8\(^{th}\) Street from the Florida Turnpike to SW 74\(^{st}\) Avenue with a state-of-the-art adaptive signal control system, as a pilot advanced signal control system in Miami-Dade County.

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\(^{11}\) See [http://www.terrafly.com/](http://www.terrafly.com/)
In addition, the Miami-Dade County is currently updating its central software to allow it to implement a central transit signal priority (TSP) system based on shared information with transit agencies, with a set of rules on both the transit agency and the signal agency sides. It is expected that the update of the central software of the Miami-Dade County signal control system will be done by the end of 2014 and a pilot transit signal priority system is implemented to test the benefits of the system. This implementation will be of direct interest to the ITPA project, particularly in relation to the GPE and University City Transit services.

There are currently three traffic-light signals in the FIU main campus, two of them located in the vicinity of PG5. There are plans to install at least two other signals in MMC. The FIU signals are currently run unconnected to a central location and the signal timing parameters are not optimized for different times of day and traffic conditions, causing significant delay and congestion during peak hours. There is a need to optimize these signals to improve the traffic and transit mobility without affecting pedestrian safety.

2.6 Issues and Needs

With FIU commitment to providing accessible high quality educational experiences to its students, the number of enrolled students has recently surpassed 54,000 and is rapidly increasing. This has resulted in several transportation issues including traffic congestion, parking shortages, delays, and traffic safety issues. Sweetwater is also facing peak hour congested conditions and parking availability problems due to limited metered parking and the absence of structure parking. Conditions will worsen when SW/NW 107th Avenue construction begins in 2016/2017. The project team identified a number of issues and needs in FIU and Sweetwater that are related to the ITPA as shown below.

- Heavy traffic within the MMC campus for periods of the day and significant conflicts between vehicles and pedestrians affect the traffic operations in the campus. In the vicinity of PG4, PG5,
and PG6, pedestrian movements have increased significantly due to the new buildings in this part of the campus and the classrooms, food court and mixed-use space in PG5. The vehicular and pedestrian traffic is expected to increase due to the new high-rise student building north of US 41 on SW 109th Avenue (109 Tower). This building has limited parking spaces given the expectation that the FIU students living there will be parking in FIU garages. This situation will impact MMC traffic and pedestrian, bicycle and community transit movements across US 41 at the intersection with US 41. One additional student oriented building has already broken ground at SW 109th Avenue and SW 4th Street and two more such structures are expected to seek permits for construction next year.

- Limited parking availability and accessibility and lack of information to FIU students, faculty, staff and visitors regarding parking availability results in significant search for parking spaces and unnecessary traffic circulation in the MMC.

- There are very limited dedicated parking spaces in Sweetwater with many of the vehicles utilizing informal curb parking at the city streets; a problem which will worsen as the number of students living in Sweetwater grows.

- There are limited alternative transportation options and there is a need to improve transit services, bus stops and safe, comfortable, useful and interesting pedestrian-oriented environments adjacent such transit stops (i.e., well design urban plazas, public spaces, and adjacent mixed use buildings) to attract more students and residents to use the transit and walking and bicycle options instead of driving their cars and trucks.
• High FIU student housing demand has resulted in new high-rise constructed in Sweetwater across US 41 from MMC. If not addressed correctly, this will introduce additional congestion, parking, and safety issues.

• FIU students, faculty, staff and the associated visitors and Sweetwater residents and business customers are currently provided with limited information regarding transit and parking availability and dynamically changing operations and conditions related to these services.

• Transportation agencies at FIU and Sweetwater currently have limited technologies to plan, operate, and manage their parking and transit assets.

• There is a need for a better integration between the transit services provided by FIU and Sweetwater (i.e., UniversityCity Transit, Metrobus, and various proposed express bus services).

• There is a need for an integrated transit and parking services to allow transit riders to efficiently park their cars and ride transit buses.

• There is a need for additional efficient and fast transit services to destinations in Miami-Dade County for use by FIU students, faculty, staff and visitors and Sweetwater residents and business customers and to coordinate community transit and Metrobus to provide feeder bus service.

• The existing and planned signals at the FIU campus need to be optimized to reduce the delays to vehicular traffic and increase transit efficiency, while maintaining pedestrian safety.

• There is a need to reduce the trip time of the FIU GPE buses and UniversityCity Transit through a combination of avoiding congested routes and reducing passenger-waiting time; this can also be a strategy deployed by MDT when the results are identified through UniversityCity deployments.
3. Functional Requirements

3.1 ITPA Requirements

This chapter presents functional requirements based on the review of the existing conditions and related issues and needs, as identified in Chapter 2. The functional requirements are statements of the capabilities that the ITPA system must support, geared at addressing the needs that the system is intended to satisfy. Note that functional requirements are written without specifying implementation details. The implementation details are addressed in Chapter 6. The following acronyms are used here in order to facilitate association with the TIGER grant application narrative and with technical acronyms used in industry:

- UniversityCity Advanced Public Transit System (UCAPTS). This is described as “Smart Transit” elsewhere in this document.
- UniversityCity Parking Information System (UCPIS). This is described as “Smart Parking” elsewhere in this document.
- Dynamic Message Signs (DMS)

The identified functional requirements mapped to the related needs and issues are shown in Table 3.1.1.

<table>
<thead>
<tr>
<th>Functional Requirement</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.0 ITPA shall provide University City Advanced Public Transportation Systems (UCAPTS)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>1.1 UCAPTS shall track the transit vehicles using accurate and reliable GPS system.</strong></td>
<td></td>
</tr>
<tr>
<td>1.1.1 Tracking system shall send operational and location data every 30 seconds, at a minimum, to one or more central locations.</td>
<td></td>
</tr>
<tr>
<td>1.1.2 UCAPTS shall allow bus driver to report special events.</td>
<td></td>
</tr>
<tr>
<td>1.1.3 UCAPTS shall report schedule adherence.</td>
<td></td>
</tr>
</tbody>
</table>
1.1.4 UCAPTS shall store schedule data such a route, block, run, trip, time, direction, etc. and vehicle and operator information in central locations.

1.1.5 UCAPTS shall have playback functionality.

1.2 **Passenger Counting System shall collect Boarding and Alighting data on the vehicles.**

1.2.1 The Passenger Counting shall have on-board Automatic passenger counting equipment to record the number of passengers boarding and alighting through each door at each stop. Said equipment may be video cameras with server-based passenger count in video streams.

1.2.2 UCAPTS shall include door sensors or video monitoring to detect Passenger boarding and alighting.

1.2.3 UCAPTS shall calculate passenger loads on-board.

1.2.4 UCAPTS shall collect dwell time information at bus stops.

1.2.5 UCAPTS shall include door sensors or video analytics in the bus to record opening and closing of doors.

1.2.6 UCAPTS shall be able to report passenger loads in real time.

1.3 **The UCAPTS shall provide real-time and static schedule and travel information to travelers.**

1.3.1 UCAPTS shall broadcast transit schedule and traveler information to smartphones.

1.3.2 UCAPTS shall broadcast information to handheld devices.

1.3.3 UCAPTS shall broadcast information utilizing DMS at transit stops and critical locations in Sweetwater and FIU.

1.3.4 UCAPTS shall use bus schedule adherence, location data, and traffic data to develop real-time predictions for bus arrival times at stops and to provide these predicted arrival times to the public using a smartphone application and dynamic message signs at selected stops.

1.3.5 UCAPTS shall broadcast next bus departure time at each station.

1.3.6 UCAPTS shall broadcast messages for service disruptions, detours, or infrequent conditions.

1.3.7 Travelers shall be able to request specific information and recommendations on their trips by using smart phone apps and by accessing a website.

1.3.8 Smart phone apps shall be able to provide scheduled information for a particular route.

1.3.9 Smart phone apps shall be able to send trip-specific alerts to travelers to notify them of bus delays due to events and updates the estimated departure times.

1.3.10 Smart phone apps shall detect user location and display nearest stops and next bus arrivals.

1.3.11 UCAPTS shall provide information of transfer locations, available modes, and schedules.

1.3.12 Non student users of the UCPS shall register with the FIU administrative system.

1.3.13 Smart phone apps shall give FIU students, faculty, staff and visitors and Sweetwater residents and businesses with the opportunity to request transfer by giving start and target locations and start time of a trip.

1.4 **UCAPTS shall provide management support**

1.4.1 UCAPTS shall be managed by a University City TMA’s Transit and Parking Management Center using technology.

1.4.2 UCAPTS shall provide bidirectional voice and text communications between management and operators.

1.4.3 UCAPTS shall include maps and vehicles in real-time color coded based on their schedule adherence (early, late, or on-time) or vehicles off route.

1.4.4 UCAPTS shall allow display vehicle #, operator ID and name, and route #.

1.4.5 UCAPTS shall support the dynamic routing and scheduling of the buses based on information including time of day, traffic conditions, incident characteristics, construction, weather formation, and real-time and predicted demand. In the case of the Sweetwater bus fleet which serves a low-density population, the routing will be responsive to real-time demand from the users themselves, collected through a user-friendly mobile and web-based platform.

1.4.6 UCAPTS shall be able to update its routing and passenger trip recommendations based on real-time and historical Automatic Vehicle Location (AVL) system data from the buses.

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1.4.8 UCAPTS shall have TSP at critical intersections at FIU and the vicinity of FIU main campus.

1.4.9 UCAPTS shall enhance traffic and pedestrian flow and safety by improving traffic signals in the FIU main campus and its vicinity.

1.4.10 UCAPTS shall be able to collect transfer requests, and to decide on optimum community bus routes and schedules to fulfill those requests as much as feasible.

2.0 ITPA shall provide for Parking Information and Management

2.1 The ITPA shall provide the Parking Information System (UCPIS).

2.1.1 UCPIS shall include smartphone apps that display the number of vacant lots at different parking garages and parking lots (color coded) in real time in FIU and Sweetwater.

2.1.2 UCPIS smartphone apps shall suggest best parking locations, based on particular destinations at FIU and Sweetwater and be able to navigate to available parking based on historical and real-time knowledge of parking occupancy.

2.1.3 DMS and smartphone apps at FIU parking garages shall provide information on available slots per parking garage.

2.1.4 DMS and smartphone apps at FIU parking garages shall provide information on overall available slots per level.

2.1.5 UCPIS shall detect vehicles arriving and leaving the garages.

2.1.6 UCPIS shall display real-time traffic information along major regional traffic arteries.

2.1.7 UCPIS shall allow customization to integrate parking information with other ITPA systems.

2.1.8 Information provided by UCPIS shall provide finding space reliability of 95% or better.

2.2 UCPIS shall support FIU and Sweetwater in providing information to allow better planning and operation of their systems.

2.2.1 Parking garages at FIU shall be managed by FIU Parking and Transportation Department.

2.2.2 The University City Transit and Parking Management Center shall have data archiving and analysis capabilities based on data collected from UCPIS and shall share it with other ITPA modules.

3.0 The ITPA shall meet other requirements as outlined in this section:

3.1.1 The UCAPTS system shall allow for a single logon to all bus technologies.

3.1.2 ADA regulations need to be considered in the ITPA plan, design, deployment, use, and management.

3.1.3 ITPA shall allow its customers to provide feedback through the website or by using a smartphone.

FIU P&T wishes to use $160k out of the TIGER match budget to provide camera-based data acquisition modules for FIU’s parking garages and parking lots. P&T will co-operate with NuPark or a similar provider, which will make available to the ITPA software a stream of real-time data on parking availability. P&T is also installing TransLoc technology for its transit vehicles and ITPA will be designed and installed so as to be interoperative or otherwise compatible with such technology or establish a system improvement thereof.
4. Project ITS Architecture, Standards, and Stakeholders

4.1 Project Relationship to the Regional Architecture

A system engineering approach identifies the portions of the regional architecture to be implemented as part of the project. The ITS architecture defines the systems, their functional operation, and the information exchanges that must take place between these systems to accomplish transportation services. The architecture is not technology-specific, allowing the architecture to remain effective with further advancements in technology.

A review of the national ITS architecture and the Southeast Florida regional architecture was conducted to identify how the ITPA fits in the regional architecture, the new subsystems and architecture flows that need to be added and the service packages that need to be modified or added. Table 4.1.1 shows how the selected service packages are mapped to the functional requirements identified in Chapter 3. Section 4.2 shows graphical representations of the service packages.
Table 4.1.1 - ITPA Functional Requirements Mapped to the Needs

<table>
<thead>
<tr>
<th>Functional Requirement</th>
<th>Service Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 UniversityCity Advanced Public Transit System (UCAPTS) as operated by UniversityCity TMA shall track the transit vehicles using accurate and reliable GPS system.</td>
<td>APTS1 - Transit Vehicle Tracking</td>
</tr>
<tr>
<td>1.2 Passenger Counting System shall collect Boarding and Alighting data.</td>
<td>APTS10 Transit Passenger Counting</td>
</tr>
<tr>
<td>1.3 The UCAPTS shall provide real-time and static schedule and travel information to ITPA customers and travelers.</td>
<td>ATIS01 Broadcast Traveler Information ATIS02 Interactive Traveler Information APTS09 Transit Traveler Information ATIS07 Travel Services Information and Reservation</td>
</tr>
<tr>
<td>1.4 UCAPTS shall provide management support for the Phase 1 transit vehicles.</td>
<td>APTS02 Transit Fixed-Route Operations APTS07 Multi-modal Coordination AD1-ITS Data Mart</td>
</tr>
<tr>
<td>1.5 The UCAPTS shall provide for transit security.</td>
<td>APTS05 Transit Security</td>
</tr>
<tr>
<td>2.1 The IPTA shall provide UniversityCity Parking Information System (UCPIS).</td>
<td>ATMS 16: Parking Facility Management ATIS1 Broadcast Traveler Information ATIS2 Interactive Traveler Information ATIS07 Traveler Services Information and Reservation</td>
</tr>
<tr>
<td>2.2 UCPIS shall support FIU and Sweetwater in providing information to ITPA users so as to allow better planning and operation of the parking and UniversityCity Transit systems.</td>
<td>ATMS 16: Parking Facility Management APTS07 Multi-modal Coordination AD1-ITS Data Mart</td>
</tr>
<tr>
<td>Transit priority and signal improvements</td>
<td>ATMS03 Surface Street Control APTS09 Transit Signal Priority</td>
</tr>
</tbody>
</table>

4.2 Selected Service Packages

This section presents graphical representations of the selected service packages from the regional architecture, as described in the previous section. These service packages were modified to include new entities (subsystems and terminators) and architecture flows to support the ITPA deployment.
Figure 4.2.1 - ISP Based Route Guidance

APTS1 - Transit Vehicle Tracking
FIU and Sweetwater

Information Service Provider

Miami-Dade Transit
Customer Information Services
+ SFRTA Consumer Information Network

Transit Management
Miami-Dade Transit Metrobus System

Transit Management
Miami-Dade Transit Metrobuses

Transit Management
Miami-Dade Transit Metromover System

Transit Management
Miami-Dade Transit Metromover Vehicles

Transit Management
FIU/Sweetwater Transit System
FIU ITS Center
FIU CAKE

Transit Vehicle Subsystem
Miami-Dade Transit Metrobuses

Transit Vehicle Subsystem
Miami-Dade Transit Metromover Vehicles

Transit Vehicle Subsystem
FIU/Sweetwater Transit Vehicles

LEGEND
planned and future flow
existing flow
user defined flow

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Figure 4.2.2 - Transit Vehicle Tracking

APTS2 - Transit Fixed-Route Operations
FIU and Sweetwater

Figure 4.2.3 - Transit Fixed-Route Operations
Figure 4.2.5 - Multi-modal Coordination
Figure 4.2.6 - Transit Traveler Information
Figure 4.2.7 - Transit Passenger Counting
Figure 4.2.8 - Broadcast Traveler Information
Figure 4.2.9 - Interactive Traveler Information
Figure 4.2.10 - Travel Services Information and Reservation
Figure 4.2.11 - Surface Street Control
4.3 Project Stakeholders

An important aspect of the developed plan is to identify stakeholder agencies and their roles and responsibilities. Based on the identified portions of the national and regional ITS architecture identified in the previous section, the following is a list of the identified project stakeholders and their roles and responsibilities.

**FDOT District 6**: The FDOT District 6 manages the state roads in Miami-Dade County including critical corridors to the ITPA implementation. The GPE, FIU shuttles, and Sweetwater buses use a number of state roads and related local roadways as parts of their primary routes or alternative routes including US 41, the Homestead Extension of the Florida Turnpike, SR 836, I-95, SR 826, SW/NW 107th Avenue, and NW 12th Street. Coordination with FDOT District 6 is needed to facilitate the use of I-95 express lanes and I-595 express lanes and the use of proposed I-75, SR 826 and Turnpike express lanes by GPE and other transit providing express services to University City. In addition, FDOT District 6 will be a source of traffic and event data that will be used to support the ITPA implementation.

**Miami-Dade Expressway (MDX)**: The GPE and other express transit will use SR 836 and eventually other MDX facilities as part of its primary route. MDX will provide traffic and event data for use in support the ITPA implementation. In addition, coordination with MDX will be necessary to allow the use of hard shoulders by buses on SR 836 and other MDX facilities.

**Florida Turnpike Enterprise (FTE)**: The GPE and other express transit will use the Turnpike segment between US 41 and the Golden Glades Interchange, as part of an alternative route in case of congestion conditions on their primary path. FTE will provide traffic and event data for use in support the ITPA implementation.
**City of Sweetwater:** Sweetwater manages a number of local roads used by FIU shuttles. In addition, it manages the buses and parking of the City. These are important elements to be supported by the ITPA and the project will coordinate closely with Sweetwater in various stages of the project and to accommodate expanded Sweetwater parking and UniversityCity Transit services.

**Miami-Dade County Public Work Department (MDPWD):** MDPWD is responsible for managing all signals in Miami-Dade County including those in the vicinity of the FIU campuses. Coordination regarding signal control and sharing of traffic and event information will be needed to optimize signal control in the vicinity of FIU and inside of FIU and to provide signal timing priority for GPE buses.

**FIU Department of Parking and Transportation (FIU DPT):** FIU DPT is responsible for managing FIU buses, parking facilities, and traffic signals; which represent major components addressed by University City. Thus, various efforts of the project will have to be coordinated with the FIU DPT especially in the creation of the UniversityCity TMA.

**FIU Police Department:** Coordination with FIU police departments is needed in case of security and safety events. In addition, FIU police is currently responsible to control the FIU intersections during various special events and overall safe conditions across MMC interior roadways.

**Sweetwater Police Department:** As with FIU police departments, coordination with Sweetwater police is needed in case of special events and in case of security and safety events.

**Miami-Dade Transit (MDT):** Coordination with MDT is required to obtain Metrorail and Metrobus information to utilize the ITPA system. In addition, the GPE services with stops at intermediate point will need to be coordinated with future MDT express buses from FIU to the MIC, MIA, and/or elsewhere. It is currently anticipated that UniversityCity Transit service will connect the FIU campus with the MIC, MIA
and MIA Metrorail Station. Thus, coordination with the MDT management will be necessary regarding the express bus stops at the MIC.

South Florida Regional Transit Authority (SFRTA): SFRTA operates a commuter rail service (Tri-Rail) that connects Miami-Dade, Broward, and Palm Beach Counties. Coordination with SFRTA is needed to obtain the arrival information at the MIC.

Miami Intermodal Center (MIC): It is currently anticipated that an UniversityCity Transit service will connect the FIU campus with the MIC. Thus, coordination with the MIC management will be necessary regarding the bus stops at the MIC.

Miami International Airport (MIA): It is currently anticipated that UniversityCity Transit service will connect the FIU campus with the MIA. Thus, coordination with the MIA management will be necessary regarding the bus stops at the MIA.

Transit Service Providers: FIU is currently outsourcing its GPE service to a private transit service provider (Academy). In addition, FIU and Sweetwater are discussing how they might combine the operation of their CATS and Circulator/Trolley services via a UniversityCity TMA. Coordination will be necessary with these service providers regarding the existing and planned services and the technologies needed to support the ITPA.

FIU Administration: FIU administration is a major stakeholder in the produced system. Their requirements and associated constraints should be identified and used in system development and implementations.

FIU Special Event Coordinators: These include entities that coordinate sport games, graduation ceremonies, orientations, and other large events and ITPA ought to examine how such events affect the traffic and parking on campus and how the effects can be mitigated.
Florida Division of Emergency Management/ US Department of Homeland Security: This coordination will be necessary in case of natural or man-made regional emergencies and the use of ITPA to provide large scale guidance related to evacuations.

4.4 ITS Standards

Implementing ITS standards increases compatibility and interoperability of the implementations. The following ITS standards were identified as applicable to the project.

The following table shows the identified the applicable ITS standards.
Table 4.4.1 - Applicable ITS Standards

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<thead>
<tr>
<th>Application Area</th>
<th>Standard</th>
<th>Development Status</th>
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<tbody>
<tr>
<td>Transit Management</td>
<td>APTA TCIP-S-001 3.0.0 Standard for Transit Communications Interface Profiles</td>
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<td></td>
<td>NTCIP 1102 Octet Encoding Rules (OER) Base Protocol</td>
<td>Published</td>
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<td></td>
<td>NTCIP 1104 Center-to-Center Naming Convention Specification</td>
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<td></td>
<td>NTCIP 2104 Ethernet Subnetwork Profile</td>
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<td>NTCIP 2202 Internet (TCP/IP and UDP/IP) Transport Profile</td>
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<td>NTCIP 2304 Application Profile for DATEX-ASN (AP-DATEX)</td>
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<td></td>
<td>NTCIP 2306 Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML)</td>
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<td>SAE J2354 Message Set for Advanced Traveler Information System (ATIS)</td>
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<td>SAE J2540/2 ITIS (International Traveler Information Systems) Phrase Lists</td>
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<td>SAE J2540/3 National Names Phrase List</td>
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<td>SAE J2540 Messages for Handling Strings and Look-Up Tables in ATIS Standards</td>
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5. Alternative Analysis

5.1 Introduction

This section presents an alternative analysis of the systems and solutions available to meet each of the ITPA functional requirements identified in Chapter 3. Potential alternative solutions that support the service packages listed in Chapter 4 are discussed here. Following a study of the available market providers for the different solutions needed in this project, a set of smart-transit and smart-parking service and product vendors has been selected which provides a good representative survey of the available commercial products, their costs, and their applicability to the current project.

5.2 Advanced Public Transportation Systems (APTS) Technologies

This section presents a review of transit solutions considered to achieve the functional requirements outlined in Chapter 3 as related to smart transit. These include advanced integrated transit solution providers, CAD/AVL, APCs, as well as real-time traveler information systems.

5.2.1 Integrated APTS Solutions Providers

A number of vendors are available in the market provide integrated APTS hardware and software solutions. The services provided by these vendors are geared for transit fleets ranging from few vehicles to several hundred vehicles. This section presents a review of the four vendors considered, which together cover an extensive survey of available commercial solutions, their applicability to this project, and their...
implementation and maintenance costs. Among the vendors considered, Transloc is an example of those that provide solutions to agencies with small fleets; Syncromatics and Avail are examples of vendors that provide solutions of small to medium fleets; and Clever Devices is an example of vendors that provide solutions of larger fleets.

**Syncromatics**

Syncromatics has been providing cloud-hosted, turn-key ITS since 2006. They currently have 30+ clients, including the University of South Florida, the University of Miami, City of Key West, the National Institute of Health, and their largest client - the City of Los Angeles. The fleet sizes of these clients range from 5 to 350 buses. The company provides the following solution components: cloud hosting, transit dispatch, real-Time tracking, transit reporting, automated passenger counting, and transit schedule performance.

Syncromatic products integrate with other technologies through Open API’s. They provide CAD/AVL, APCs and real-time arrival prediction based on GPS and cellular data with six second refresh rates. The Syncromatics solution uses off-the-shelf hardware for provisioning buses with on-board devices. A web application tool provides administrative access to reports and dispatching and vehicle tracking tools. Mobile applications provide information to users. Updates for all software are included in the service contract. Facilities for trip planning and reservation systems are currently not in their product offerings. In addition, Syncromatics provides a web ticketing process for support which is included in the solution pricing.

**Avail**

Avail has been providing transit technology solutions since 1999. They currently have 90+ clients, 45 using fully integrated CAD technology. Florida clients include the transit agencies in Collier County, Lakeland, Ocala, and West Palm Beach. Avail provides hosting via servers at their facilities in Pennsylvania or can support client on premise environments using Windstream.
Avail solutions are not proprietary and employ industry standard open system architecture and interoperability between products and 3rd party vendors. They provide pro-active route scheduling and notifications to bus drivers. Avail provides a large selection of technologies and solutions to build custom transit solutions. They analyze data with Data Point, their data analytics tool. Refresh rates of the AVL system can be performed as often as 1-5 seconds, but 30 seconds is normally used.

Clever Devices
Clever Devices has provided innovative technology solutions for all modes of public transportation since 1988. They are mostly in large markets, but also provide solutions for smaller applications like a recent implementation of Lynx in Orlando with a fleet size of 23 buses. Clever Devices provide a wide selection of core offerings including signage, turn warning system, onboard computer with diagnostics, real time prediction called BusTime, Back Office which analyses bus driver behavior patterns, and Smart Yard technology which tracks vehicles on property using RFID technology. Clever Devices also offers Intelligence Reporting Solution to monitor web based reports.

TransLoc
TransLoc was founded in 2004, and provides user focused transit solutions for all modes of transportation. They currently have many clients focusing on University environments including Duke University, Miami-Dade County, and the Santa Clara Transit Authority.

TransLoc utilize onboard tablets as on-board devices. Cellular technology is used to transmit data from buses and there are no limits on data transmission. Their information processing system is web based. Transloc provides fleet management through the web as well as via driver input through the onboard tablet. TransLoc provides hosting, offers informative transit reports, and provides Open API's for data access. Riders can access transit route information including real time arrival predictions through their smartphones. TransLoc relies on rider to mobile devices and as a result does not sell dynamic message
signs. TransLoc assumes that all vehicles have radios for communication to the driver. Equipment needed for the bus includes a tablet and charger. The tablet can be used to count passengers manually rather than using automatic passenger counters that are not normally used with the system but can be added, if so desired.

5.2.2 Real-Time Transit Information

Real-Time Transit Information systems provide passenger information services that can be accessible through different channels such as the internet, cellular and tablets, display boards, and kiosks. Since real-time transit information is a main focus of ITPA, this section provides discussion of existing systems that provide transit information. Below are some examples of real-time information systems.

*Bus Tracker* is powered by Clever Devices and uses GPS devices to report bus location data in real time. The system displays buses on a map and estimates when they will arrive at stops.
Figure 5.2.1 - CTABUSTRACKER

A transit information system has been in Key West based on the Syncromatic product. The system provides a live bus map and arrival times at stops.
**Syncromatics** also provides services to the University of South Florida (USF) Bull Runner in Tampa Florida. USF runs one of the busiest university transit operations in the country with a fleet size of 37 buses. The system includes real-time information, automated passenger counting, and voice annunciators. The figures below shows the USF BullTracker Live Map and USF BullTracker Arrival Times.
Transloc provides advanced real-time maps and arrival predictions available on a variety of platforms. The University of Arizona, Yale, and University of North Florida (UNF) use this application. The figures below show the UNF and Yale applications.
Figure 5.2.6 - TransLoc Application in UNF

Figure 5.2.7 - TransLoc Application for Yale Real-Time Shuttle
**NextBus** is a vendor that provides cloud-based solution for real-time passenger information systems to over 135 transit agencies and organizations. NextBus uses GPS technology and a proprietary algorithm that incorporates historical travel data to track vehicles and predict vehicle arrival time. By taking into account the actual position of the buses, their intended stops, and typical traffic patterns, NextBus can estimate vehicle arrivals with a high degree of accuracy. This estimate is refreshed constantly to provide riders with up-to-the-minute information. A user can also send a text to receive arrival information and subscribe to receive messages pertinent to a route. The figure below shows San Francisco application of NextBus.

![NextBus Application](image)

**Figure 5.2.8 – NextBus**
**Transit App** is an example of mobile applications available in the market to provide transit information. It is available for download using iOS or Android systems. Transit App lets a user see all nearby departures, with real-time predictions where available and download schedules and access them while offline. Transit App is also an open data application. The next figure shows various screens of Transit App.

![Nearby Mode, Route Maps, Trip Planner](image)

**Figure 5.2.9 - Transit App**

Most of the apps mentioned before use the Google Maps API system. In addition, Google has its own transit trip planner, as shown in the figure below.
5.2.3 Trip Planners

A Trip Planner is another component of advanced transit systems. A multimodal trip planner is a tool to help users navigate a city/community by providing biking, riding, walking, and transit options by simply entering the start and destination points. Real-time information systems are services that access transit information through different channels such as the internet, cellular and tablets, display boards, and kiosks. The growing popularity of mobile devices, that enables quick and personalized traveler information, is changing the public’s expectations for how transportation agencies communicate with customers and deliver services. Travelers who are able to access real-time data on traffic congestion, transit schedules, or transit arrivals can make more informed decisions and adjust their travel plans “on the fly”. There are a couple of multimodal trip planners and real-time passenger information services/tools a person can choose from to get to their final destination.

OpenTripPlanner is an open source multi-modal trip planner, which runs on Linux, Windows, or potentially any platform with a Java virtual machine. OTP provides a range of passenger information and

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transportation network analysis features using infrastructure for finding itineraries combining transit, pedestrian, bike, and car segments. USF is currently using OpenTripPlanner, developed as part of a research project. The figure below shows the OpenTripPlanner.

**Figure 5.2.11 - OpenTripPlanner**

**TriMet’s Map Trip Planner** is fully open-source/open-data trip planner by a U.S. transit agency. The application was developed in collaboration with OpenPlans, a New York-based nonprofit, and a team of developers around the world. The new trip planner uses all open-source technologies, including OpenTripPlanner for multimodal routing. Because it uses open-source software and open data, TriMet's Map Trip Planner is less expensive to develop and the technology can be used by other agencies worldwide. It is already deployed in 10 countries. The Map Trip Planner also has the capacity to become a regional trip planner.

TriMet's new Map Trip Planner as shown below. It makes it easy to plan trips that combine transit and biking. Explore and print an interactive map of your route, see an elevation chart and get detailed (biking, walking, bus, transit) directions all in one place.
**Goroo** is a multi-modal trip planner for Chicago and its metropolitan region. It was developed by the Regional Transportation Authority (RTA) and utilizes the services of the Chicago Transit Authority (CTA), Metra, and Pace. Goroo is a powerful online map and trip planner tool that provides its users with directions using a combination of bus or train routes, driving, biking, and walking directions. With the Goroo trip planner the user can also view travel itineraries, public transit schedules, maps, alternative routes, area attractions, travel alerts as well as suggested ways to reduce the carbon footprint of your trip.

The RTA Trip Planner, which uses Goroo, as shown in figure below, allows travelers to plan trips in the Chicago region using public transit (CTA, Metra, and Pace buses and trains) and it includes driving, biking, and walking directions.
Better Directions. Better Trip Planner.
The RTA Trip Planner allows travelers to plan trips in the Chicago region using public transit (CTA, Metra, and Pace buses and trains) that include driving, biking, and walking directions.

From:
e.g. 123 N Main St, State & Adams, Navy Pier
From City: [optional]

To:
e.g. 123 N Main St, State & Adams, Navy Pier
To City: [optional]

Your Recent Locations

I want to Leave Arrive on 04/22/14

I prefer accessible services: Yes No

Transportation Mode Preferences
Train Bus Driving Drive to Transit Bicycling Walking

Show Advanced Options Clear Form

take me there!

OneBusAway is in use by a growing number of transit agencies such as in Atlanta, Puget Sound, Tampa, and New York City. OneBusAway is another open-source software that provides real-time transit information for their riders. OneBusAway requires GTFS-format schedule data, and real-time arrival data from the vehicles. The figure below shows OneBusAway.
5.3 Parking Technologies

This section presents a review of parking solutions needed to implement the functional requirements outlined in Chapter 3. The solutions include sensor-based parking space availability system, crowd sourcing based space availability system, parking reservation system, parking DMS, and traveler information systems components such as mobile apps and websites.

5.4.1 Sensor-Based Parking Space Availability

As stated in the functional requirements, the identification parking spaces will likely require the installation of sensor-based system to determine parking availability at PG5 and other FIU parking locations. The FIU DPT has selected a license plate system to support the validation, enforcement, and payment of parking at MMC. The FIU DPT has already a comprehensive and detailed vision and plan to
install these license plate readers. Thus, the sensor-based parking space availability will be installed to be compatible with the FIU planned systems. License plate readers of the same type procured by the FIU PTD will be installed at the entrances to the PG5 and other parking garages. These devices will allow the identification of the types (i.e., administrators, faculty, students, and visitors) of the parking garage users that are entering the facility. Additional detectors will be installed at pass-through points and the exit points to complement the license plate readers, allowing the determination of space availability at each parking level (see the implementation plan in Chapter 6).

A number of non-intrusive and intrusive detection technologies are available. Examples of utilized intrusive detectors in parking applications include loop detectors and magnetometer. Examples of non-intrusive technologies include infrared, microwave radar devices, video image-based detectors, and ultrasound detectors. Non-intrusive detection technologies are preferred to detect vehicles at pass-through points and exit points of FIU parking garages because of the less maintenance requirements and the ease of installation in these parking garages. When these devices are procured, they must be demonstrated to provide accurate and reliable counts in the FIU garage environment. One issue with some of the technologies is that they may detect pedestrians walking through the detection zone affecting the accuracy of space availability determination. This is a consideration when selecting the detector type and mounting of these detectors.

The cost of the sensor-based system is estimated at $105,000 per garage. This cost includes one license plate reader per garage entrance, non-intrusive sensors for entry & exit lanes and pass-through points, and other hardware and software, installation costs, and electricity costs.
5.4.2 Crowd-Sourcing Parking Space Availability

The sensor-based solution at PG5 as mentioned above lack in two aspects. First, it covers only a small fraction of the parking garages and lots at FIU and Sweetwater. Second, the availability of parking spaces when communicated to travelers may not be accurate, since the parking spaces may be filled by the time that drivers reach these locations. To address these issues, the ITPA will include a probabilistic and crowdsourcing solution provided by Pirouette Software that provides the following features:

1. **Parking detection** that does not depend on sensors by analyzing smartphone movement and other crowd-sourced information

2. **Statistical analysis** to complement parking detection in building parking occupancy profile

3. **Navigation assistant** to highest probability of finding parking using a mathematically proven gravitational approach which is improves upon the common but rudimentary “shortest distance” approach

An application provided by Pirouette Software would detect parking events in FIU/Sweetwater, whenever a user has the app running on his/her phone and communicate the event to the server.

Pirouette Software Inc. is a company founded in 1995 by Professor Ouri Wolfson. The company specializes in Mobile Peer-to-Peer software for local search. An NSF grant was used to develop and productize the crowd sourcing parking solution.

This smart-parking product uses crowd-sourcing based on smart-phones to study street parking availability and navigate a driver to an available parking slot. It consists of an innovative Intelligent Parking Assistant (IPA), a software application that runs on smart phones and car navigation systems, and guides a driver to a parking slot, similarly to a Car Navigation System (CNS) that guides at driver to a destination.

*Page 91*
The IPA consists of two subsystems, a Parking Detector (PD) and a Parking Navigator (PN). PD automatically estimates the average number of parking slots for a given area. It uses a novel method that builds a historical profile of parking availability on each city block, and combines it with real-time information from smartphones. In contrast, existing solutions that detect parking availability either use specialized expensive sensors, or require manual input. PN guides the driver through a path where she is most likely to compete effectively for parking. PN uses a novel Gravity-based Parking Algorithm, developed using game-theory to address the competitive aspect. The proposed product accomplishes a parking time reduction of roughly 30%.

This solution has the cost-effective advantage that it relies solely on crowd-sourcing from smartphones to build the parking probability profile and navigate users to available parking. Thus, the data acquisition and monitoring systems are automatically provided by the users themselves rather than by the service provider, in this case the UniversityCity TMA who would be managing the use of ITPA for smart parking and smart transit applications.

The crowdsourcing solution is estimated at a license cost of $100,000. Significant development and adaptation will be conducted by the project team and technical experts to make this solution work in the FIU and Sweetwater areas. Additional analytical layers are envisioned to enhance this application. A combined budget for the license and development of this solution is provided in Chapter 6.

5.4.3 Parking Space Reservation

A Premium Parking Reservation System (PPRS) will not be a part of the ITPA project in Phase 1, but is envisioned for Phase 2. A description of this plan and an alternate analysis is provided here to assist further future development of ITPA. In Phase 2, some parking spaces in PG 4 (the Red Garage) or elsewhere will be equipped with detectors along with notification display for each parking space. The display will indicate
that the space is reserved by displaying either the name of the subscriber for whom the space is reserved or a reservation number. As soon as the space is reserved by the ITPA, the electronic display will begin to display the reservation information to indicate to others not to use the space. The mobile application would then tell the ITPA user where the parking spot is located. The optical camera based license plate detection system would detect when the appropriate ITPA user parks in the reserved space. If a different vehicle enters the space, the system will display warning sign about illegal parking and notify FIU Parking Management to have the car ticketed and towed immediately. Pricing for the reserved parking spaces may vary depending on peak availability, demand elasticity, and whether the user is making a transit connection. If demand for reserved parking by ITPA users regularly exceeds the number of premium reservation spaces at FIU, the number of premium spaces will be expanded in future. It is anticipated that should the UniversityCity TMA develop a positive cash flow from smart transit and smart parking operations, that it might choose to launch PPRS sooner than when Phase 2 funding is available.

Two types of systems are considered for identification space availability:

- Optical camera based license plate detection that provides the vehicle presence and identification of parked vehicles in each space. This system is estimated to cost about $50,000 for 34 spaces. This system will utilize the existing FIU communication network. An example of an optical camera system and its software for detecting license plates is the system provided by Amano McGann, Inc. This company was recommended to FIU project development team by TransCore which developed the electronics system for SunPass. Also, Amano McGann, Inc. installed optical camera based license plate detection system at a West coast mall in Santa Monica, CA, a shopping plaza in Chicago, and several locations in Europe.
Streetline’s parking surface mount magnetometer sensor with a wireless mesh network. It is estimated that it will cost $250 per space to install and $18 per month to operate. For a total cost of $30,000 for three years of operations. However, Streetline sensors will not provide the vehicle identification that is necessary for this application.

In addition to the above costs, a central parking reservation system would need to be developed to meet the requirement of the ITPA project. This development is estimated to cost $110,000 in the first two years for development and $34,000 for the third year for operation. As already stated, this system is envisioned for future phases of ITPA given the limited scope of Phase 1.
5.4.4 Parking Management Support Software

An example of existing parking management software is the ParkSight software provided as part of the StreetLine parking solutions, mentioned elsewhere in this chapter. ParkSight provides analytics charts, graphs, and reports that communicate easy-to-understand parking patterns and statistics. Reports are based on key metrics to make decisions including average length of stay, enforcement actions, occupancy, parking sessions, potential violations, and turnover by time of day. However, this system only acquires and uses data from the StreetLine space availability detectors. Because of the various sources of the ITPA parking information, it is recommended that new central software be developed for use in supporting the parking management decisions. This software development is estimated to be $50,000.

5.4.5 Parking Dynamic Message Signs

An LED Dynamic Message Sign will be installed at the two entrances of PG5. LED technology is the most widely used and proven DMS technology. The parking availability estimated by the central software will be downloaded the DMS. The DMS will be able to display the number of spaces available by type and garage level and customized messages by the operator. It is estimated that the cost for the two LED signs is $60,000.

5.4.6 Parking Information Systems

There are a number of vendors that provide mobile applications and web services to disseminate parking availability information to travelers. This section presents a review of these vendors and their products.

Streetline was founded in 2005 and is a leading provider of smart parking solutions to cities, garages, airports, and universities. They currently have 45+ clients with cities being their prime deployments. The City of Los Angeles is their largest parking solution deployment with 8,500 sensored parking spaces. They
also have smaller deployments like Clemson University with 400-500 sensored visitor parking spaces. The Streetline Smart Parking Platform includes platform software that provides parking guidance, parking analytics, API access to data, information access through smartphones and web, and mobile payments. Below are some of the modules offered by StreetLine:

- **Parker** – This module is compatible with smartphones, tablets and in-car navigation systems and the apps are available on the App Store and Google Play. It provides a voice-based navigation and offers minute by minute parking availability. The system has been used by more than 30 cities and universities in the US and the UK, providing access to information for over 24,000 parking lots and garages. It enables users to find open parking spots based on user preferences. It gives instant access to location (on which side of the street), prices, payment options and hours of operations. Once the user selects a street with available spots or garages on the map, the user will get turn-by-turn voice navigation. The built-in timer reminds of meter expiration. The Walk-to-Car provides directions back to your car.

![Parker Modules](image)

**Figure 5.3.3 - Parker**

- **ParkSight** – As mentioned previously, StreetLine also offers ParkSight. This is a cloud-based, software-as-a-service application that allows customers to access real-time and historical parking
data through analytics platform. It provides vital information to parking administrators including occupancy, turnover and length of stay. With a sophisticated analytics, it provides a highly robust reporting capabilities including 19 standard reports and customized reporting. It supports the implementation of new initiatives such as demand-based pricing models.

- ParkerData - This module assists consumers to find their desired parking at the best price with the minimum amount of unnecessary driving factors. ParkerData is a tool to reach sustainable transportation objectives through saving time and money, reducing traffic congestion and gas emission. It also enables users to understand demand and supply patterns, and adjust their preferences to optimize occupancy.

Figure 5.3.4 - ParkerData
**ParkMe** is provided by ParkMe Inc. The system is accessible from in-car navigation systems. They also offer a website, online widgets, iPhone, iPod touch, iPad, and Android. Their apps are available on the App Store and Google Play. ParkMe includes more than 30,000 worldwide locations, 1800 cities, 40 countries and 7 continents. The system has a live map of available street parking in selected cities. It also calculates estimated costs based on location, type of vehicle and park duration before the user arrives. It compares calculated rates for the available parking facilities and presents real-time info on exact number of spots available in a particular garage or lot. Further, it allows reserving a parking spot at certain lots or garages, and shows expected cost before arrival. The system can set a parking timer to avoid additional charges, waste of time and getting a ticket and it provides navigation that directs the users to the nearest driveway.

![Figure 5.3.5 - ParkMe](image)

The **BestParking** application is compatible with iPhone, iPad, iPod touch, Android and BlackBerry and is available on the App Store and Google Play. This system considers a trade-offs between cost and time of travel and pricing variations (e.g. early-bird, evening, holiday specials and extra overnight charges). The system can be used to finds available parking lots and garages in 105 North American cities and 115 airports. It offers guaranteed rates, reservations, coupons, monthly specials and exclusive deals directly to the site’s users. It provides over 600,000 motorists with hourly, daily, weekly and monthly rates of over 11,000 parking facilities. Motorists can search for parking by neighborhood, address, cross street or cross street...
attraction. It provides detailed information including: address, phone numbers, capacity, valet/park and lock/self-park, indoor/outdoor, clearance height, electric vehicle charging and SUV/Minivan/Van/Truck regulations.

Figure 5.3.6 - BestParking

Parking Mate is provided by Wilson Parking. The system is compatible with iPhone, iPad, and iPod touch and it is available on the App Store. It has a graphical interface that includes parking alerts, while is limited to parking reminders and has no live searching. Parking Mate has Access to more than 200 car parks in and around Australia’s major cities. It browses for available parking lots based on operating hours, surrounding attractions or special rates. It sets a meter timer to avoid tickets and towing result from expired meters and other parking restrictions. The system can add locations with street sweeping rules to show the safest and closest place to park. It saves a note, photo or GPS marker to remind you where you left your vehicle. It uses the share button to send any of details including meter timers and street restrictions to other drivers.
The SFPark App is provided by San Francisco Municipal Transportation Agency (SFMTA). It is available on SFpark.org, App Store, Google play (Rated 3+ and is free) and the region’s 511 phone system. It provides availability and rates for streets and city-owned garages. The App is open source and manages 20 public garages across the San Francisco. The system includes an advanced parking management system including new meters, sensors and demand-responsive pricing. Its goals are to create easier parking, faster public transit, safer bicyclists and pedestrians and better businesses neighborhoods.
ParkingPanda is an open source system provided by Parking Panda Corp. It is compatible with iPhone, iPad and iPod touch and their apps are available on the App Store and Google play. It includes 1,300,000 parking spaces at over 12000 parking garages, lots and private spaces in 73 cities. It provides a real-time info about available parking lots and allows for parking reservations. It ensures a guaranteed spot with even renting someone’s driveway, and provides exclusive discounts. It handles safely transactions through the app and provides instant confirmation to show garage attendants on the way.
5.4 Signal Control Improvements and Transit Signal Priority Alternatives

As stated earlier, there are currently three signals in the FIU main campus. There are plans to install at least two other signals. The FIU signals are currently run unconnected to a central location and the signal timing parameters are not optimized for different times of day and traffic conditions. In addition, some signals are on the FIU bus primary and alternative routes. Furthermore, there are a number of signals on NW 107th Avenue and NW 8th Street that are managed by Miami-Dade County and are on the routes of the FIU buses. Staff from Lehman Center for Transportation Research will work with Miami-Dade County Public Work and FIU DPT to optimize the signals and implement TSP.

According to the requirements, the ITPA system will have TSP at critical intersections at FIU and the vicinity of FIU main campus. Miami-Dade County is currently updating their central software to allow it to implement a TSP based on shared information with transit agencies, with a set of rules on both the transit agency and the signal agency sides. The Lehman Center for Transportation Research will work with Miami-Dade Public Work and FIU DPT to implement a signal priority system for GPE and UniversityCity Transit on Miami-Dade County signals and to optimize the timings of FIU signals.
Central-type TSP operation on FIU signals will require the connection of FIU signals to a central solution similar to that of the County. At the current stage, the County is not ready to connect these signals to their systems because they do not meet the standards. Bringing these signals to standards may be costly. Another alternative is to connect the signals to a central location at FIU LCTR, FIU DPT, and the UniversityCity TMA. This option would require:

1. Central Servers and Workstation Hardware, including SQL license (Note 1)
2. Central Communications Hardware
3. Central Software License (to be provided by Miami-Dade County consultant)
4. Central System Integration, Training, and Support (to be provided by Miami-Dade County consultant)
5. Intersection Controller Firmware Upgrade Cost (5 intersections)
6. Intersection Communications Interface, Controller IP Cards (for 5 intersections)
7. Initial Intersection Installation/Integration (for 5 intersections)
8. Ongoing Integration Support (5 intersections to central) (to be provided by Miami-Dade County consultant)
9. Signal Timing Conversion (for 5 intersections)

Items 3, 4, and 8 would be provided by a Miami-Dade County consultant at at the likely cost of $75,000, to be confirmed. Items 1, 2, and 6 would be procured by FIU Parking and Transportation Division at a cost of about $15,000, to be confirmed. Items 5 and 7 could be performed by LCTR faculty at a cost not to exceed $25,000. Discussion will continue with Miami-Dade County and FIU PTD regarding this solution.
and these costs are not added to the ITPA budget, since the TSP on MMC signals may be Phase 2 implementation. This may be another project for the UniversityCity TMA to undertake with available positive cash flow.

5.5 ITPA Team Evaluation and Recommendations

Bus ITPA equipment and tracking software. In Phase 1 of the UniversityCity ITPA project, the APTS implementation for FIU buses described in Chapter 2 will be funded and procured through FIU procurement procedures in conjunction with FIU’s DPT. However, the UniversityCity Transit vehicles will be equipped with APTS devices utilizing the TIGER/UniversityCity and FDOT SDG funds to support smart transit applications. The ITPA team will be an active advisor on choosing a vendor and will guarantee that the vendor will provide a solution that can be integrated with the broader ITPA system. APTS implementation for UniversityCity Transit vehicles is envisioned to be procured through a SDG from FDOT following FDOT procurement procedures. Given the limited number of initial UniversityCity Transit vehicles, a solution from a company specialized in small fleets is more cost effective. The ITPA team recommends purchasing the solution from Transloc or Syncromatics, which specialize in limited fleets and are therefore more cost effective. The review of these two companies presented earlier reveals that the Syncromatics solution is more complete in meeting the functional requirements, provides a more robust solution, and supports future phases of ITPA. It is also realized that purchasing an off-the-shelf solution from one of these two companies is more cost effective than developing a solution.

Smart transit smartphone application. The ITPA will also require a smart phone traveler information application that integrates different layers of smart parking and smart transit information, including parking navigation requests and community transit requests. The app as described in detail in Chapter 6 does not exist in the market to the best of the ITPA team’s knowledge. As such, it is recommended that
such application is developed by a dedicated FIU-CAKE hub, leveraging data warehousing and front-end development experience and infrastructure.

**Smart parking application.** The vendor survey shows that there exist commercial products for tracking and displaying to users different types of parking information. The commercially available products, however, do not meet the functional requirements of this project, which require the integration of parking information systems with transit information in an integrated, single smart application environment. For this reason, it is recommended a new mobile and web based environment be developed using the expertise and existing infrastructure of FIU CAKE, leveraging a common architecture development for the smart transit and smart parking components. A detailed estimated budget for development and associated implementation plan are provided in Chapter 6.

**Crowd sourcing solution.** Given the limited budget for phase 1 of this project, a sensor-based solution covering all single-parking spaces in FIU is not viable. The ITPA team recommends that the crowd-source solution be implemented instead as a cost-effective, breakthrough solution of great potential benefit for the FIU and Sweetwater communities. The necessary software development and customization will be carried out by FIU-CAKE technical experts as described in Chapter 6, where a detailed implementation plan and estimated budget are provided.

**Transit and Traffic Management.** After a careful survey of the industry providers, including integrated, large-scale solutions provided by world-class companies such as IBM or Cisco, the ITPA team has found it more cost-effective to exploit existing resources at FIU to develop the Smart Transit and Smart Parking solutions needed for ITPA. Although the creation of a central future ITPA control center is envisioned, the ITPA team considers it significantly more cost-effective to develop a multi-modal system through close cooperation of different specialized centers and faculty at FIU and Sweetwater, working in unison to create a single integrated system with a novel and seamless trip awareness service to ITPA users. A
detailed description of the roles of each of the centers and the implementation plan for each module, along with the estimated budgets is provided in Chapter 6. In what follows is a detailed description of some of the resources available at FIU, provided in support of sole-source procurement of FIU resources for this project.

Further, it is expected that the UniversityCity TMA, in coordination with FIU and Sweetwater, will want to seek to secure a IOT software license and support from IBM in order arrange for an examination of its capabilities when compared to ITPA functionalities with the intent to integrate these products for optimum results, use IOT as a back-up to ITPA or use IOT as a related program serving unmet UniversityCity TMA, FIU and Sweetwater needs.

**Description of existing FIU resources**

**FIU-CAKE** was established to develop long-term partnerships among industry, academe and government. FIU-CAKE, in conjunction with the High Performance Database Research Centre (HPDRC), have developed an advanced geo-spatial database for tracking and recording geo-spatial data, including moving and static objects, and providing a plethora of sophisticated analytic capabilities for both research and the public. This high-performance architecture and the expertise at this center will serve to build much of the intelligence required for the first phase of ITPA. ITPA will evolve under a database analysis and user-end development hub of FIU-CAKE. In particular, this hub will collect data from different sources, including real-time vehicle position transit data, real-time traffic data provided by the IITS Lab (see below) and real-time transit and parking data from FIU DPT and Sweetwater. This hub will use the collected data to create an environment for users to seamlessly navigate their trip options and to guide users to available parking and convenient transit routes. It will also support the management of transit and parking by the, to be
formed, UniversityCity TMA. The development of the Smart Transit and Smart Parking modules of ITPA will occur as described in the implementation plan detailed in Chapter 6.

**Lehman Center for Transportation Research (LCTR) IITS.** The IITS Laboratory at FIU Lehman Center has extensive expertise in traffic and transit system management and operations. Faculty at LCTR will carry out transit and traffic management support functions and will support the UniversityCity TMA, FIU DPT, FIU-CAKE and other ITPA modules with relevant traffic and transit information, including traffic event and congestion information. The IITS Lab is already equipped with a video wall, the statewide ITS SunGuide software and data and traffic analysis software, as well as servers and operator workstations which make it ideal for carrying out some of the real-time management, operations, monitoring and predictive functionalities required by ITPA. LCTR faculty has developed a number of tools to accomplish these functionalities, as part of projects in collaboration with FDOT and USDOT. **ITSDCAP** is a tool that has been developed for performance measurements and decision support of transportation systems based on archived data from multiple sources. ITSDCAP real-time component, referred to as **IRISDS**, has been developed for real-time of data sharing and decision support. These tools have been integrated for use to support the FDOT Transportation System Management and Operations and have been used in national, state, and regional projects. The tools currently fuse and analyze data from a number of freeway and signal control agencies in Southeast Florida and will include data from other agencies for the purpose of this project. The integrated ITSDCAP/IRISDS will be the platform to support transit and traffic management and for some of the data analytics required for the project. It will also continue to be a powerful platform for use by transportation agencies in the region. The tool will exchange data with external sources and other ITPA modules, such as UniversityCity TMA and FIU-CAKE, where additional analytics will be carried out using the data produced by these tools in order to provide the desired service to ITPA users. These tools will reside in the IITS Lab and will be further developed and maintained by LCTR experts.
6. Implementation Plan

6.1 ITPA system description

This chapter presents an implementation plan of the ITPA based on the project needs, existing conditions, project architecture, alternative analysis, and scope of service described in the previous sections. Figure 6.1.1 shows the overall project architecture that will result from the implementation of the ITPA system. The figure identifies the ITS architecture that includes the following main components:

- Parking management support. This includes data warehousing and analysis of data from parking and transit operations by UniversityCity TMA, FIU DPT and Sweetwater. This intelligent parking management also includes parking guidance modules developed and maintained by the team and based on sensor and crowd-sourcing information.

- A traffic and transit management support module developed and supported by the Lehman Center for Transportation Research (LCTR) and residing in the FIU IITS lab. This component will provide travel time prediction, transit advisories, signal optimization, TSP, and other traffic and transit management support for UniversityCity TMA.

- A smart-transit module consisting of on-demand schedule and route optimization for a fleet of community transit limited-distance vehicles in the UniversityCity area. The team will develop this module for UniversityCity TMA.

- Mobile application units and web services to disseminate information through UniversityCity TMA to ITPA travelers that are supported by FIU and IBM technology.
Data warehousing and analysis of data from transit operations by UniversityCity TMA, FIU DPT and Sweetwater.

Real time mapping and multi-object visualization of the movement of the plurality of local and county-wide transit for UniversityCity TMA

- Redeployment of pre-existing traffic and transit management support module for regional express buses such as the GPE and UniversityCity Transit vehicles going from MMC to the MIC, MIA or Palmetto Station. This module will provide real-time and predictive traffic awareness such as estimated current and future traffic congestion and estimated trip durations along certain routes, signal optimization within FIU, and route recommendations to FIU DPT. This module will be provided by IITS faculty in support of FIU DPT operational management. The traffic and transit information generated by this module, including current and future traffic conditions along major freeways related to UniversityCity, will be used to support the user interface.

- **User interface (smartphone app and webpage)**
  
  An app to be developed and implemented in close coordination with UniversityCity TMA, FIU DPT, Sweetwater, and LCTR faculty. The app creates a user-friendly, comprehensive awareness of real-time positions of transit vehicles at the local and regional level, transit options at the local and regional level, parking occupancy around the UniversityCity area, and current and predicted traffic congestion along major freeways. These features combined in a single, seamless environment create a new experience and an informed awareness of trip options for users, therefore increasing multi-modal trip planning and inter-modal change.
The app features two advanced and unique functionalities: parking navigation and on-demand community vehicle schedule and route optimization. Parking navigation will be accomplished using the crowd-sourcing off-the-shelf solution described in the previous chapter; this solution will be adapted to the UniversityCity environment via effort of the present ITPA project. Real-time transit routes will be displayed on applications to both ITPA users and vehicle drivers.

This chapter provides a description of the implementation plans for each of these components, including equipment, human resources, timeline and estimated costs. As the main components are not de-coupled but rather share features, as in the case of crowd-sourcing parking and responsive community-bus routing. Individual descriptions are given but a common budget and implementation plan is provided in the section describing the front-end, which is the convergence point of all ITPA sub-modules.

ITPA system will be highly consistent with the regional ITS architecture and is designed to accomplish the project goals and functional requirements in a cost-effective way. The ITPA team envisions a future “ITPA operations center” operated by UniversityCity TMA to manage and maintain many of the facets of this complex system. In Phase 1 of the project, however, the ITPA team deems it more cost effective (see Chapter 5) to exploit the existing labs and human resources at FIU for development and initial deployment of the system, resulting in the various entities and faculty from different centers working in unison to build a single, integrated ITPA system. These centers, faculty and their overall responsibilities are summarized below for convenience:

- **FIU DPT.** Operational control and real-time management of parking garages and lots at FIU MMC and FIU GPE vehicles described in this document. There will be a flow of information between FIU DPT, UniversityCity TMA, and other ITPA modules. In particular, FIU DPT will receive transit
management and operations support from UniversityCity TMA who will be operating ITPA as described in this chapter and they shall share data from transit and parking operations with ITPA.

- **Sweetwater.** Sweetwater is responsible for the management of parking at Sweetwater locations that is to be expanded over time as described in this document. There will be sharing of information between Sweetwater, UniversityCity TMA and other ITPA modules.

- **Dedicated hub at FIU-CAKE.** Development and management of the crowd-sourcing parking and on-demand community bus scheduling and route optimization systems, as well as front-end interface (smartphone apps and webpage). This includes an Information Service Provider (ISP) module providing real-time awareness of typical and/or current and predicted traffic conditions along major freeways, transit and parking conditions as related to UniversityCity. ISP will be able to analyze and display this real-time data to users in various forms. The hub will exchange related operational parking and transit data, traffic current and predicted data, and transit data from the Miami-Dade region with UniversityCity TMA, LCTR IITS, FIU DPT and Sweetwater.

- **LCTR IITS.** LCTR IITS faculty will manage the acquisition and processing of regional and local traffic and transit data in order to deliver real-time and predictive traffic awareness with their existing, advanced traffic analysis tools. Predictive capabilities include: estimated time of travel predictions and route-change recommendations, transit management and will provide data and information to UniversityCity TMA, FIU DPT, Sweetwater, and the FIU-CAKE hub. IITS faculty will work closely with UniversityCity TMA the FIU-CAKE hub and provide fluid data exchange for the creation of real-time and predictive traffic and transit ITPA user and operator awareness.

- **IBM.** IBM will leverage world-wide SmartCity expertise and prior deployment case–studies to assist the present Project’s software engineers in the deployment and adaptation of IBM middleware to the applications of the present ITPA Project. IBM will provide a senior software engineer for said deployment and adaptation assistance. For Phase 1 of ITPA, IBM will also provide
the MobileFirst and the IBM Integration Bus. IBM will provide to UniversityCity TMA its OIT software and support so that it can become operational through the efforts of LCTR.
Figure 6.1.1 – Possible ITPA Architecture.
6.2 Smart Parking and associated modules

Smart parking consists of a concerted set of parking data-acquisition and software systems developed, implemented, and operated by UniversityCity. These systems include:

- Parking-garage (per level and type) occupancy data
- Crowd-sourcing parking occupancy data with single parking space resolution
- Parking situation awareness for ITPA users and operators, and navigation to available parking

6.2.1 Parking-garage (per level and type) occupancy data

Description. As stated in the alternative analysis, license-plate readers will be installed at the entrance and exits to the PG-1, PG-2, PG-3, PG-4 and PG-5 parking garages and the parking lot at the Lehman Center in 107th. In addition to supporting the validation, enforcement, and payment systems mentioned above; these devices will be used to identify the number of vehicles entering the garages and the types of permits on these vehicles allowing the identification of space availability by permit category. In addition, non-intrusive detectors will be installed at the exit points of the garages and the ramps between garage levels, allowing estimation the number of available spaces at each level. The garage has network connectivity to the server that will be utilized for system communications.

Implementation Plan: The system for PG-6 will be procured by FIU DPT utilizing the FIU procurement procedure. Those for PG-1 through PG-5 will be procured by using TIGER funds. The data gathered by the license plate reader and detectors will be communicated to a controller and sent to a server, located as will be agreed on by a memorandum of understanding between UniversityCity TMA, FIU DPT, CIO, Sweetwater, FIU ITPA team. This data will be shared fluidly with ITPA and UniversityCity TMA as the prime user of ITPA in order to assist in the front-end development of parking awareness and parking navigation features. The cost of the sensor based parking system including detection and DMS for one parking garage is assumed to be paid by TIGER/UniversityCity funds. This ITPA funding will pay for the limited involvement
of FIU parking technology experts on an advisory capacity to assist in the implementation and integration of the system. Estimated direct cost from the TIGER-grant budget is $13,000.

6.2.2 Crowd Sourcing Parking System

Description. In order to provide parking awareness and navigate users to available parking in the ample parking areas of FIU and Sweetwater, ITPA will implement a novel probabilistic and crowd source-based model. This model will be purchased as an initial turn-key product under a license from Pirouette Software, according to the alternative analysis recommendation described in Chapter 5. The basic initial product will consist of the following essential features:

1. **Parking detection** by analyzing smartphone movement and other crowd-source information

2. **Statistical analysis** to complement parking detection in building parking occupancy profiles

3. **Navigation assistant** to highest probability of finding parking using a mathematically proven gravitational approach which improves upon the common, but rudimentary “shortest distance” approach

The application will detect parking events in FIU/Sweetwater by analyzing movement information from the user’s smartphone. Central software will fuse data from the sensor-based parking detection system, crowd sourcing data, and archived parking history data to navigate users to along the paths that maximize the probability of finding parking. The maximization algorithm uses a gravitational model mathematically shown to be better than the “shortest distance” approach. The information acquired through this platform will inform ITPA and UniversityCity TMA in various ways; both of real-time traffic and parking occupancy, as well assist in building a historical database for analysis and guidance in ITPA adaptation.

**Implementation Plan:** Pirouette Software will provide a fully functional Android/iPhone app capable of detecting parking events and navigating users with the highest likelihood of finding parking in FIU’s open.
parking lots. Pirouette Software will also guide ITPA in the customization of this product to UniversityCity specific conditions. The first stage of development will focus on implementing the solution on FIU open parking spaces, using a limited number of users as a test-bed and informing ITPA of the penetration-to-confidence level ratio particular to the FIU environment. This stage will inform ITPA as to whether the system needs to be complemented by additional sensor-based occupancy information. Upon initial deployment, ITPA staff and professional software developer personnel will adapt the solution for indoor navigation in FIU parking garages, under the guidance of Pirouette experts. For a more detailed implementation plan, including timeline, benchmarks, agile approach description and software development budget, see Section 6.4.

**Table 6.1.1 - Estimated cost of crowd-sourcing parking solution. Development costs are coupled to front-end development and responsive feeder-bus system. The following table shows the combined budget.**

### 6.3 Smart Transit and Associated Modules

Smart Transit and Traffic Management Support will consist of:

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<th></th>
<th>License</th>
<th>Software development/Implementation</th>
</tr>
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<tbody>
<tr>
<td>Estimated Cost</td>
<td>$100,000 (one-time license)</td>
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- Monitoring Bus APTS technologies
- Route advisory for express FIU/Sweetwater transit vehicles based on traffic conditions
- Schedule and route optimization for community transit vehicles adapted to real-time and predicted user demand
- Optimization of traffic signals at FIU MMC
- Potential implementation of TSP on Miami-Dade signals.
- Study potential of TSP on internal FIU campus signals.
- Assist in the preparation of proposals, procurement to acquire the transit technologies, and the deployment of these technologies.
- Estimate and predict travel times on bus routes and expressways, as related to UniversityCity.
- Monitor traffic events and share information with other ITPA modules.
- Smart transit and traffic performance measurements and reporting.

**Express Transit.** Faculty at the IITS lab will provide support to UniversityCity TMA for ITPA traffic and transit management. The center has developed software tools that will be extended to support the routing in real-time based on information including time of day, traffic conditions, incident characteristics, construction, and weather information collected from different sources. The ITSDCAP will share the selected base-line routes and those modified based on real-time conditions with other ITPA modules utilizing XML data stream. The central transportation operations will have the capability of accepting, rejecting, or modifying the routes updated in real-time as described above. These tools will be used by ITPA for operations support of express transit such as the GPE and express transit operated by the UniversityCity TMA. They will also be responsible for coordinating with FDOT and MDX the use of UniversityCity Transit vehicles on managed lanes and shoulders.

**Community Transit.** Due to the low average population density of the UniversityCity region, particularly in Sweetwater (ca. 8.0 units/ac), a classic fixed-route public transit will not achieve the transit system performance goals set by this project. An insufficient percentage of residents live near bus stops, and a fixed-route service would either have to function with a low number of potential customers or would have to implement long and winding line routes, and thus operate at low convenience and economy. For these reasons, ITPA will develop a system to optimize route and schedule of the UniversityCity Transit fleet in real-time, based on current and predicted demand. ITPA will display the optimal route given current demand conditions on the driver’s dashboard and on the ITPA user’s app. ITPA users will be able...
to place a request for transit through the ITPA app. The ITPA servers will then negotiate the different requests, optimize the transit system’s vehicle routes, and provide a response to the user. Upon the user confirming this response, the server will then display the new route on both the user end and the bus driver’s dashboard consistent with published schedules.

**Additional Transit and Traffic Management Support items.** This section describes additional equipment needed for ITPA data collection. In what follows is a list of identified items needed for the implementation plan of different ITPA modules:

a) There are currently plans to install a number of Bluetooth/Wi-Fi readers on SW 8th Street and SW 107th Avenue. The data from these devices will be imported to ITSDCAP.

b) There is a need to install five additional readers on SW 107th Avenue, SW 109th Avenue, and FIU MMC campus.

c) There is a need to install at least one closed-circuit video camera on the top one of FIU garages or 109th Tower student resident building.

d) In order to assist the parking navigation module, it is estimated that additional cameras will have to be mounted at high altitude in certain open parking lots for data collection periods of less than a week. The ITPA teams will rely on existing tethered balloon-based technology developed at FIU.

The transit management system will be procured from a selected vendor utilizing the FIU procurement procedures and will not be funded by direct TIGER/UniversityCity ITPA funds. The provided system will include and integrate an AVL system, APC system, a real-time information system, estimated bus arrival/departure times, periodic performance reports, as specified in the scope of service presented in Chapter 7. The vendor will make all acquired data accessible to all ITPA modules for archiving, analysis and reporting and ITPA front-end development.
6.4 Front-end development

The project team will develop a novel traffic awareness environment for smartphone ITPA users that integrates transit, traffic, and parking awareness. This front-end environment is where the different modules for Smart Parking and Smart Transit are harmoniously integrated to provide a new experience to ITPA users.

Some examples of the information this front end will display to users are:

- Parking occupancies at FIU and Sweetwater open parking lots, street parking, and parking garages
- Next-bus arrivals and estimated times of arrival for the UniversityCity Transit vehicles
- Real-time and predicted congestion along major freeways related to UniversityCity
- Amtrak, Tri-Rail, Metrorail, and Metrobus information
- Alerts for service disruptions, detours, or infrequent conditions
- Navigation to best probability of finding parking in areas within scope of UniversityCity

This front-end must also be understood as a data-acquisition tool for ITPA, which will be used to guide ITPA development in the future. In particular, the front-end will gather:

- Information on real-time user demand for bus routes and bus schedules
- Information on real-time parking activities
- Information on traffic patterns corresponding to the ITPA user base (FIU students, faculty and staff and Sweetwater residents)

Implementation: This front-end relies on seamless data transfer between ITPA server and users, bus-tracking devices, parking sensors such as parking counters, and traffic congestion estimates provided by LCTR IITS. An agile software development approach will be used, where different functionalities of the system are developed in parallel as independent small modules and the system is built in an incremental,
intermediate-goal oriented way. All members of the ITPA team need to coordinate to respond to the anticipated needs of UniversityCity TMA in the operation of an ITPA-enabled smart parking and smart transit.

6.5 Project Timeline

The following is the project timeline:

1. Months 1-15

This schedule assumes that APTS technologies will be installed on FIU and Sweetwater buses that become the UniversityCity TMA fleet in parallel with this effort. It also assumes that PG5 and other parking garages at FIU will have a sensor based system.

Development of software interfaces for ITPA. This includes the associated benchmarks:

   a. A database set-up (including a data service provider to the front-end) for acquiring and formatting regional and local transit, parking and traffic data from different sources. This database set-up will reside on UniversityCity TMA controlled ITPA servers.

   b. A smartphone application that displays parking occupancy information in PG5 and transit information at the local and regional levels. This will establish the first major link between the ITPA enabled UniversityCity TMA and ITPA users. It will be a novel display of both transit and parking information on the same layer.

   c. Analytical modules will be developed for crowd-sourced parking by ITPA. The licensed crowd-based module for parking occupancy and navigation should have been customized to function on FIU open parking lots without deployment. Tests of penetration rates vs. parking occupancy confidence levels at FIU will be carried out to determine how much complementary sensor material needs to be deployed to guarantee a working system. In addition, development for incorporating parking garage solution.
d. ITSDCAP of LCTR IITS will be extended to include the routes that are related to UniversityCity Transit deployment and predictive traffic modeling component will be applied to these routes based on collected data.

e. Transit optimization will be conducted by LCTR, based on data collected from APTS systems related to UniversityCity deployment. This will include also studying bus on shoulder, utilization of manage lane alternatives, and TSP. LCTR will provide overall support to UniversityCity TMA for optimization of transit scheduling and operations of UniversityCity buses.

f. Analytical modules responsible for the responsive-routing transit system are to be developed by traffic modeling experts. These models should be well on their way by the end of the first 15 months, and testing on simplified simulations, mimicking true conditions as much as possible, should be advanced.

g. Traffic signal optimization at FIU MMC campus to be conducted by LCTR.

2. Months 16-30 The second 15-month-period will see a set of additional landmarks. Real testing of the smart aspects of transit and parking should begin on this phase with UniversityCity TMA using the smallest possible testing units to avoid disturbance to the traffic and transit systems at all costs. Once the system is well tested on these units, the deployment will be incremented in small steps striving for full coverage. This stage will strive to accomplish the following benchmarks:

   a. Start testing smart parking and transit applications based on APTS data and parking data.

   b. Implementation and fine tuning of optimized transit and traffic strategies. This will include demand-responsive transit, transit routing, bus scheduling, bus on shoulder, transit on-time performance, travel reliability, TSP, and parking and transit integration.

   c. FIU students will be recruited as beta testers of the smart app. Findings from this stage will be of the great assistance for the final deployment.
d. Data integration between smart transit and smart parking will be tested and evaluated for potential improvements before the full ITPA deployment and handing off to UniversityCity TMA for ongoing operations.

e. The crowd-sourcing parking solution should have been adapted to FIU-specific open parking conditions. If additional parking detection equipment is needed to aid the parking detection, this equipment will be procured and installed. The navigation app will be deployed and tested with a number of volunteer students in a single open parking lot and with UniversityCity TMA.

f. The on-demand bus routing and parking navigation layers should all be incorporated in the front-end environment at a “Beta” stage and released to a number of volunteer students for usage. They will only affect one vehicle from the UniversityCity TMA fleet and a single open parking lot at FIU.

3. **Months 31-45.** Expanding the system to full coverage.

   a. As real-life deployment issues with the pilot projects are identified and solved, this phase should see an incremental deployment to UniversityCity of the additional parking lots, parking garages and UniversityCity Transit vehicles

   b. Any vulnerability of the system should have been identified by testing all possible cases of the system during incremental deployment with UniversityCity TMA.

   c. Evaluate the performance of smart parking and smart transit implementation in operation by UniversityCity TMA.

### 6.6 Procurement Plan

Hardware and software acquired from vendors other than IBM and Pirouette Software will be procured using the FIU procurement process unless other approvals are obtained.
6.7 Operation and Management Plan

FIU, Sweetwater and UniversityCity TMA will submit to USDOT an operation and management plan, associated budget, and funding mechanism to operate the system beyond the three years of the ITPA project the draft of which is attached.

6.8 Evaluation Plan

The ITPA will include a number of innovative components that will need to be evaluated to determine their effectiveness in meeting the needs of the project. In particular, these will include the Crowdsourcing parking component, transit management and routing components, and traveler information system component. The ITPA project will procure for an independent evaluator to assess the implementation and operation of the different ITPA modules and ascertain how effectively they are achieving the project goals.

**Implementation and cost:** This task will be conducted by an independent evaluator during the second and third years of the implementation plan, at a total cost of $50,000.

6.9 Project Budget

This section provides a project budget overview, found on Table 6.4.1. This budget gives an estimated cost for all the different aspects of ITPA stated to be within the scope for this project in the “Scope of Work”.

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## ITPA Phase I

<table>
<thead>
<tr>
<th>Budget Categories</th>
<th>Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking implementation guidance by FIU faculty</td>
<td>$13,000</td>
</tr>
<tr>
<td>Software development</td>
<td>$1,100,000</td>
</tr>
<tr>
<td>Evaluation (Independent Evaluator)</td>
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<tr>
<td>IBM senior software engineer and consulting</td>
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<tr>
<td><strong>Total Labor Costs</strong></td>
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<td>Other Materials and Supplies</td>
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<td>Software IBM</td>
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<tr>
<td>Software Pirouette</td>
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<tr>
<td>Sensor-based Parking and DMS</td>
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</tr>
<tr>
<td>APTS Equipment (9 vehicles) – procured through separate SDG</td>
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<tr>
<td>Equipment (ALTA/Bluetooth devices) and deployment</td>
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<tr>
<td>Equipment (computers, servers, etc.) and deployment</td>
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<td><strong>Total Direct Costs</strong></td>
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<td>Indirect Costs @ 27% of MTDC ($1,503,020)</td>
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<tr>
<td><strong>TOTAL COSTS</strong></td>
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</tr>
</tbody>
</table>

All costs include the functional testing of the developed individual components and their integration.
7. Scope of Service

7.1 General Information

The scope of services described herein is a general guide and is not intended to be a complete list of all work necessary to complete the project. The Contractor will be required to ensure all work necessary to meet system goals and objectives will be defined and conducted to deliver a fully functional and maintainable system. The scope of work herein contains work tasks believed necessary for a systems integrator to deliver a system that meets the system requirements.

7.2 History and Background

The University City Prosperity Project is a multimodal project supporting innovation and sustainability benefits. It will link the Sweetwater and FIU’s MMC through technology and infrastructure improvements, as well as, express transit services to and from major destinations in Miami-Dade County. The University City Prosperity Project was awarded a FY2013 TIGER Discretionary Grant to address transportation mobility and safety problems facing FIU, Sweetwater, Miami-Dade County and the Southeast Florida Region.

The University City Prosperity Project consists of the following four components:

- Pedestrian-Oriented Transit Access Infrastructure Improvements (Infrastructure)
- Community Transit Service Development Enhancements (Community Transit)
- Informed Traveler Program and Applications (ITPA)
- Design & Engineering Support & Construction Management (DES&CM)
The Informed Traveler Program and Applications (ITPA) is one of the major components of the University City project. This scope of service is for the ITPA component of the University of City Project.

ITPA will be predictive in nature, allowing users to make better travel decisions before they start their trips. ITPA will provide recommendations to travelers based on historical and real-time information about events, traffic performance measures, transit services, weather, construction, special events, and other information. This will include easy to access and use of information needed to avoid congestion, construction or accident delays and to otherwise optimize each trip and associated parking with completion of the trips via transit whenever it will improve trip characteristics.

ITPA will provide personalized, timely information and advice regarding the trip of the consumers. It will also offer faster and reliable parking. ITPA users will be able to query the system about travel options before they begin their trip. Using advanced information technology platforms, intelligent transportation systems, and smartphone-based software, ITPA will provide significant benefits to the traveling public.

It is expected that these ITPA transit and parking implementations will increase transit use by FIU students, faculty, staff and visitors as well as Sweetwater residents and business customers.

### 7.3 Purpose of the Project

The TIGER funds allocated for the current project will be for the purpose of delivering an integrated platform to support:

- FIU transit and passenger movements between the City of Sweetwater and MMC with the potential for a transit service to the MIC, MIA and Metrorail’s Palmetto station.
- Smart parking management and information system in FIU MMC and Sweetwater locations integrated with the FIU and Sweetwater transit services operated by UniversityCity TMA.
• Supporting traffic signalization and other improvements to reduce any traffic delays along US 41 and SW/NW 107th Avenue and within the MMC campus to express transit vehicles approaching or departing the AIMS.

As indicated above, the project will focus on smart parking and smart transit implementations and the integration of these components. It is expected that these ITPA transit and parking implementations will increase transit use by FIU students, faculty, staff and visitors as well as Sweetwater residents and business customers.

The ITPA team will select the best technologies available and will work with the different partners to integrate them and to create the ultimate transit and parking management and information tool with an advanced mobile application to support travel decisions, based on real-time conditions and predictive analytics. This one of a kind application will make use of locational and temporal information that registered drivers will be sharing via cell phones to help establish very useful and timely travel recommendations.

7.4 ITPA Requirements

This section outlines the ITPA System requirements to be delivered by the Project Contractor.

7.5 Advance Public Transportation Systems (APTS)

ITPA shall provide a UniversityCity Advanced Public Transportation Systems (UCAPTS), as specified in the following subsections.

Automatic Vehicle Location and Tracking
The UCAPTS shall include an Automatic Vehicle Location (AVL) system to track the transit vehicles in an accurate and reliable manner that can be used to provide real-time information and predictive-based recommendations to users and to assist in managing transit fleet.

The AVL systems are computer-based vehicle tracking systems that function by measuring the real-time position of each vehicle and relaying this information back to a central location. AVL systems are most frequently used for fleet management to identify the location of vehicles for a variety of purposes including: improved dispatch, operation efficiency, and faster response times to disruptions in service.

The Contractor shall provide an AVL System with real-time wireless communication capabilities to central locations. The AVL system shall provide accurate vehicle location allowing vehicles to be tracked. The preferred mechanism of tracking vehicles is through the use of Global Positioning Systems (GPS). The accuracy shall be 30 feet or less. Data shall be sent at regular intervals (also known as poll rates) of at least 30 seconds. Data also need to be sent at time and location points, as specified by the system manager. Real-time data shall be archived into a database for future use.

Central software shall also be provided to support the operation and management of the transit system by FIU and Sweetwater personnel. The system must be able to provide a vehicle location determination anywhere in Miami-Dade County and adjacent counties, considering potential future expansions of the system.

The central software shall utilize a common base map, which will encompass Southeast Florida. The software shall utilize a user-friendly graphical interface that includes mapping capabilities and displaying of messages, events, and alarms as well as other functionality needed for the efficient management of the fleet. The software shall incorporate capabilities that allow pan and zoom viewing for the map of the service area. Information shall be automatically added or deleted to maintain clarity as the users moves

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between zoom levels. The street network definition shall include characteristics needed to allow the computation of navigable routes, including speed limits, one-way restrictions and turn prohibitions, and other necessary features and attributes required for transit management and routing. The system shall permit the definition and display of physical features that act as barriers to transportation.

The Contractor shall provide a voice and data communications system design. Data communications shall not interfere with voice communications. The provided system must ensure that bus operators can easily communicate with dispatch. In addition, the system shall allow bus operators to monitor their own schedule adherence, which enhances their ability to meet the goals for on-time performance.

Using on-board equipment, the bus operators shall be able to communicate with dispatch. Therefore, system shall allow sending and receiving text messages. This capability must include the ability to send pre-programmed text messages to report incidents. Messages sent from the buses shall be displayed on a screen as soon as they are received. Messages shall be easy to read and the software shall provide the necessary tools to quickly handle the request.

Buses on maps shall be color coded to represent a particular scheduled adherence event or other operational events (e.g., early, late, on-time, off-route, emergency alarm, etc.).

Data playback shall be included as part of the AVL system. At the minimum, the system shall provide a minimum of three (3) months of automatic playbacks. The Contractor shall provide a mechanism for easily archiving and retrieving data for playback.

The developed software tools shall allow monitoring, managing, and generating standard and user customized reports from the system.

Data needs to be tested for accuracy and shall be stored in a database. The system shall include the necessary software to access the database, retrieve the data, perform analysis, and generate reports.
central database shall be capable of keeping AVL data, reports, and other related information for a minimum period of five (5) years in a single standard database. In addition, backup and retrieval procedures shall be in place to be able to use archived data as needed. This will provide UniversityCity TMA management and staff with the necessary data to monitor and make recommendation to improve the performance of the system.

Data accuracy and reliability shall fall within the following ranges:

- Overall reliability of AVL hardware and software (excluding on-board vehicle hardware) system is expected to be 95% or better (System and all components are fully functional at least 95% of the time);
- Overall reliability of AVL on-board bus hardware is expected to be 95% reliable;
- Bus location information is expected to be 95% accurate based on a GPS accuracy of +/- 30 feet or less;
- Schedule Adherence information is expected to be 95% reliable based on a +/- of 30 seconds;
- Real time travel time information is expected to be 95% reliable based on a +/- of two and one half (2.5) minutes;
- Any hardware component with a failure rate in excess of 10% or greater during the first twelve (12) months of the original warranty will be considered as a 100% failure.

The system shall be able to operate, without degradation in performance, under existing weather conditions.

The system shall allow for future fleet growth during the life of the system. In addition, system shall support other applications include mobile applications, web-enabled components, and other services.
It is desirable that the contractor utilizes the applicable national standards in interfacing between the central software and on-board devices. All equipment shall meet all Local, State, and Federal regulations for safety and environmental control. The Contractor will take special note of all pertinent Federal Communications Commission (FCC) regulations.

The System shall be based on configurable open interface architecture. The System interfaces shall provide a secure means of data exchange, including providing historical and real-time data such as vehicle position and schedule adherence data on the fleet.

**Passenger Counting**

Passenger Counting System shall collect Boarding and Alighting data on the project buses. Automatic Passenger Counters (APCs) are devices that automatically count the number of passengers as they board and alight buses at each stop during a trip. An on-board microcomputer is the central processing unit of an APC system. It analyzes the signals received from the sensors in real time, then creates an electronic record at each bus stop and stores the results in memory. Data stored typically include the following: vehicle location (usually latitude and longitude coordinates), date and time the bus stops, times the doors open and close, number of passengers boarding, and number of passengers alighting. Often, additional information is recorded by time and location, such as the deployment of wheelchair lifts and bike rack utilization. These records are grouped by trip and are also stored on the vehicle until they are downloaded to an internal computer at the transit property for further processing. Real-time passenger load data will be sent to the central servers.

Automatic Passenger Counters can automate the data collection of passenger boardings and alightings by time and location. They also reduce the need to collect data manually, improve the accuracy of the data,
and it will provide information for more intelligent decision making. The collected data can be used to assist the planning, operations, and scheduling functions to help improve operational efficiencies.

In order to facilitate the passenger data collection and predictive arrivals, the Contractor shall perform a complete bus stop inventory (BSI). Bus Stop Amenities shall be added to the bus stop database by the Contractor when preparing the BSI database.

**Real-Time Traveler Information**

The UCAPTS shall provide real-time and static schedule and predictive travel information and recommendations to travelers. In addition to historical transit information such as route maps, schedules, and fare information; dynamic real-time information shall be provided.

The Real-Time Traveler Information system shall provide accurate predicted arrival and/or departure information to transit riders through the web and mobile applications. UCAPTS shall use bus schedule adherence, location data, and traffic data to develop real-time predictions for bus arrival and departure times at stops and to provide these predicted arrival and departure times to the public using methods including dynamic message signs at selected stops, handheld devices, and websites.

UCAPTS shall be able to broadcast Tri-Rail, Metro-Rail, and Metro-Bus connection information. The system shall provide information of transfer locations, available modes, and schedules.

UCAPTS shall broadcast messages for service disruptions, detours, or infrequent conditions. In addition, travelers shall be able to request specific information on their trips by using smart phone application and by accessing a website. Smart phone application shall provide scheduled, real-time and predictive information for a particular route considering the time of the trip. In addition, the smart phone application shall be able to send trip-specific alerts to travelers to notify them of bus delays due to events.
and updates the estimated departure times. Smart phone applications shall detect user location and display nearest stops and next bus arrivals.

The system shall be able to detect mobile application user locations and provide recommendations regarding the best bus trip to their destinations (including where to board the bus, the time of boarding, the best route, and the estimated arrival time at their destination). The system shall also provide recommendations regarding the availability of parking in the vicinity of these bus stops. These recommendations shall be based on the Parking Management and Information System discussed later in this document.

The central Real-Time Information System software shall be able to provide information, send messages, and generate reports. The system shall be integrated with the on-board systems described in this document, as required to deliver the functionality of the system. The Contractor shall provide the final system design, integration, provision of hardware and software equipment, database setup, system training, maintenance, and technical support.

**Transit Management**

The UCAPTS will include a Transit Management System that involves a central system that manages the ITPA vehicles. The system provider shall provide central software and hardware to manage the transit system in real-time.

**Express Transit.** UCAPTS shall support the routing of the buses based on information including time of day, traffic conditions, incident characteristics, construction, and weather information. UCAPTS shall be able to update its routing recommendations based on real-time and historical Automatic Vehicle Location
(AVL) system data from the buses. The UCAPTS transit management component shall interface with the ITS Data Capture and Performance Measurements (ITSDCAP) developed for FDOT by FIU LCTR IITS. ITSDCAP shall be extended to allow it to select the best routes for buses based on archived and real-time traffic data and bus AVL data and predictive analytics. The baseline routes shall be selected by time-of-day considering archived traffic conditions on alternative routes, as determined by ITSDCAP under different traffic, weather, and event conditions.

The selected transit routes can be modified in real-time recognizing the traffic parameters and incident, weather, and construction events. The ITSDCAP shall share the selected base-line routes and those modified based on real-time conditions with other UniversityCity ITPA modules. The central transportation operation operator shall have the capability of accepting, rejecting, or modifying the routes updated in real-time as described above. The software shall be able to download the selected route information to bus drivers in real-time at critical points in their trips to allow them to select the best alternative routes.

In addition to currently captured data, additional archived and real-time data shall be captured and analyzed by ITSDCAP for use in support of the selection of baseline and modified routes.

Community Transit. Due to the low average population density of the UniversityCity region, particularly in Sweetwater (ca. 8.0 units/ac), a classic fixed-route public transit will not achieve the transit system performance goals set by this project. An insufficient percentage of residents live near bus stops, and a fixed-route service would either have to function with a low number of potential customers or would have to implement long and winding line routes, and thus operate at low convenience and economy. For these reasons, we will develop a system to optimize route and schedule of the Sweetwater bus fleet in real-time, based on current and predicted demand. ITPA will display the optimal route given current demand conditions on the driver’s dashboard and on the ITPA user’s app. ITPA users will be able to
place a request for transit through the ITPA app. The ITPA servers will then negotiate the different requests, optimize the transit system’s vehicle routes, and provide a response to the user. Upon the user confirming this response, the server will then display the new route on both the user end and the bus driver’s dashboard; such that the route schedule is still largely adhered to in order to meet identified passenger demands downstream.

Transit Security

The UCAPTS shall provide for transit security. The onboard security system will provide remote monitoring and recording of the passenger safety environment on board transit vehicles. These systems will include on-board event recorders, silent alarms, and covert microphones.

7.6 Parking Information and Management

The IPTA shall provide the UniversityCity Parking Management and Information System (UCPMIS). The UCPMIS shall support FIU and Sweetwater by providing information to allow better planning and operation of their systems. In addition, it shall provide the IPTA user to access parking real-time information and to make parking reservations.

The UCPMIS shall be closely integrated with the UCAPTS, described earlier and other ITS components of ITPA, described earlier. The UCPMIS will cover parking garages and lots at the FIU main campus (MMC) and Sweetwater, and will provide information to FIU students, faculty, staff and visitors, as well as, Sweetwater residence and business customers regarding parking space availability. The contractor shall provide the hardware and software necessary for the system, as outlined below, as well as the web and smart phone mobile application to provide information to travelers in an integrated manner with the
transit information provision. The provided system will support parking management and sharing the information with users utilizing mobile applications, web site, and DMS.

The data collection system and devices must be able to expand to more locations, particularly with the ability to add more sensing devices and DMS signs to accommodate other parking locations in FIU and Sweetwater. The detectors, DMS, and other supporting systems shall be in accordance with FDOT Design Standards.

Parking Availability Detection

The system providers will install sensing technologies to allow the determination of the total number of parking spaces available in the PG5 garage and each PG5 garage level by parking type (administrators, faculty/staff, students, and visitors). These vehicle detection devices will be installed at pass-through points of PG5 including entry/exit points. Such parking availability detection technologies shall be extended to PG1-4 as funding permits.

The monitoring system will communicate all collected real-time parking data to a central location utilizing an IP based communication system. The sensing devices will communicate the vehicle pass-through information and equipped stall occupancy in real-time to the central software.

Individual stall detection will only be installed at the present time at one level of PG4. The contractor shall provide backup information confirming the appropriate selection of the sensing devices for both pass-through as well as stall detection. The ITPA team shall provide a proven technology such as loop detectors, magnetometers, ultrasound detectors, or license plate readers and demonstrate that it provides the required accuracy in FIU garages.
The sensing devices shall be extremely resilient, with low-level of needed maintenance and high-level of accuracy. The vehicle count devices must be proven to work in structures similar to the FIU parking structures. The system provider shall provide backup information confirming the appropriate selection of the sensing devices. The system shall continuously monitor its health and produce and automated system alerts via email, text and/or web interface in the event of a hardware outage.

The system shall have the ability to be recalibrated remotely and locally on site to adjust the system to produce the correct count, if needed. The system shall remain functionality and performance under all environmental and lighting conditions. All system components shall require a mean time between failures (MTBF) of 50,000 operating hours.

In addition to the sensor-based system installed in PG5, an additional system component procured from Pirouette Software will be implemented by the contractor to provide the capability for identifying the parking availability at other parking garages and lots without the need to install all the detectors as planned for PG5, and shall meets all the functionality and performance requirements identified for the project. This system shall be able to estimate the average number of parking slots on each level of the garages that are candidates for parking of a specific type of parking permit (administrator, faculty, student, and visitor permits).

Central software will fuse data from the sensor-based parking detection system, crowd sourcing data, and archived parking history data to determine the available parking locations with the highest probability to communicate to drivers. The central system will streams parking information to the statistical analysis and navigation module, which communicated back to the user and guides her to the maximum probability of finding parking.

Parking Information System Provision
The central software shall register data from the parking availability detection system with a maximum of one minute of latency. The central system shall be able to make the parking availability information through a mobile application, web page, two dynamic message signs (in PG5) and to third party applications, as needed. The Information provided by the system shall be accurate to the level of 95% or better.

The central software will provide real-time updating of parking availability on a web site, exterior DMS (4 signs), and mobile application. The provided system will include smartphone application that displays the number of vacant lots (color coded in real time). The project will procure and install two exterior parking availability DMS that cover the two entrances of PG5. The installed DMS shall comply with campus standards in style and design.

The information provided by smartphone apps and DMS shall differentiate between available spaces for different types of parking permits. The App shall allow travelers to setup their parking locations and favorite locations for later use in accessing the information and making reservations.

The DMS, smartphone application, and web page shall provide information on available slots per parking garage and parking garage level. The mobile application shall recommend best parking locations, based on particular destinations, transit trip, driving distance to the parking garage, walking distance from the slot to the final destination, and driver preferences. When parking prior to taking public transportation, the system will adjust its guidance to parking spaces using schedules, delays, and real-time location data associated with UniversityCity Transit and GPE buses.

**Parking Management Support**
The central system shall archive and provide access to historical data that can be used for parking system management and planning. The system must produce user customized reporting to meet management needs. Such reporting may include daily, weekly, monthly, and yearly generated reports and graphs for easy analysis. Examples of reports and produced graphs must include occupancy counts by minute, hour, day, week or month; and reports indicating the time a parking lot fills should also be producible. The administrator shall be able to specify the start and end of each report. The collected parking data will be archived in relational database management system for future use.

The Central hardware and software for parking management shall be installed at a central location agreed on by the FIU DPT, Sweetwater, and UniversityCity TMA. The central system shall allow remote monitoring from additional FIU and Sweetwater management locations.