TerraFly MobilityConcierge
An Informed Traveler Application
USE AND DISCLOSURE OF DATA

The data in this proposal shall not be disclosed outside the Government and shall not be duplicated, used or disclosed - in whole or in part - for any purpose other than to evaluate the proposal. However, if a contract is awarded to this offeror as a result of or in connection with submission of these data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract. This restriction does not limit the Government's right to use information contained in these data if they are obtained from another source without restriction. The data subjected to this restriction are contained in Sheet(s) 3-24.

Project duration: 5 years (with intent of productization beginning in parallel in Y4 under private sector funding)

Type of business: Educational institution

Complete list of subcontractors: Pirouette, Inc.

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Part B: Executive Summary

B.1 Proposed vision

This Accessible Transportation Technologies Research Initiative (ATTRI) project will leverage the Proposal Team’s current US DOT TIGER-2013 work and $50 million of fundamental research at the NSF Industry-University Center at FIU. It will involve interdisciplinary efforts in close collaboration with Miami-Dade County Department of Transportation and Public Works, Neuroscience Centers of Florida Foundation (NSCFF), and the City of Sweetwater's Senior Center.

The Proposer Team will design, develop, and beta-deploy for testing and evaluation an automated human-assisted transportation concierge system, which will provide pre-trip and en-route traveler guidance, recommendations, and concierge services, especially addressed to people with cognitive impairments, adults without technology experience, individuals with low vision, hearing impairments, and people with different degrees of mobility impairments. The product will include web-based applications for a PC and smart-phone apps which provide the traveler with maximum mobility, autonomy, and self-confidence while optimizing the caregiver’s supportive efforts, and providing support to the transportation services agencies: a traveler concierge system and guidance applications that works in unison with a companion app designed for caregivers and transportation providers. This second application will enable the caregiver and agencies to help with specific problems beyond the system’s automated capacities.

The Proposer Team has developed both the science and initial illustrative demonstration of the major components of the proposed system, as shown at http://CAKE.fiu.edu/ATTRI/.

B.2 Significant innovative ideas

The proposed project applies cutting edge computer science and engineering technologies to provide innovative assistance and services to improve the mobility of special-needs customers. Some of the innovations are: complete, automatically generated video tours of route scenarios with textual and audio information on landmarks and waypoints; directional information via spatialized
audio; real-time and predictive parking recommendation methods; and transportation booking and routing methods specifically designed for passengers with disabilities.

B.3 Current approaches

Many products on the market display geo-tagged multimedia on a map, most of which are photo-based. They only reference, however, videos and photos as points on the map; they do not constitute full pre-trip concierge and virtualization systems. It is difficult for users to completely experience the whole street by these scattered points. A number of products on the market cater for comparable needs, but none are specialized for people with cognitive impairments, low vision, hearing and mobility impairments, or older adults without technology experience.

B.4 Expected impact

According to CDC, 74.8 million U.S. adults have a complex activity limitation in their daily lives. For adults 65 years and older, 60.5% are reported to have a complex activity limitation. These limitations negatively impact people’s abilities to live full, independent lives in numerous ways including significant mobility and travel limitations. Using today’s cutting edge technologies and leveraging existing resources, effective solutions can be created that will provide for greater mobility and travel capabilities for persons with disabilities. This leads to greater independence, a healthier lifestyle, and more positive social interactions; resulting in a higher quality of life.

Our proposed product will focus on providing greater mobility access and travel information to people who have complex activity limitations in their daily lives. Our suite of applications and services will improve pre-trip planning, guidance, and concierge services for persons with disabilities, older adults without technology experience, and persons with low vision and hearing and mobility impairments. With detailed and clear pre-trip traveler information, detailed en-route information, and instant connectivity to a human caregiver, the uncertainty as to how to overcome identified obstacles and a resulting fear to travel is reduced to facilitate independent mobility using different mode choices, especially those that do not require the traveler to drive. It will improve the quality of life for its client base and reduce societal costs.
The proposed project is an extension of the technology component of the TIGER-2013 funded “University City Prosperity Project”, the Informed Traveler Program and Applications (ITPA), in combination with a number of other FIU-developed knowledge and technologies. Using these platforms and technologies, we can minimize technical and schedule risks, while at the same time maximally leverage prior investments by US DOT and NSF. ITPA is an advanced consumer-oriented, predictive, and multimodal transportation management software and technology system developed at FIU in cooperation with industry, academic, and municipal partners. ITPA enables the individual user to make timely schedule, route, mode, and destination choices while reducing congestion by limiting the need for private passenger automotive trips and optimizing intermodal and multimodal movement. It also enables the service providers to more effectively manage more integrated roadway, transit and parking assets.

An agile scrum software development process will be established for both research and software design and development. This method is especially suitable for complex projects with evolving requirements, new research results, and environment changes. The proposed deliverables will be comprehensively evaluated and iteratively tested by members of the target group. This evaluation will be conducted in co-operation with the Senior Center in Sweetwater, Florida, and with the NSCFF’s 7,500 patients in South Florida. (See Senior Center and NSCFF letters in Volume II.)

Deliverables are: MobilityConcierge smart-phone application and website; MobilityCompanion smart-phone app and website; MobilityProvider operations center software; MobilitySage cloud-based server software; and a comprehensive prototype system evaluation report. FIU shall grant Government Purpose License Rights to all software delivered as a part of these funded efforts. All software deliveries, preliminary and final, will include well-documented source code in electronic readable format, overall software architecture documentation, overall and individual module interface documentation, and a user operations manual.
Part C: Innovative Claims

The proposed project applies cutting edge computer science and engineering technologies as illustrated at [http://CAKE.fiu.edu/ATTRI/](http://CAKE.fiu.edu/ATTRI/) to provide innovative assistance and services to improve mobility of special needs customers: pre-trip planning and preview; en-route orientation and navigation; transportation management and recommendation methods; parking management and recommendation methods; and semi-automated concierge services.

The Proposal Team has developed an initial prototype of the pre-trip planning and preview module, the *TerraFly Video Trip Planner*. Its front-end allows users to request routing, and then to preview a video tour of the recommended route, comprised from segments automatically stitched together from most appropriate archived videos. The back-end collects user-uploaded dash-cam videos for immersive route preview. This platform transcends the state of the art in a number of ways: it features a smart data importing system able to recognize the different brands of dashboard cameras and support various other data sources like smartphone applications; it automatically and intelligently retrieves and merges related videos; video playback is synchronized with map route view, with cross-interactive capability; video stitching selection is sensitive to time, weather, season and resolution; privacy protection is integrated. The technology leverages the Proposal Team’s fundamental research “Moving Objects Databases for Exploration of Virtual and Real Environments” funded by NSF at $3M 2012-2017 (Lead PI: Rishe, UIC PI: Wolfson).

As a majority of information sources used for preparing a trip are visual, the process presents significant challenges for those individuals who are blind. In the proposed project, we will utilize smart-phone technology to produce spatialized audio and provide visually-impaired pedestrians or passengers with a North direction indication and directional information about landmarks within a user-adjustable radius. To maximize potential accuracy of the localization, we will use Head-Related Transfer Functions, personalized to the characteristics of each user. This proposed work

Pre-scheduled paratransit services, using shuttles or taxis outfitted with equipment to accommodate special needs are relatively expensive to operate, and restricts passengers to pre-scheduled routes due to the complexity of matching passengers with disabilities with appropriate vehicles and properly trained personnel. In contrast, current ride-sharing systems such as UberPool and LyftLine are flexible, but lack the capability for passengers to specify constraints. The Proposal Team has developed an initial prototype of *TransitMatch* (patent pending; see Section I), a transportation booking and routing system specifically designed for passengers with disabilities, leveraging NSF-funded research at UIC and Pirouette. It allows passengers to specify constraints such as arrival-time and necessary facilities. Special transportation resources are then allocated based on the prospective travelers’ needs using a novel ride-matching algorithm and the trip is planned on an optimized route. This will help older adults and people with disabilities to transition from paratransit to community transit, fixed-route, and rapid transit service. (See Pirouette letter.)

The Proposal Team has developed a prototype application to manage and predict parking availability in controlled access enclosed parking sites (e.g., parking garages and lots), and to recommend optimal parking spots to individual end users (patent pending; see Section I). The models predict where and when users park, and include sub-models for routing, attractiveness relations, real-time availability, classes of parking decals, and long-term experience and expectations. The Proposal Team has also developed a prototype of *StreetSmart* (patent pending; see Section I), a crowd-based parking discovery and navigation software designed to help drivers find on-street parking quickly and safely. These innovations make searching for parking more effective and convenient, lowering emissions and cruising time.

The Proposal Team will bring together the aforementioned innovations to significantly and uniquely improve pre-trip planning, guidance, and concierge services for persons with disabilities, older adults without technology experience, and persons with low vision. The proposed applications, developed following the lead of our user experience experts (see [Ortega-2015]) with significant knowledge regarding media participation for people with cerebral impairments, will be equipped with an audio-visual user interface advancing the state of the art.
Part D: Vision

The Proposal Team will design, develop, and beta-deploy for testing and evaluation an automated human-assisted transportation concierge system, which will provide pre-trip and en-route traveler guidance, recommendations, and concierge services, especially addressed to people with cognitive impairments, older adults without technology experience, individuals with low vision, and people with different degrees of mobility impairments. The product will include a web-based application for a PC and smart-phone apps which provide the traveler with maximum mobility, autonomy, and self-confidence while optimizing the caregiver’s supportive efforts: a traveler concierge and guidance app that works in unison with a companion app designed for caregivers. It also includes a cloud-based back-end server, and an interactive management and decision support module.

The MobilityConcierge app and website are designed with an interface focused on the needs of people without technology experience and persons with cognitive disabilities. It assists users with pre-trip planning, if necessary with the help of a connected caregiver. This app shows a video clip of the proposed route, automatically stitched together from user-uploaded and geo-tagged videos, and including textual and audio descriptions of landmarks and navigation points. The app’s functionality includes the capability to create scenarios using different modes and accessibility options custom-tailored to the user’s personal profile when walking or bicycling, taking transit or paratransit and/or driving and parking.

Once a user embarks on the trip, MobilityConcierge gives detailed guidance on navigation, including waypoints, landmarks, and mode changes. The user’s position and direction are provided both visually and with the help of spatial sounds. The system shows public transit options in simplified language and in accordance with the Americans with Disabilities Act (ADA), while balancing accessibility information with the user’s personal abilities. The system interfaces with parking providers and recommends available parking (patent...
pending; see Section I), and with third-party providers of paratransit or last-mile transportation, providing information and guidance to help users’ transition to fixed route, community transit, and rapid transit services (patent pending; see Section I). For participating service providers, MobilityConcierge embeds a pay-as-you-go component to save users from having to handle cash or credit cards.

The app’s design is sensitive of varying screen size and includes a visual mode to be used on tablets or smart-phones with larger displays, to enable people with low vision to utilize its potential. In addition, users can interact with the app using natural language. Should users require assistance or concierge services beyond the app’s own services, they can request to be connected via chat or video call to a designated caregiver or concierge. With detailed and clear pre-trip traveler information, detailed en-route information, and instant connectivity to a human caregiver, it helps to remove fear to travel, and facilitates independent mobility.

The MobilityCompanion app and website connect caregivers or human concierges to patrons by audio and video, and gives them consent-based access to the patron’s app interface, thus enabling caregiver or transportation service provider to help with specific problems beyond the system’s automated capabilities. The MobilityProvider operations center module provides management and decision support to providers of transportation or other services. These applications will be connected by MobilitySage, a cloud-based server software, including real-time and predictive guidance and recommendation models (patent pending; see Section I).

The system will be tested, evaluated and iteratively improved in two tiers: During development in co-operation with the Senior Center in Sweetwater, Florida, which provides paratransit services and adult day care for approximately 200 participants every weekday. It will then be evaluated in co-operation with NSCFF which is geared to serve 15,000 patients, a majority of whom are diagnosed with Alzheimer’s, Stroke, or Parkinson’s. NSCFF works towards improving the mobility of its patients, and will leverage its experience in evaluating services and calculate metrics of improvement or satisfaction.
Part E: Technical Rationale

E.1 Technical Merit

The proposed project is an extension of the ITPA technology component of the TIGER-2013 funded “UniversityCity Prosperity Project” in combination with a number of other FIU results and technologies (see Section C). Using these platforms and technologies we can minimize technical and schedule risks, while at the same time maximally leverage prior investments by US DOT and NSF.

E.1.1 Informed Traveler Program and Applications (ITPA)

ITPA (patent pending; see Section I) is an advanced consumer-oriented, predictive, and multimodal transportation management software and technology system developed at FIU in cooperation with industry, academic, and municipal partners, under the umbrella of National Science Foundation's Industry-University Cooperative Research Center for Advanced Knowledge Enablement at FIU (NSF-CAKE, http://CAKE.FIU.edu). ITPA enables the individual user to make timely schedule, route, mode, and destination choices while reducing congestion by limiting the need for private passenger automotive trips and optimizing intermodal and multimodal movement. It also enables the service providers to more effectively manage more integrated roadway, transit and parking assets.
Once completed, ITPA will recommend trip segment choices before travel decision points that improve travel arrival times, costs, and reduced greenhouse gas emissions. It is being developed to be interoperable with and to receive information from various locally deployed technology systems. ITPA not only provides optimal experiences from an individual user’s point of view, but it also considers global aspects of resource optimization and maximum decongestion from a public service provider’s point of view.

ITPA is tested and evaluated in co-operation with the neighboring City of Sweetwater and the University City Transportation and Management Association of Sweetwater, Inc. (UTMA), which will be directing the operation of community transit that functions a feeder bus services to rapid transit and providing transportation, parking, and event information and management services at FIU and Sweetwater. (See UTMA letter in Volume II.)

E.1.2 Pre-trip Route Visualization and Trip Planner Using Geo Referenced Videos

The Proposer Team has developed an initial prototype of the *TerraFly Video Trip Planner* (see [Zhang-2015] and [Zhao-2015]), to collect user-uploaded dash-cam videos and as a proof of concept for an immersive route preview technology. Video Trip Planner is designed with flexibility and reusability in mind, modularizing various components involved in the process of video collection, route generation, and user interaction.

This platform provides street level video tours by stitching segments from user-uploaded driving videos, showing both the route as it progresses on a map and a smooth vision of what the user would see when traveling via the route (as driver, passenger, or on foot).

Within the proposed ATTRI project, we will further develop this technology, and will deploy a working pilot thereof in Miami-Dade County, utilizing a large number video collected by FIU Honors students. We will assess user experience and adapt the technology based on experience of large groups of customers with disability served by our partners.
E.1.3 Concierge Service for an Autonomous Transit Vehicle Fleet

A number of shortfalls exist regarding the deployment of autonomous vehicles in public transit. These result from the software’s inability to resolve unforeseen situations, security concerns resulting from the absence of a driver, and the missing option for a passenger to ask a driver for information or assistance. The Proposal Team has designed a method (patent pending; see Section I) to add services to and to remotely control autonomous transit vehicles. Advanced analytics software and/or a standard simulator toolset and interface are used to enable a small number of operators to control a larger number of vehicles, providing a concierge service to passengers and/or emergency remote driving triggered by the robot's inability to resolve a situation and requesting help. Unusual events are detected by a fuzzy logic system (see [Tamir-2015]) analyzing data streams transmitted from the vehicle to a central server, or are triggered by a passenger’s request via pressing a button or speaking up. Operators switch between immersive environments of vehicles they control. In any given environment, an operator can see a panorama outside and inside the vehicle, and can hear onboard sounds and language, talk to people within and outside the vehicle, and remotely drive the vehicle using a standard simulator.

We propose to develop this technology and deploy a working pilot thereof on FIU Campus, utilizing the autonomous transit vehicles that FIU intends to deploy and the Operations Center being setup under the FIU’s TIGER-2013 project with operations funded by UTMA.

E.1.4 Service Area Concierge

The Proposers have developed a TerraFly Concierge Simulator Demo presenting a prospective concierge digital application offering safety, security, on-demand services, video-calling, navigation, schedules and information on businesses, retailers, points-of-interest, among other features. This consent-based inter-modal and multi-modal application will enable patrons to safely and efficiently navigate around the vicinity, with all the location-based information, to conduct business or for leisure travel. The application will also provide video-calling with a human
concierge in the event of an emergency or an urgent need, ensuring help is dispatched and provided in a swift manner via navigational tools.

E.1.5 Navigation and Wayfinding for Blind Travelers through Spatialized Sound

As a majority of information sources used for preparing a trip are visual in nature, the process presents significant challenges for individuals who are blind. The FIU Digital Signal Processing Lab has considerable experience in the development of systems aimed at facilitating the use of computer GUIs (Graphic User Interfaces) and navigation by blind users, by means of spatialized sound (patent pending; see Section I).

In previewing a route for a trip on a map, sighted individuals utilize the mapping convention that represents North at the top of the map and focus on a point (avatar or cursor). Blind users cannot use the same standard sources of information. We therefore utilize smart-phone technology to produce spatialized or 3D audio to provide the user with an indication of the North direction, with respect to the “current location and orientation”, as well as directional information about landmarks within a user-adjustable radius. As the “current location” changes by real or virtual progress along a route, the system retrieves the information of any map landmarks within a radius, and spatialized synthesized speech reads the identity of the landmark. At way points the technology helps the user to turn to the right direction based on the next leg of the itinerary.

To maximize the potential accuracy of the landmark localization we use Head-Related Transfer Functions (HRTFs), personalized to the characteristics of each user, for spatialization. Our previous research has shown that this type of implementation of spatialized sound has a significant potential to enhance auditory localization.

E.1.6 On-demand ride-sharing for passengers with disabilities

Public transportation for passengers with disabilities is generally provided via pre-scheduled shuttles or taxis outfitted with equipment to accommodate special needs. This system is relatively expensive for transportation authorities to operate, and restricts passengers to pre-scheduled routes due to the complexity of matching passengers with disabilities with appropriate vehicles and properly trained personnel. In contrast, current commercial ride-sharing systems are flexible, but lack the capability for passengers to specify constraints. Specifically, a passenger cannot specify
constraints such as tolerable delay, stoppage time, and special vehicle accommodations considering the specified disabilities and special needs, and vehicle stop facilities.

*TransitMatch* would be a prototype transportation booking and routing system specifically designed for passengers with disabilities. It allows passengers to specify constraints such as departure and arrival times, special vehicle accommodations given the specified disabilities and special needs, and necessary vehicle stop facilities or characteristics. Passengers are enrolled in virtual “pools” associated with a location and time-interval representing the pickup time and location of the passengers. Special transportation resources (e.g., shuttles, taxis) can then be allocated to each pool based on the prospective passengers’ needs using a novel ride-matching algorithm and the vehicle to be used can be directed on an optimized route to the desired destination.

### E.2 Other ongoing research

Many products on the market can display geo-tagged multimedia on a map, most of which are photo-based. They typically only reference videos and photos as points on the map, and do not constitute full Pre-Trip Concierge and Virtualization systems. It is difficult for users to completely experience the whole street by these scattered points.

A number of products on the market cater for comparable needs, but none are specialized for people with cognitive impairments, low vision, or older adults without technology experience:

- Google Maps and other services provide navigation and arrival time data based on location, but do not provide a video tour or audio guides.
- TripGo is a mobile application offering pre-trip planning similar to Google Maps; it also provides an overview of a planned trip, but specializes in hotel reservations and does not include video tours or audio guides.
- Local or regional trip planners, like the Metropolitan Transportation Authority (MTA), NY, and TripPlanner+, allow to plan multi-modal trips, provide estimated travel times, and include turn-by-turn directions regarding MTA’s public transportation system, but these applications do not provide audio and video guides.
Overall, other applications similar to the ones mentioned above never go beyond showing arrival times, turn-by-turn navigation in text, and a map-based zoomed-out overview of the trip. They do not include virtual tours of the trip nor do they provide concierge service base on the traveler needs.

Some research papers from companies or universities propose similar applications: [Guo-2016], [Aydin-2015], [Sharda-2008], [Szanton-2016].

E.3 Risk Mitigation

As we plan each step and as we execute the project plan, there is a need to identify all risks and perform either qualitative or quantitative risk analysis. We will adopt a risk register to record the risks of the project, their probability of occurring, the impact the risk has on the project and either mitigation or contingency plans to handle each one. They will be reviewed before the start of each agile sprint and handled as tasks to be either mitigated or eliminated. The project manager will maintain the risk register, which is a list of all risks, their impacts, and their status and assign owners to address the obstacles.

We know from our preliminary results that major components of the proposed project produce reliable and valid data. For each of the components, there are several potential paths to completion so that roadblocks can be avoided. E.g., our parking availability model currently has a prediction accuracy of 92% percent. Several options to improve the model exist, including further development of each of the sub-models, and integration of further data sources. We assume that a combination of these options will improve the accuracy to at least 97%. However, if no path should lead to the accuracy goal, we can still utilize the benchmark model to validly predict and recommend available parking.
Part F: Statement of Work

F.1 Objectives

The increasing number of older adults and people with disabilities present a significant challenge to the transportation system. The mobility issues for this segment of population need to be addressed to improve access to jobs, healthcare, and educational opportunities. Efficient, safe, and accessible transportation services for all travelers have a direct impact on the quality of life and economic development of our communities. By reducing barriers and enabling people with disabilities and older adults to continue to be independent, the entire population can stay healthier and be contributors to the welfare of our society (see our report to FTA at [Cevallos-2010]).

Older adults and people with disabilities (including veterans with disabilities) present particular characteristics that need to be understood and addressed in order to provide transportation service that is sensitive to those needs. The ability to access and use public transportation or other transportation options may be limited by a series of physical, cognitive, visual, auditive, mental, or other disabilities. Accessibility to transportation is often restricted due to the lack of information, inadequate infrastructure, or costly services. This makes the mobility of older adults and disabled persons a serious challenge, and, therefore, transit and transportation providers in general must be aware of these limitations when planning and providing transit service, to allow this group of the population can become an active and productive element of society.

Knowing the travel patterns and preferences of the older adults and disabled community can help with the development of alternative travel options. This can help to provide better information, improved infrastructure, accessible vehicles, and enhanced services to ensure compliance with the Federal ADA regulations; thereby helping to improve the overall mobility of older adults and people with disabilities.

To help this segment of population, the use of technology to provide information is vital. Technology can also be used to detect deficiencies in the infrastructure and services provided. In addition, this can be accompanied by travel training programs. Older age is often associated with a decrease in cognitive ability. Therefore, concepts learned from technological systems can be
enforced with travel training efforts. This can also be extended to programs that offer service to people with physical or mental disabilities and help individuals to go through the actual traveling steps, so that they become comfortable and confident of taking the trips by themselves.

The proposed MobilityConcierge application will help the user understand one’s environment and routing and will also offer alternative transportation options and the opportunity to explore new routes and destinations. That, combined with travel training programs, can greatly enhance the opportunities for this important segment of our population and ensure successful and permanent transitions to more efficient transportation alternatives. The user can take virtual video tours to her destination, explore scenarios, and see information about the facilities where passenger can board or alight the vehicles, fare type, vehicle information, ADA capacities, hours of service, or other general information. This will improve such users’ quality of life as they get acquainted with all aspects of the different transportation options and it opens the opportunity to explore new destinations.

Presently, the operating costs of paratransit in the U.S. are largely borne by government subsidies. By providing less costly travel alternatives, transit providers and policy makers can program more funds into capital improvements to enhance pedestrian-oriented transit access infrastructure, navigation applications, transit frequency, and demand responsiveness. Thereby, subsidies can be further reduced. MobilityConcierge will provide information about different transportation modes and services that help older adults and people with disabilities transition from expensive paratransit services or risky driving to: very smart, electric, autonomous, demand responsive community transit vehicles improved for enhanced customer experience; fixed route metropolitan transit; and, regional rapid transit services.

MobilityConcierge service will provide pre-trip and en-route traveler guidance via smartphone apps, websites, and the back-end services to support them. The NSF Industry-University Cooperative Research Center for Advanced Knowledge Enablement at FIU (NSF-CAKE) has developed technologies that can be applied to new transportation solutions.
F.2 Scope

The scope of work includes development of the new TerraFly Concierge Services prototype and system evaluation. This scope is further described in the sections below.

F.2.1 Scope of New Software Development

The scope of software development work includes two new smart phone applications (*MobilityConcierge* and *MobilityCompanion*), one new Operation Center web service (*MobilityProvider*) and a new back-end service *MobilitySage*. These features are built upon existing TerraFly services such as InformedTraveler, TerraFly Video Trip Planning, as well as other TerraFly Cloud services.

The work plan strategy is to utilize the already developed transportation products of the TerraFly portfolio of modules and build upon them to provide the new services outlined here. NSF-CAKE employs the *agile scrum* process, an industry accepted and proven process for delivering products in a dynamic environment where customers can see deliverable pieces of the product early in the development and developers can accommodate new and continually changing requirements. We will utilize the strength of this process to do early user-centered design and testing of mockups and prototypes. This approach is a best practice in the software development lifecycle that incorporates tried and true user experience design techniques combined with targeted user experience testing with actual potential users of the product. It provides potential users with early views of the product to interact with and provide just-in-time feedback on. This greatly contributes towards being able to see and correct potential issues before deeper levels of development are done.

F.2.2 Scope of Prototype System Evaluation

Prototype Development and System Evaluation are two overlapping phases:

1. **Phase 1 – Software Development Phase**: Baseline surveys, mockups, and development of cloud services, human/machine interactions and user experience approaches that focus on the
specific needs of our target user population.

2. **Phase 2 – Pilot Deployment Phase**: Pilot trials of each app as they becomes available that include usage statistics and user experience research.

The evaluation approach for the project will start at the beginning of the project and continue throughout the entire design, development and pilot deployment phases. It will integrate user-centered design best practice approaches in user experience design and research into the design and development process for each of the project’s application. The primary evaluation components are described below, including the interim deliverables that will be part of the final evaluation report. As is described in Section D, the data collection and evaluation will be conducted in cooperation with the Senior Center in Sweetwater, the Neuroscience Foundation, and Miami-Dade County (see Letters). IRB approval or exemption will be obtained.

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<tr>
<th>Evaluation Effort</th>
<th>Time Period</th>
<th>Proposed Work</th>
<th>Interim Deliverables</th>
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<tbody>
<tr>
<td>Baseline Data Collection</td>
<td>Phase 1: Beginning of the Project</td>
<td>• Collection of baseline data to be used for project planning and design for the targeted user population, including persons with disabilities, elderly clients and caregivers (from existing sources)</td>
<td>• [Raw Data and Data Analyses] Existing Population Demographics and Statistics regarding current potential users, and recommended impacts on system design</td>
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<td></td>
<td></td>
<td>• Survey Development for target users (persons with disabilities, elderly clients and caregivers)</td>
<td>• [Survey Instrument] Baseline Survey instrument with 10-15 questions for target users’ needs, limitations and propensities (depending on disability)</td>
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<td>• Survey Data Collection from a representative sample of 100 target users</td>
<td>• [Raw Data and Data Analyses] Survey data responses, results and recommended impacts on system design</td>
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<td>Evaluation Effort</td>
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<td>Domain Expertise/Heuristic Analysis</td>
<td>Phase 1: Application Design and Development Phase</td>
<td>Provide information and feedback regarding application and interface requirements and analysis for the user population(s) from domain experts who help provide services to the target users. This will include requirements gathering, planned system integration (e.g., integrated use of 3rd party services such as Uber), and domain expert user feedback.</td>
<td>[Document - Key Needs] Domain Expertise Analysis of key requirements and integration with current systems and services from service domain experts who have a good understanding of service needs of our target users.</td>
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<td>Given mockups and interactive prototypes, provide analysis and feedback on the meeting of requirements and user workflow needs. This is an iterative process throughout the development lifecycle.</td>
<td>[Document – Interface Analysis and Feedback] Feedback and analysis of specific interface mockups, interactive prototypes and user workflows, along with recommended design changes.</td>
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<tr>
<td>Design Partner User Testing and Feedback</td>
<td>Phase 1: Application Design and Development Phase</td>
<td>(1) Generate iterative test plans and user tests for app interfaces throughout the development life cycle. (2) Given mockups and interactive prototypes, recruit and facilitate target users who are willing to provide user experience and usability feedback on a periodic, ongoing basis.</td>
<td>[Testing Plan and Iterative Reporting] Iterative facilitation of target users to engage in user experience research and reporting to inform the design and development process</td>
</tr>
<tr>
<td>Pilot Deployment</td>
<td>Phase 2: Pilot Deployment Phase</td>
<td>Facilitate engagement in recruitment and enrollment efforts for the ATTRI Concierge Pilot Program. Actively engage target users at related points of contact to recruit and enroll a total of 7500+ active users of the program.</td>
<td>• [Facilitation] Rolling enrollment of 7500+ patients and caregivers into the ATTRI Concierge Pilot Program • [Facilitation and Engagement] Training and deployment of training materials to</td>
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<tr>
<td>Evaluation Effort</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>• Pilot 1 will consist of users recruited from the Sweetwater Senior Center</td>
<td>Sweetwater and NSCFF staff for recruitment of program users.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pilot 2 will consist of 50% of the NSCFF patient/caregiver base</td>
<td>• [Document - Recruitment Plan and Materials] Recruitment plan and materials to be used by Sweetwater, NSCFF staff and the FIU Recruiter for recruitment of 7500+ users.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Each pilot study will include data collection and analysis of:</td>
<td>• [Iterative Reporting - User Experience and Usability Feedback and Usage Statistics] Facilitation of target users to engage in user experience research and reporting, along with automated usage statistics and just-in-time, in-app feedback and data collection.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Recruitment strategies and planning and coordination, including training components</td>
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<td></td>
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<td>• User, usability and usage studies with data collected from within the apps and web interfaces</td>
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</tr>
</tbody>
</table>

**F.3 Work Breakdown Structure**

The development work is broken down into new smart phone applications, new web services, new operations center, new backend service, and interfaces to and modifications of existing TerraFly services. The WBS chart is shown in Figure 8.

All the concierge services are depended upon the basic back end service that supports them: *MobilitySage*. This functionality resides on the TerraFly Cloud and provides the new server functions that along with TerraFly Services provides the base for all the front end applications both smart phone and web services.
Figure 8 - WBS chart
The tasks to develop the deliverables (see Part H) are described as follows:

1. **MobilityConcierge**: Fully integrated service providing travel information via smart phones and Web Services
   1.1 New Smart Phone App: Services running on all versions of smart phones
      1.1.1 Smart Phone App Development: Initial Smart Phone Design, Implementation, and testing
      1.1.2 Porting the working code from the initial development platform (Android) to others
   1.2 New Web Service: Integrated, tested working Web Service
   1.2.1 Web Development: Design, development, and unit testing of web platform
   1.3 New Backend Service: Fully integrated backend service for both Web and Smart Phone Front Ends
      1.3.1 Backend Development: Design, implementation, and unit testing of backend service
   1.4 TerraFly Services Modifications: Fully integrated modifications for TerraFly Services
      1.4.1 TerraFly ITPA Modifications: Design, implementation, and unit testing of modifications for the TerraFly ITPA Service
      1.4.2 TerraFly Video Trip Planning: Design, implementation, and unit testing of modifications for the TerraFly Video Trip Planning Service

2. **MobilityCompanion**: Fully integrated service connecting caregivers or concierges to users
   2.1 New Smart Phone App: Services running on all versions of smart phones
      2.1.1 Smart Phone App Development: Initial Smart Phone Design, Implementation, and testing
      2.1.2 Porting the working code from the initial development platform (Android) to others
   2.2 New Web Service: Integrated, tested working Web Service
      2.2.1 Web Development: Design, development, and unit testing of web platform
   2.3 New Backend Service: Fully integrated backend service for both Web and Smart Phone Front Ends
      2.3.1 Backend Development: Design, implementation, and unit testing of backend service
   2.4 TerraFly Services Modifications: Fully integrated modifications for TerraFly Services
      2.4.1 TerraFly ITPA Modifications: Design, implementation, and unit testing of modifications for the TerraFly ITPA Service
      2.4.2 TerraFly Video Trip Planning: Design, implementation, and unit testing of modifications for the TerraFly Video Trip Planning Service

3. **MobilityProvider**: Completed integrated Operations Center services for management and decision support to users
   3.1 New Operations Center Web Service: Fully integrated operations center
      3.1.1 Web Development: Design, Implementation, and unit testing of operations center
   3.2 New Backend Service: Fully integrated backend service for Operations Center
      3.2.1 Backend Development: Design, implementation, and unit testing of backend service
3.3 TerraFly Services Modifications: Fully integrated modifications for TerraFly Services
3.3.1 TerraFly ITPA Modifications: Design, implementation, and unit testing of modifications for the TerraFly ITPA Service
3.3.2 TerraFly Video Trip Planning: Design, implementation, and unit testing of modifications for the TerraFly Video Trip Planning Service

4. MobilitySage: Fully integrated cloud based server software
4.1 New Backend Service: Base Backend Service for all TerraFly Mobility Concierge Services
4.1.1 Backend Development: Design, implementation, and testing of basic backend service, database, and collection algorithms
4.2 TerraFly Service Modification: Fully integrated initial modifications of TerraFly services
4.2.1 4.2.1 TerraFly ITPA Modifications: Design, implementation, and unit testing of modifications for the TerraFly ITPA Service
4.2.2 TerraFly Video Trip Planning: Design, implementation, and unit testing of modifications for the TerraFly Video Trip Planning Service

5.1 Survey, Prototype, Mockup for interaction with customer for special requirements
5.2 Pilot Testing of Integrated TerraFly Concierge Services

F.4 Technical Approach

The TerraFly Mobility Concierge Services are a unique set of functions that will provide a valuable service to a subset of the community addressing specific needs of these individuals. It is enabled by prior research on, to which this Proposing Team has contributed: geospatial data, transit and parking management and recommendations, and human-machine interfaces. In particular it draws from TerraFly Cloud Services such as Informed Traveler and Video Trip Planner. Much of the infrastructure for producing new transit type features already exists in both hardware and software and the Proposing Team is experienced in developing smart-phone apps, web services, and backend functions.

Software development processes are practiced within the proposing NSF Center that can be utilized to develop high quality software and are very adaptable to changing requirements, new features, and customer requests. Test suites can be reused to test new similar features and many tests at the unit level have been automated to ensure continual progress.
Part G: Schedule, Milestones, and Evaluation Metrics

Schedules and milestones are provided in detail in Part J.

G.1 Performance Requirements Summary

Contractor’s service requirements are summarized into performance objectives that relate directly to mission essential items. The performance threshold briefly describes the minimum acceptable levels of service required for each requirement. These thresholds are critical to mission success.

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<th>PERFORMANCE OBJECTIVE</th>
<th>Performance Standard</th>
<th>Performance Threshold</th>
<th>Method of Surveillance</th>
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</thead>
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<td>PRS # 1.</td>
<td>Contractor shall provide <em>MobilityConcierge</em> app and website</td>
<td>Contractor has provided a smart phone app and web application that meets the stated requirements and provides a high level of user experience and usability.</td>
<td>97% System Test pass rate with no more than 0 critical errors, 1 major error, 5 medium errors, 20 minor errors. Functionality &amp; usability testing by targeted users and caregivers</td>
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<td>PRS # 2</td>
<td>The Contractor shall provide <em>MobilityCompanion</em> app and website</td>
<td>Contractor has provided a smart phone app and web application that meets the stated requirements and provides a high level of user experience and usability.</td>
<td>as above</td>
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<tr>
<td>PERFORMANCE OBJECTIVE</td>
<td>Performance Standard</td>
<td>Performance Threshold</td>
<td>Method of Surveillance</td>
</tr>
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<td>---------------------------------------------------------------------------------------</td>
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<td>------------------------</td>
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<td><strong>PRS # 3</strong></td>
<td>Contractor shall provide <em>MobilityProvider</em> app and website</td>
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<tr>
<td>Contractor shall</td>
<td>Contractor has provided operations center software that meets the stated requirements</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td>provide <em>MobilityProvider</em> app and website</td>
<td>and provides a high level of user experience and usability.</td>
<td></td>
<td></td>
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<tr>
<td><strong>PRS # 4</strong></td>
<td>The Contractor shall provide <em>MobilitySage</em> app and website</td>
<td>as above</td>
<td>as above</td>
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<tr>
<td>Contractor shall</td>
<td>Contractor has provided a cloud-based server software that meets the stated requirements and provides a high level of user experience and usability.</td>
<td>as above</td>
<td>as above</td>
</tr>
<tr>
<td>provide <em>MobilitySage</em> app and website</td>
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<td></td>
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<td><strong>PRS # 5</strong></td>
<td>Contractor shall provide a comprehensive evaluation report</td>
<td>Does not apply</td>
<td>Peer review process</td>
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<td>Contractor shall</td>
<td>Contractor has provided a comprehensive evaluation report that documents the</td>
<td></td>
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<tr>
<td>provide a comprehensive evaluation report</td>
<td>evaluation process throughout the project life cycle.</td>
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</table>
G.2 Deliverables Schedule

This technical exhibit lists the reports and documentation that is required as a deliverable, including the frequency, medium/format and who/where it is to be submitted. A deliverable is anything that can be physically delivered but may include non-physical things such as meeting minutes.

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>Print Ready</th>
<th>Frequency</th>
<th># of Copies</th>
<th>Medium/Format</th>
<th>Submit To</th>
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</thead>
<tbody>
<tr>
<td>MobilityConcierge app and web service source code and documentation</td>
<td>Yes</td>
<td>Within 30 days of accomplished milestones</td>
<td>1</td>
<td>online storage; source code files, PDF and MS Word documents</td>
<td>US DOT/ FHWA</td>
</tr>
<tr>
<td>MobilityCompanion app and web service source code and documentation</td>
<td>Yes</td>
<td>Within 30 days of accomplished milestones</td>
<td>1</td>
<td>online storage; source code files, PDF and MS Word documents</td>
<td>US DOT/ FHWA</td>
</tr>
<tr>
<td>MobilityProvider source code and documentation</td>
<td>Yes</td>
<td>Within 30 days of accomplished milestones</td>
<td>1</td>
<td>online storage; source code files, PDF and MS Word documents</td>
<td>US DOT/ FHWA</td>
</tr>
<tr>
<td>MobilitySage source code and documentation</td>
<td>Yes</td>
<td>Within 30 days of accomplished milestones</td>
<td>1</td>
<td>online storage; source code files, PDF and MS Word documents</td>
<td>US DOT/ FHWA</td>
</tr>
<tr>
<td>Deliverable</td>
<td>Print Ready</td>
<td>Frequency</td>
<td># of Copies</td>
<td>Medium/Format</td>
<td>Submit To</td>
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</tr>
<tr>
<td>Comprehensive evaluation report</td>
<td>Yes</td>
<td>Once, within 30 days of completed data collection and analysis for at least 5000 users in final deployment</td>
<td>1</td>
<td>online storage, printed copies; PDF and MS Word documents</td>
<td>US DOT/ FHWA</td>
</tr>
<tr>
<td>Development specifications document</td>
<td>Yes</td>
<td>Within 90 days after start of project, within 30 days of accomplished milestones</td>
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<td>online storage, printed copies; PDF and MS Word documents</td>
<td>US DOT/ FHWA</td>
</tr>
<tr>
<td>Test plan document</td>
<td>Yes</td>
<td>Within 90 days after start of project, within 30 days of accomplished milestones</td>
<td>1</td>
<td>online storage, printed copies; PDF and MS Word documents</td>
<td>US DOT/ FHWA</td>
</tr>
</tbody>
</table>
Part H: Deliverables and Products

H.1 Deliverables

The proposed project’s deliverables are:

- **MobilityConcierge** smart-phone application and web application, as described in Part D, which will be developed using a platform-neutral development framework, and will therefore run on multitude of smart-phone operating systems.

- **MobilityCompanion** smart-phone application and web application, as described in Part D, which will be developed using a platform-neutral development framework, and will therefore run both on a multitude of smart-phone operating systems and on PCs utilizing a web browser.

- **MobilityProvider** operations center software, as described in Part D, platform neutrally running utilizing a web browser. This software can be run on a PC in addition to usual office tasks, but will typically be displayed on one or two larger wall-mounted screens.

- **MobilitySage** cloud-based server software, as described in Part D. FIU agrees to run the MobilitySage server software for at least three years from the day of deployment.

- Prototype system evaluation report: As described in Part D, the proposed system will be tested and evaluated in cooperation with the City of Sweetwater’s Senior Center in Sweetwater, the Neuroscience Foundation, and Miami-Dade County. A comprehensive test and evaluation report will be delivered.

FIU grants Government Purpose License Rights to all software delivered as a part of these funded efforts. All software deliveries, preliminary and final, will include well-documented source code in electronic readable format, overall software architecture documentation, overall and individual module interface documentation, and a user operations manual.

H.2 Products

The smart-phone applications MobilityConcierge and MobilityCompanion will be made available at no charge to the general public via Internet and via major app stores for at least three years from the day of deployment. The MobilitySage server software will be run by FIU for at least three years.
from the day of deployment; its usage will be at no charge for end users. The MobilityProvider management and decision support software will be made available to third parties based on a yet to be determined licensing model.

In addition to the listed deliverables and products, FIU expects the publication of research findings in peer reviewed journals, acknowledging US DOT ATTRI funding. We also expect a number of patent applications resulting from this project.
Part I:    Proprietary Claims

The content of this proposal is hereby requested to be kept confidential to the extent reasonable for the purpose of US DOT review. Some of the technology principles described herein (particularly in Sections C, D, and E) are/may be protected by patents and patents applications currently pending as follows, while other aspects are yet subject to protection.

FIU and its partners shall grant Government Purpose License Rights to US Department of Transportation to all software delivered as part of the funded efforts, and protected Intellectual Property produced in the proposed project, including software, patents, patent applications, and artifacts, as well as to FIU background intellectual property as required to fully utilize the project’s intellectual property.
Part J:  Management Plan

J.1 Organization

This project will be led by the NSF Industry-University Center at FIU (N. Rishe, Director) and will combine efforts of the School of Computing (S.S. Iyengar, Director), Lehman Center for Transportation Research (F. Cevallos, Director of Transit Office), Department of Electrical Engineering (A. Barreto, Director of Signal Processing Lab), and Office of the CFO Research Program (T. Gustafson, Director), in close collaboration with Miami-Dade County (C. Cruz, Director of Transportation and Public Works), Neuroscience Foundation (J. Horstmyer, President), the City of Sweetwater (Mayor Orlando Lopez), and the Sweetwater Senior Center (R. Herrada, Director). (See their respective Letters of Commitment in Volume II.)

Dr. Naphtali Rishe will be the Principal Investigator, leading this Team organized in three laboratories: the Computational Transportation Laboratory does research and development in transportation and parking; the Geospatial Laboratory leads TerraFly’s big data research and development; the Human-Computer Interfaces Laboratory provides state of the art development in assistive technologies. Heads from these laboratories will participate in guiding development teams of students, scientists, and engineers to execute the research and development steps. In addition, the researchers will work with Sweetwater's Senior Center and the Neuroscience Foundation to ensure the products meet the special needs and requirements of these institutions’ patrons, a representative sample of the target customer.

For the herein leveraged project (US DOT TIGER-2013) we are working with FDOT, FHWA, and Miami-Dade Expressway Authority. On 3/29/2016 we had the privilege to demonstrate our technologies to US DOT Acting Under Secretary for Policy Carlos Monje visiting our lab at FIU and we received valuable guidance from Mr. Monje.

J.2 Execution of Effort as Described by WBS

As can be seen by the Work Breakdown Structure, the development fits well into the expertise and resources of the Proposer Team. We will involve resources from all three research and development laboratories, utilizing expert developers and scientists who have had significant
experience in building smart phone applications, web services, and human machine interactions. Tasks and subtasks as defined by the WBS are very similar to projects done in the past and we will build upon assets already established, such as the TerraFly Cloud Services.

An **agile scrum** software development process will be utilized for the TerraFly Concierge software design and development. This method is especially suitable for complex projects in which requirements and solutions evolve as new information is gathered and the project's environment changes. The project will be set up according to the standards set out in the Project Managers Book of Knowledge and will follow the process steps as follows: Initiating, Planning, Executing, Monitoring/Controlling, and Closing. It will ensure that detailed project plans are provided to manage integration, product scope, time/schedule, cost/budget, quality, human resources, communication, risk and procurement.

### J.3 Milestones, Schedule, and Evaluation

The TerraFly Mobility Concierge Services project will proceed in two phases: 1. Research and Development of the Concierge Services (2 Years), and 2. Field Evaluations with local partners (3 Years) with expectation that productization can commence in parallel in Year 4 upon securing private sector funding necessary for productization phase.

During the first two year interval we will develop the system in weekly sprints as defined by the agile scrum process. We will also be working with Sweetwater’s Senior Center to demonstrate prototypes for review and deliverable functions they can try out on a friendly-user basis. Some of the major milestones will be as follows (based upon a January 2017 Start):

1. Delivery of *MobilitySage* Backend and TerraFly Services – July 2017
2. *MobilityProvider* Operations Center Available – January 2018
3. *MobilityConcierge* Smart-Phone App Available – March 2018
4. *MobilityCompanion* Smart-Phone App Available – May 2018
5. Completion of System Verification Concierge Services – December 2018
6. Comprehensive evaluation report – December 2021

The basic requirements for the concierge services will be established and reviewed by the target customers (i.e., the Senior Center and the Neuroscience Foundation). This will form the basis for evaluating the success or failure of the product and whether or not the expectations have been met.
Part K: Technology Transition Plan

The Proposers will produce the described deliverables, software executables and documented source code, and a comprehensive evaluation of the prototype system’s strength and weaknesses. We will distribute the smart-phone applications free of charge via our partner community service institutions as well as via major app stores, and will run the corresponding server software for at least three years from the time of deployment. We assume that, after successful evaluation, the City of Sweetwater will be interested to continue operating the system as an important component of their senior citizen program, in conjunction with Transportation Association’s services (see Sweetwater and UTMA letters). We expect Miami-Dade County and offer a county-wide extension of the system (see Letter). With these customers as references, with comprehensive evaluation by the Neuroscience Foundation, and with guidance by the Center’s Industrial Advisory Board members, the Proposing Team will approach other counties and service providers nationwide. Our community interaction, while having the primary goal to test, improve, and evaluate the system, will help us to identify future clients for deployment and technology transfer after the completion of the proposed ATTRI DOT-funded project. We will also approach NSF, especially their program “Partnerships for Innovation: Accelerating Innovation Research (PFI: AIR)” to enable further development and commercialization efforts. For our success with prior grants from this program please see Part M, Experience.

As the NSF-CAKE Center at FIU is an R&D organizations, we expect to leverage the proposed project to further the understanding in a number of research areas by publishing results in peer reviewed journals and by giving presentations at research conferences. We also have a long history of successful patent applications and plan to extend our patent application program to expand the proposed project successes to other communities with license agreements with third party vendors and communities.
Part L: Facilities

The School of Computing and Information Sciences (SCIS) maintains a data center, research and instructional labs, and computer classroom facilities. These facilities are housed in the Engineering and Computer Science Building (ECS) on the Modesto A. Maidique Campus located in Miami, Fl. The facility is maintained by a dedicated professional IT support staff as noted in the staffing section below.

The School provides computing services such as file, compute, web, email, messaging, backup, print, and other computing services. Our networking services include a 10 Gigabit Ethernet core network that interconnects rack mounted switches and servers. All school desktop systems are connected by 1 Gigabit switched ports. Our network is highly redundant with multiple fiber and copper paths and is designed with routing fail-over capacity. We provide automated monitoring of our network and servers 24x7. The building subscribes to the university 802.11 WiFi network and SCIS maintains a legacy research WiFi network. Our network interconnects at 10GBs to the campus backbone, which provides a 10GBs connection to the NAP of the Americas to provide for connections to Internet, Internet2, Florida and National Lambda Rail, and CLARA (South American Research) networks.

Our systems feature a variety of open source, commercial development and scientific software products from numerous vendors, including IBM, Microsoft, ESRI, MathWorks and others. We provide middleware technologies to support web services. Our environment takes advantage of hundreds of open source software solutions including Apache with full mods, PHP, Perl, and many others. Many of our shared infrastructures provide virtualization services.

I-CAVE™: Established in 2015 as in instructional and research visualization laboratory, allows for interactive visualization and provides standard software information for basic 2-D and 3-D visualization including animations, videos, graphics software and 3D modeling.

Visualization Lab: houses two Sharp PN-L802B 80" Class AQUOS BOARD LED Displays, which are multi-touch capable. Each display is driven by a Dell Workstation containing Intel i7 processors with 16GB of RAM and an AT17 series graphic processing units for high load applications and 3D rendering. The workstations support Surface gesturing. Metro Applications
can be built that provide native gesture support for touch input. Other lab software includes AutoDesk 3D Studio Max for industrial quality 3D design and animation capabilities.

**Student Laboratories:** SCIS operates seven instructional laboratories for use by undergraduates and graduate students in support of our computer science and information technology degree programs. Our instructional labs offer students access to Windows, CentOS Linux, and Mac OS X which run a variety of software development tools, libraries, databases, and have the capacity to host virtual machines. The specific lab equipment is listed in sections below. The School has dedicated servers for student files and/or computing services and a printer in each.

**Staffing:** The school maintains all its computing facilities (total research and instruction: 26 labs, 350+ desktops, 100+ servers, layer 2 and 3 networking) via a dedicated Technology Group. The SCIS Technology Group consists of 5 FTE of permanent professional staff assigned to all of the school's research and instructional laboratories management. In addition, there are at least 2 FTE of temporary students specifically assigned to laboratory assistance. The SCIS Technology Group staff is organized into three groups: Engineering Services, including Networking, Systems, Desktop, and Help Desk Support, and Business Services including Technology Procurement, Asset Management, and Budget/Contract Management, and a Marketing Technology group that promotes the school via digital and social media outlets.

**Data:** The 100TB TerraFly data collection includes, among others, 1-meter aerial photography of almost the entire United States and 3-inch to 1-foot full-color recent imagery of major urban areas, and selected areas at 1cm resolution drone-capture and balloon-captured imagery. TerraFly vector collection includes 3 billion geolocated objects, 100 billion data fields, 2B polylines, 250M polygons, including: all World roads (90M roads, 130M intersections, 1B segments), the U.S. Census demographic and socioeconomic datasets, 150 million polygons of buildings, 110 million U.S. parcels with property lines and ownership data current and historical, 270 million U.S. residential records, 15 million records of businesses with company stats and management roles and contacts, various public place databases (including the USGS GNIS and NGA GNS), Wikipedia, extensive global environmental data (including daily feeds from NASA and NOAA satellites and the USGS water gauges), and hundreds of other datasets.
Part M: Experience

The proposing NSF-CAKE Center was established to develop long-term partnerships among industry, academe and government. It is supported primarily by industry center members, with NSF taking a supporting role in its development, evolution, and core funding. Center affiliation is open to industrial members and government agencies. Affiliation benefits include early access to the Center’s research innovations and interaction with faculty, students, and industry peers.

The Center conducts industry-relevant studies and deployments in the representation, management, storage, analysis, search and social aspects of large and complex data sets, with particular applications in geospatial location-based data, disaster mitigation, healthcare, transportation, and town planning. Director Naphtali Rishe, the inaugural Outstanding University Professor of FIU, is the principal investigator of $50M in grants.

The Computational Transportation Lab (CTL) is a division of the NSF-CAKE Center. CTL is focusing on research and development of advanced consumer-oriented, predictive, and multimodal transportation management software and technology in cooperation with industry, academic, and government partners. CTL is led by Oliver Ullrich, who has ten years of experience in the field of computational transportation science, and has successfully conducted research in France, Germany, and USA.

Pirouette Software, the proposed subcontractor, is a Small Business and has provided its StreetSmart parking discovery technology for integration into the U.S. DOT TIGER-funded UniversityCity Prosperity Project as described in Section C.4. Pirouette Software was founded to transfer technologies created at the University of Illinois at Chicago’s Department of Computer

Figure 9 - NSF 2014 Report’s cover featuring FIU TerraFly
Science and has been funded by two National Science Foundation SBIR awards (IIP-0611017 & IIP-1315169) to facilitate the transfer process.

The Transit Office of the Lehman Center for Transportation Research (LCTR) at Florida International University (FIU) has experience in the following areas: Transit Planning and Operations, Advanced Public Transportation Systems (APTS) or Transit Intelligent Transportation Systems (ITS), Transit Databases, Driving Simulation, Development of Transit Software Applications and web-based Systems, and Transportation for Special Populations which includes the Accessibility and Safety of older adults and people with disabilities.

The Neuroscience Foundation (NSCFF) was founded to improve healthcare delivery through a team-based approach that is comprehensive, coordinate, patient-centric, and disease-specific. NSCFF believes that optimal care can be better achieved with integrated social services. It has designed comprehensive and coordinated care systems that integrate non-medical services and social support programs to answer to patient needs. Licensed clinical social work programs coordinators provide the utmost service to patients. They provide individual counseling and/or familial counseling as well as educate and empower those affected by neurological diseases. Social workers establish and provide different therapeutic events such as support groups and alternative therapies in order to provide the best care possible, while evaluating outcomes to ensure performance.
Part N: Key Personnel

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<td>17</td>
<td>24</td>
<td>17</td>
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<tr>
<td>Iyengar</td>
<td>21</td>
<td>16</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>17</td>
<td>18</td>
<td>17</td>
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</table>

Table 1. Hours per Calendar and Fiscal Year per Key Personnel

Naphtali Rishe, Ph.D. (PI), Eminent Chair Professor of Computer Science, and Director of NSF Center at FIU. Rishe will lead and oversee all aspects of the project providing guidance, direction, and resources as needed to complete the program successfully.

Oliver Ullrich, Ph.D. (Co-PI), Director, Computational Transportation Lab, will be the project's technical development architect and lead researcher on transportation issues.

Fabian Cevallos, Ph.D. (Co-PI), Director of Transit Office at the FIU Lehman Transportation Center, will provide transit expertise during the development and testing of the proposed applications and will ensure that accessibility and safety issues are taken into consideration.

Armando Barreto Ph.D. (Co-PI), Director of Digital Signal Processing Lab and Assistive Technologies expert, will develop sound interfaces.

Debra Davis, Ph.D. (Co-PI), Instructor, School of Computing and Information Sciences, at FIU, has performed evaluation and outcome measurement of FIU’s US DOT TIGER project and several NSF-funded projects; she will perform this role in the proposed project.

Thomas Gustafson, J.D. (Co-PI), will be in charge of the coordination between Miami-Dade County, the UniversityCity Alliance, and supporting efforts.

S. S. Iyengar, Ph.D. (Co-PI), Director and Ryder Professor at FIU’s School of Computing and Information Sciences, will provide technical expertise and direction on visualization, sensor networks, and cybersecurity.
Part O: Qualifications

Biographical sketches for each key person follow:

- Naphtali Rishe
- Oliver Ullrich
- Fabian Cevallos
- Armando Barreto
- Debra Lee Davis
- Thomas Gustafson
- S.S. Iyengar
Dr. Naphtali Rishe
Eminent Professor, School of Computing and Information Sciences
The Inaugural Outstanding Professor, Florida International University
Director, NSF Industry-University Cooperative Research Center at FIU and FAU CAKE.fiu.edu
Director, FIU High Performance Database Research Center HPDRC.fiu.edu
FIU MMC, 11200 SW 8th St, ECS-243, Miami, FL 33199, +1-786-268-9625, rishe@fiu.edu

(a) Professional preparation

<table>
<thead>
<tr>
<th>Institution</th>
<th>Major/Area</th>
<th>Degree &amp; Year</th>
</tr>
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<tr>
<td>Israel Institute of Technology</td>
<td>Computer Science</td>
<td>B.Sc., Summa Cum Laude, 1975-1979</td>
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<tr>
<td>(Technion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tel Aviv University</td>
<td>Computer Science</td>
<td>Ph.D., 1981-84 Dissertation: Semantics of Universal Languages and Information Structures in Data Bases</td>
</tr>
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</table>

(b) Appointments

1987-present Outstanding University Professor (2000-), Professor of Computer Science (1992-), Associate Professor (1987-92) -- Florida International University (tenured in 1990)
1984-1987 Visiting Assistant Professor, Computer Science Department, University of California, Santa Barbara

(c) Sample Publications (more at: http://cake.fiu.edu/Publications/Rishe.html)


(d) Synergistic Activities

- Rishe leads the TerraFly public service disseminating geospatial data. TerraFly has been featured on TV news programs including in FOX News worldwide broadcast, worldwide press, covered by the New York Times, USA Today, NPR, and Science and Nature journals. TerraFly is among the 120 NSF projects in the 2010 NSF Annual Report and Budget Request to Congress. TerraFly is on the cover of 2014 NSF Annual Compendium of I/UCRC Technology Breakthroughs.
- Inventor of 5 U.S. patents, Author of 300 refereed papers, the P.I. of over $50M in grants (including over $20M from NSF and $11M from DOT).
- Among the nation’s leading producers of minority PhDs; Rishe’s graduates included Hispanics who became computer science professors, an African-American woman who authored four successful database books, five PhDs recruited to senior positions at Microsoft, and undergraduate Black women who got the best STEM GPAs at FIU.
- Eight years of industrial and governmental employment as head of software and database projects. Directs NSF Industry/University Cooperative Research Center for Advanced Knowledge Enablement at Florida International and Florida Atlantic Universities.
- The first recipient of the Outstanding FIU Faculty Award (2000) for performance in education, research, and service.
Dr. Oliver Ullrich

Senior Researcher, NSF Industry-University Cooperative Research Center,
Florida International University, ECS 243C, 11200 SW 8th St, Miami FL-33199
(305) 348-7852, oullrich@cs.fiu.edu

a. Professional Preparation

<table>
<thead>
<tr>
<th>College/University</th>
<th>Major</th>
<th>Degree &amp; Year</th>
</tr>
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<tbody>
<tr>
<td>University of Cologne, Germany</td>
<td>Information Systems</td>
<td>Diploma, 2006</td>
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<tr>
<td>University of Cologne, Germany</td>
<td>Computer Science</td>
<td>Dr. rer. nat., 2014</td>
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</table>

b. Academic/Professional appointments

Senior Researcher, NSF Industry-University Cooperative Research Center 03/14 – Present
Florida International University, Miami, Florida
Research Associate, Institute of Computer Science 10/06 – 12/13
University of Cologne, Germany

C. PRODUCTS

(i) Most Closely Related to Proposal


(ii) Other Significant Products


D. SYNERGISTIC ACTIVITIES

- Editorial Board Member, Simulation Notes Europe
- Chairperson of ASIM SIG Traffic Simulation (2011-2013)
- Awarded by University and City of Cologne with Koelnpreis 2007 for diploma thesis on light rail rapid transit simulation
- Student Government President and member of University of Cologne's Academic Senate (1999-2001).
Debra Lee Davis
School of Computing and Information Sciences
Florida International University (FIU), Miami, FL 33199
Tel: (305) 348-1219, Fax: (305) 348-1705, Email: dledavis@cis.fiu.edu

Professional Preparation
Florida International University      Psychology, minor: Computer Science      B.A., 1993
University of Texas at Austin      Psychology, minor: Statistics      M.A., 1996
Florida International University      Computer Science      M.S., 2000
University of Texas at Austin      Cognitive Developmental Psychology      Ph.D., 2004
                                      Minor: Statistics

Appointments
2014 – Present       Instructor, School of Computer and Information Sciences, FIU
2013 – 2014       Digital Instructor, Department of Psychology, FIU
2012 – 2013       Senior Scientist, NOA, Inc.
2010 – 2013       Faculty Research Associate, NSF Industry-University Cooperative Research Center at FIU and FAU, School of Computer and Information Sciences, FIU
2010       Research & Technical Consultant, Child Anxiety and Phobia Program, Department of Psychology, FIU
2006 - 2009       Chief Information Officer, The Children’s Trust, Miami, Florida
2005 - 2007       Education Specialist, Miami-Dade County Public Schools, Adult Education/Regional Operations (part-time)
2001 - 2004       Research Lab Coordinator and Research Assistant, Department of Psychology, University of Texas at Austin (UT Austin)
1993 - 1997       Teaching/Research Assistant/Instructor, Department of Psychology, UT Austin
Products


Synergistic Activities

- Applied Usability Studies and Human-Computer Interaction Expertise (2001-present)
- Program Evaluator, Read 2 Succeed 21st Century Grant (2009-2010)
- Principal Investigator for the All Stars Effectiveness Research Project, McGraw-Hill, Education Division (2007-2008)
- Invited to be a Board Member on the Collins Center of Public Policy’s Community Technology Advisory Board (2008)
- Grant Proposal Reviewer and blind Program Evaluator for multiple government and non-profit organizations such as the City of Miami, City of South Miami, Early Learning Coalition, and Columbian American Service Association (CASA) (2005-2009)
Florida International University: Miami, Florida

Director, Research Programs, Office of Finance and Administration (2011 and presently):

- Assumed support responsibilities for UniversityCity Project after conceptualizing and drafting, in a team effort, the 2011, 2012 and 2013 TIGER Discretionary Grant proposals for UniversityCity Prosperity Project (see http://uc.fiu.edu/); these proposal describe how an Advanced Transit Oriented Development (ATOD) anchored at the Modesto A. Maidique Campus and City of Sweetwater can be established by integrating: i) pedestrian oriented transit access infrastructure; ii) an Informed Traveler Program & Applications (ITPA) that is a newly developed customer-oriented, predictive, and multimodal electronic wayfinding system that disperses travelers in time, place and mode and to alternate destinations; and, iii) improve community transit operating as an advanced feeder bus service that connects local destinations to rapid transit accessible at advanced intermodal and multimodal stations (AIMS) so as to provide enhanced and more frequent transport to metropolitan, regional, national and international destination. Such a South Florida Fast and Slow Transformative Multimodal and Intermodal System of Transport (FASTMIST) will: i) optimize UniversityCity trips; ii) enhance express bus service to and from Miami Intermodal Center (MIC) and Miami International Airport (MIA); and, iii) reinvent multimodal transportation. UniversityCity, through a sequence of federal and state grants, will develop an advanced built, natural and electronic environment that supports a prosperous, high-density, vibrant urban community that attracts students and faculty to FIU and global talent, businesses, and investors to Sweetwater. This will support development of the “Islands of South Florida” and a transformation of Miami-Dade County to a safe, resilient, resolute, self-sufficient, healthy, prosperous, just, intelligent, well-educated, and sustainable community that grows an economy to the size of Singapore on a narrow isthmus securely connected to the most powerfully nation on earth.

- Assigned to support the Sea Level Solution Center (SLSC) and its missions to mitigate climate warming and help South Florida adapt to sea level rise and other climate warming impacts: identifying funding options to respond to climate warming impacts; identify, refine, and accomplish adaptation strategies; and, originate methodologies for a real world environment.
**Director, Govt. & Trans. Policy**, Lehman Center for Transportation Research (2009-2011):

- Assumed responsibilities for development of the Miami-Dade Expressway Authority project report that examined opportunities for an express bus service in Miami-Dade County on the Dolphin Expressway (SR-836). With advanced transit oriented developments and express bus services, the FIU Maidique Campus was linked with MIC and MIA. That work effort was a basis for several TIGER Discretionary Grant submittals in 2010, 2011, 2012 and 2013. See SR-836 Express Bus Service Study (December 2010) at [http://uc.fiu.edu/](http://uc.fiu.edu/).
- Provided advice to the FIU College of Engineering and Computing Dean, faculty and staff on government and transportation policy matters.

The thought process for the SR-836 Express Bus Service Study and UniversityCity submittals was first described in *Growing the New American Economy* and that thought process still guides us today. See [http://cake.fiu.edu/TIGER2012/drop/GTNAE.Complete.pdf](http://cake.fiu.edu/TIGER2012/drop/GTNAE.Complete.pdf).

**Nova Southeastern University**: Fort Lauderdale, Florida

- Director of Government & Ocean Policy, Oceanographic Center (2006 – 2009)
- Director of Governmental Relations, Institute of Government & Public Policy (2003 -2006)

**Florida House of Representatives**: Tallahassee, Florida

- Presiding Officer Southern Legislative Summit: Healthy Infants & Families (1990)
- Speaker of the House (1988-1990)
- Chairman, Criminal Justice Committee (1986-1988)
- Chairman, Healthcare and Insurance Committee (1984-1986)
- Chairman, Transportation Committee (1982-1984)
- Chairman, Insurance Committee (1980-1982)
- Member (1976-1978)

**Thomas F. Gustafson, PA and other law firms**: Fort Lauderdale, Florida

Attorney and Partner (1974 -2003); practiced law for 30 years representing thousands of client regarding a wide variety of subject matters.

**Education**

- University of Notre Dame, Bachelor of Arts (1971): South Bend, Indiana
SITHARAMA S. IYENGAR, Ph.D.
Director and Ryder Professor
School of Computing and Information Sciences
Florida International University, Miami, Florida 33199
Phone: (305) 348-3947 Fax: (305) 348-3549 E-mail: iyengar@cis.fiu.edu
URL: http://cis.fiu.edu/~iyengar

A. PROFESSIONAL PREPARATION
Bangalore University Mechanical Engineering B.S., 1968
Indian Institute of Science Mechanical Engineering M.S., 1970
Mississippi State University Engineering Ph.D., 1974

B. APPOINTMENTS
Aug 2011 - Present Director and Ryder Professor, SCIS, Florida International University
Nov 2002- Aug 2011 Roy Paul Daniel Chaired Professor, LSU
July 1991-Aug 2011 Professor and Chairman, Department of Computer Science, LSU
1980-July 1991 Faculty, Department of Computer Science, Louisiana State U.
1991 (Summer Research) Faculty Fellow, Jet Propulsion Lab., Calif. Inst. of Tech.
1985 (Summer Research) Faculty Fellow, Oak Ridge National Laboratory, Tennessee
1974 –1979 Faculty (JSU) also at various times visiting professor at Indian Institute of Science, University of Paris, etc.

C. PRODUCTS


D. SYNERGISTIC ACTIVITIES

- He has authored/co-authored/edited 15 books in Modeling, Biological Systems, Sensor Networks and Parallel Computing (published by John Wiley and Sons, Prentice Hall (2), and CRC Press, Inc. etc.), and over 400 refereed research publications in these areas.
- Served as a principal investigator/project director/Co-PI on federal grants and contracts valued over $5 million.
- Frequently serves as a member of the program committees for many national and international conferences and also served as a program chairman.
- Over 15 Keynote/Plenary talks in various international conferences.
Fabian Cevallos, Ph.D.

Transit Program Director (305) 348-3144 (Tel)
Associate Research Professor (954) 234-4183 (Cell)
Lehman Center for Transportation Research (305) 348-2802 (Fax)
Florida International University Email: fabian.cevallos@fiu.edu
10555 W. Flagler Street, EC 3609 LCTR: http://lctr.eng.fiu.edu
Miami, FL 33174

(a) Professional Preparation

<table>
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<th>Institution</th>
<th>Major/Area</th>
<th>Degree &amp; Year</th>
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<tr>
<td>Guayaquil State University, Ecuador</td>
<td>Civil Engineering</td>
<td>B.S., 1985</td>
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<tr>
<td>San Jose State University, CA</td>
<td>Transportation Engineering</td>
<td>M.S., 1993</td>
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<tr>
<td>University of Las Vegas, NV</td>
<td>Postgraduate Studies</td>
<td>1993-1994</td>
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<tr>
<td>Florida International University, Miami, FL</td>
<td>Transportation Engineering</td>
<td>Ph.D., 2006</td>
</tr>
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(b) Appointments

2006-present Transit Program Director, Associate Research Professor, Lehman Center for Transportation Research, Miami, FL
2002-2006 Senior Research Associate, Center for Urban Transportation Research, Tampa, FL
1997-2002 Senior Planner, Broward County Mass Transit, Pompano Beach, FL

(c) Products


(d) Synergistic Activities

• Established a transit program for the Lehman Center for Transportation Research (LCTR) at Florida International University (FIU). Project sponsors include the United States Department of Transportation (US DOT), Federal Transit Administration (FTA), the Florida Department of Transportation (FDOT), the Center for Urban Transportation Research (CUTR), the National Center for Transit Research (NCTR), Miami-Dade Transit (MDT), and Miami-Dade County Public Works.

• FIU representative to the National Center for Transit Research (NCTR) Consortium. NCTR is one of the 22 national University Transportation Centers (UTCs) designated by the U.S. Department of Transportation. The goal is to advance research and education programs that address critical transportation challenges facing the nation. It supports the priorities of the U.S. Department of Transportation (DOT) and the participating universities are a critical part of the national transportation strategy.
ARMANDO B. BARRETO, Ph.D.
Departments of Electrical & Computer Engineering and Biomedical Engineering
Director, Digital Signal Processing Laboratory and Professor
Florida International University
10555 West Flagler Street, Miami, FL., 33174, Room EC-3981
Phone: (305) 348-3711 Fax: (305) 348-3707 email: barretoa@fiu.edu

(a) Professional Preparation

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<td>National Autonomous University of Mexico (UNAM)</td>
<td>Electrical-Mechanical Engineering</td>
<td>(BSEE equivalent), 5/1987</td>
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<tr>
<td>Florida International University, Miami, FL.</td>
<td>Electrical Engineering</td>
<td>MSc, 8/1989</td>
</tr>
<tr>
<td>University of Florida Gainesville, FL.</td>
<td>Electrical Engineering</td>
<td>PhD, 5/1993</td>
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</table>

(b) Appointments
2010 - Present Professor, Electrical & Computer Engineering Dept., Florida International Univ.
2003 - Present (Courtesy) Appointment, Biomedical Engineering Dept., Florida International Univ.
1999 – 2003 Associated Faculty, Biomedical Engineering Institute, Florida International Univ.
1994 - Present Director, Digital Signal Processing Laboratory, Florida International University
(c) Products


(d) Synergistic Activities

- Established the FIU Digital Signal Processing Laboratory, and created the course: EEL-5757: Real-Time DSP Implementations, to combine the teaching, practice and research of Digital Signal Processing.
- Directed DSP research applied to the development of practical DSP-based alternative human-computer interfaces, with emphasis on assistive technologies.
Part P: Other Proposals

ATCMTDP: Developing a Partnership for Deploying Innovative Transportation Solutions, Pending Proposal, Miami-Dade County/US Department of Transportation, $14,008,741 (to FIU), Includes committed effort for Rishe (665 hours per year), Iyengar (184 hours per year), Ullrich (1,181 hours per year), Gustafson (385 hours per year), and Cevallos (740 hours per year).

UniversityCity Prosperity Project, Current Project, Funded by USDOT TIGER V (FM#434688-1/Contract-ARI73), 2/1/2014-1/31/2017, $11,397,120, Includes committed effort for Rishe (261 hours per year), Iyengar (87 hours per year), Gustafson (174 hours per year), and Davis (261 hours per year).

MRI: Development of an Integrated Neuroimaging Instrument with Temporal and Spatial Alignments for Brain Research, Current Project, Funded by National Science Foundation (CNS-1532061), 9/15/2015-8/31/2020, $3,955,110, includes committed effort for Rishe (87 hours per year) and Barreto (87 hours per year).

IUSE/PFE: RED: Florida International Computer Science Institutional Transformation, Pending Proposal, National Science Foundation, $1,999,897, includes committed effort for Iyengar (87 hours per year) and Davis (87 hours per year).

Student Learning and Engagement in STEM Gateway Courses Supported by a Cyberlearning Environment (STEM-CyLE), Pending Proposal, US Department of Education, $1,400,000, includes committed effort for Davis (174 hours per year).

III: Large: Collaborative Research: Moving Objects Databases for Exploration of Virtual and Real Environments, Current Project, Funded by National Science Foundation (IIS-1213026), 9/1/2012-8/31/2017, $1,331,000 (to FIU, also includes collaborative awards at Brown, UIC, and Northwestern), includes committed effort for Rishe (174 hours per year).

Collaborative Research: Engaged Student Learning – Design and Development Level II: Using a Cyberlearning Environment to Improve Student Learning and Engagement in Software, Current Project, Funded by National Science Foundation (DUE-1525112), 9/1/2015-8/31/2019, $821,954 (to FIU), includes committed effort for Davis (174 hours per year).
I/UCRC-CAKE Phase II: Center for Advanced Knowledge Enablement, Current Project, Funded by National Science Foundation (IIP-1338922), 10/1/2013-9/30/2019, $741,000, includes committed effort for Rishe (5 hours per year).


CICI: Regional: South Florida Cybersecurity Testing and Resource Center for Scientific Collaboration, Pending Proposal, National Science Foundation, $500,000, includes committed effort for Iyengar (44 hours per year).

RET SITE: Research Experience for Teachers on Cyber-enabled Technologies, Current Project, Funded by National Science Foundation (CNS-1407067), 8/1/2014-7/31/2017, $498,000, includes committed effort for Iyengar (17 hours per year).

MRI: Development of an Instrument for Acquisition, Management, and Analysis of Super-resolution Aerial Imagery, Current Project, Funded by National Science Foundation (CNS-1429345), 9/1/2014-8/31/2017, $366,000, includes committed effort for Rishe (5 hours per year).


REU SITE: ASSET: Research Experiences for Undergraduates in Advanced Secured Sensor Enabling Technologies, Current Project, Funded by National Science Foundation (CNS-1560134), 2/1/2016-1/31/2019, $360,000, includes committed effort for Iyengar (3 hours per year)

At the time of submission, eight additional Current Projects, totaling $1,184,772, and one additional Pending Proposal, totaling $189,434, involve this project’s Key Personnel. Space does not allow the enumeration of these Projects and Proposals.
Part Q: Bibliography


For a comprehensive bibliography, please see http://CAKE.fiu.edu/ATTRI/.