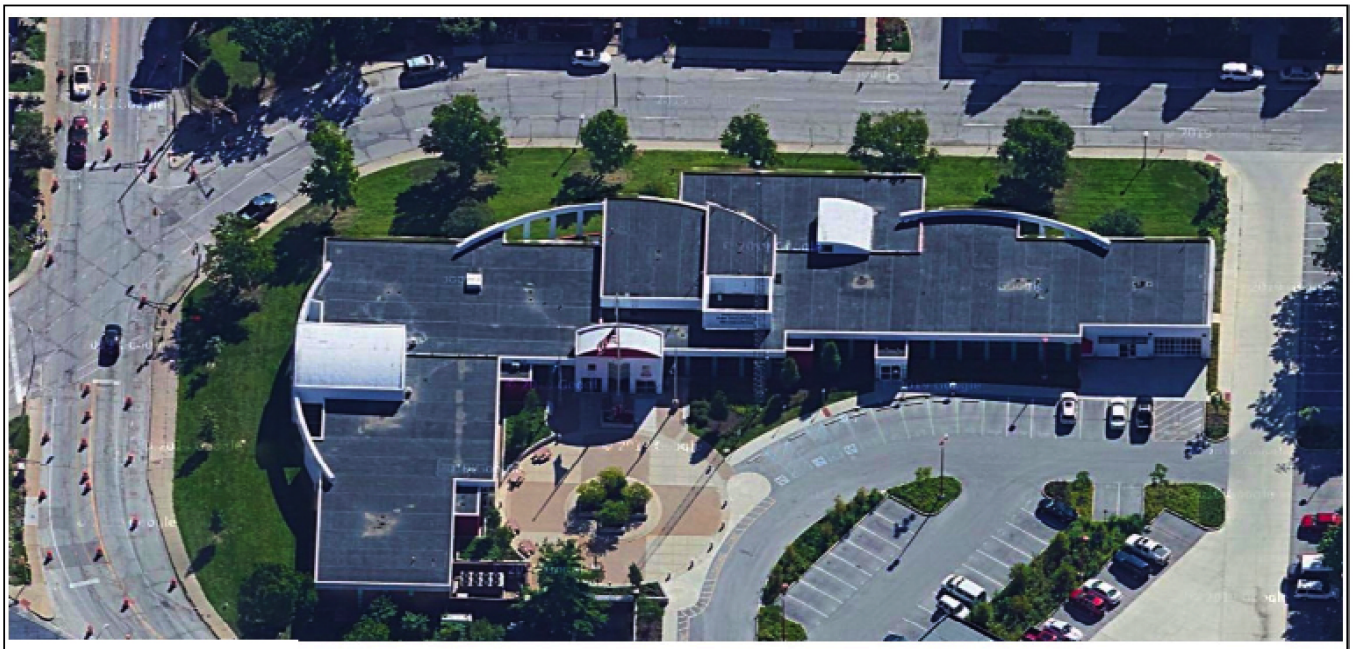
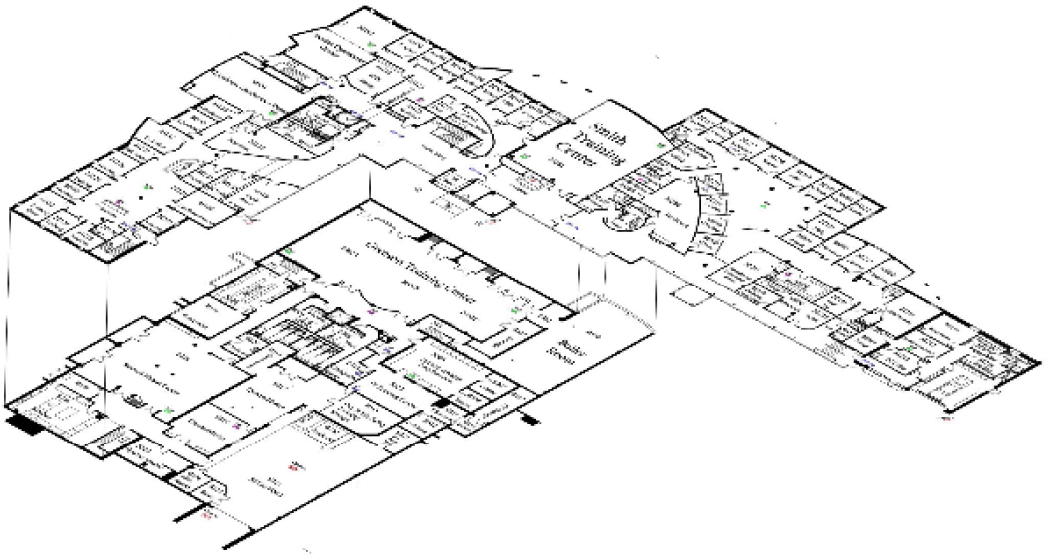




Indianapolis Fire Department
Headquarters Building
955 Ft, Wayne Avenue
Indianapolis, IN 46202

iSite Project

Public Safety Demonstration Testbed

A TABA Grant Application
to the
National Institute of Standards and Technology
Public Safety Communications Research

May 2022

iSite Project
TABLE OF CONTENTS

Section 6 - Project Narrative

A Proposal to NIST PSIAP TABA from Indiana University

Project Title: iSite Smart Pre-Plans Public Safety Demonstration Testbed

(6a) Cover Page

Previous Award Title: The Indiana First Responder 3D Indoor Tracking Challenge

Award Number: 70NANB21H022

Awarding Funding Agency: U.S. Department of Commerce, National Institute of Standards and Technology

Description of the work performed under the previous award: The previous award is focused on administering a five-phase prize competition focused on indoor location tracking of first responders called the First Responder Smart Tracking (FRST) Challenge. The Indiana University team has completed the first two phases of the competition, with three additional phases to be completed. In the final two phases of the competition, competitor prototypes will be tested at an urban training center. The judging platform for the competition will include 2D and 3D maps of the testing facilities. The team has been working with San Francisco Communications to leverage technology, processes, and procedures it has been developing over the past decade to develop maps.

Applicability of your project to public safety communications: This project addresses one of the core gaps identified by the NIST PSCR-funded i-Axis project, the need for better mapping technologies. Specifically, the iSite Smart Pre-Plans is built on open standards such as the Indoor Mapping Data Format (IMDF) and off-the-shelf tools. The resulting maps are interoperable with various types of maps such as Google Maps, Apple Maps, and ESRI. In this proposed project for TABA, we will leverage the mapping work from the competition and develop a testbed implementation with the Indianapolis Fire Department. This testbed implementation will serve as a reference model for how public safety organizations can develop custom public safety maps at low cost and using open standards.

(6b) Project Description

Introduction

NIST PSCR LBS Research & Development Priority - Emergency responders have a compelling need to understand the physical environment in which they are working. Where are public safety personnel and equipment? What hazards and resources are present in the area? What entry and exit routes are available? PSCR refers to the collection of technologies and systems that gather, store, disseminate, and act on location and located information as location-based services (LBS). This project seeks to build on prior work, such as the i-Axis project, by providing critical technologies, processes, and procedures for generating standards-based indoor maps for public safety organizations.

Previous Demonstration Project - For the last nine months, Indiana University's Crisis Technologies Innovation Lab (CTIL) has been collaborating with San Francisco Communications (SFC) and coordinating with the Open Geospatial Consortium (OGC) to develop an open system methodology for the integration of location-based services into a tactical common operating picture. This work was presented to NIST personnel in October of 2021. This collaboration originated with the need to develop maps of the testing facility for the judging platform for the First Responder Smart Tracking Challenge (FRST Challenge). While the use case for the iSite Smart Pre-Plan technologies for the competition is relatively narrow, IU recognizes the opportunity to demonstrate the value of the map generation processes developed by SFC using OGC standards for its competitor teams and the broader stakeholder community. In addition, IU CTIL has an ongoing collaborative relationship with the Indianapolis Fire Department on several initiatives, including the FRST Challenge. They will provide expert input and serve as a testbed for this project.

Our Approach - This application proposes to develop an integration framework for the PSCR set of location-based services to implement a tactical common operating picture (Local-COP). This real-time shared graphic depiction of the incident area and the responding units will be invaluable for coordinating multidisciplinary emergency response resources.

Technical Outputs/Fundamental Innovation - This approach will create facility iSite Smart Pre-Plans built with open system standards and formats and minimal dependence on proprietary software products. An iSite is a GeoArea containing one or more iBObs. An iBOb is an intelligent Building Object that contains minimal BIM and other data, as well as internal and external behaviors. External behaviors are actuated through an API (Application Programmer Interface). The major sub-objects are floors, rooms, doors, and features. An iBOb is an independent web object that can be called from any host program and thus serves as an interoperable reference for source information and shared messaging. Peer-to-peer communications will be based on the pre-distribution of these modular maps. In addition, these smart pre-plans will provide interactive room identification and highlighting, together with pre-located safety elements. The core technology capability is at a TRL 5 with the target of a TRL 7 by the end of this project.

The Project Strategy - A well-documented system for establishing a Local-COP capability at the jurisdictional level will be created. The fire service would be the lead agency to process and distribute facility pre-incident plans from the site owners. These plans would be shareable with law enforcement, emergency medical services, and public works in the local area. Initial implementation prototypes will be demonstration testbeds to validate the approach and provide a platform for experimentation with evolving LBS technologies.

Demonstration Project with Partner Public Safety Agency – The Indianapolis Fire Department Headquarters, which also includes a fire station, has been chosen as the testbed and pilot case study to demonstrate the iSite approach. This building will be mapped, including all major fire and life safety equipment, and building controls. In addition, the OGC Indoor Mapping Data Format (IMDF) standard will be implemented to include the ability to track personnel indoors. Once this testbed is established, incident scenarios will be emulated to demonstrate dispatch-able location and other iOS LBS services on iPhones and iPads.

Emergency Response Problem Landscape

The traditional fire service practice of documenting facility pre-incident plans is paper-based and dependent on each site owner to provide indoor floor plans on a voluntary basis. Understandably, many facilities go undocumented for the Public Safety agencies. Until recently, the available plans were published as one or more binders for the Fire Chief and the Battalion Chiefs each to have in their vehicles. These paper plans are not shareable except with those who are physically present at the incident command post.

Modern adaptations often append PDF copies of these facility plans to wireless apps for first responder mobile access. However, these floor plans are just static reference graphics with no capability to interact with other components of the Incident Management Software (IMS). The lack of a standard method to integrate indoor floor plans with wireless tracking technologies represents a significant barrier to interagency interoperability and mutual aid for larger incidents. Lack of interoperability translates into vulnerability.

Many important public safety goals depend on integrating indoor floor plans with first responder applications for a more comprehensive outdoor-indoor common operating picture. However, there have been limited responses to this technology/methodology gap from government and industry. When there have been responses, they are at unaffordable prices for many organizations or locked into proprietary platforms. New methods are desperately needed to break this public safety interoperability log jam.

The i-Axis project conducted by the National Alliance for Public Safety GIS Foundation and funded by NIST PSCR seeks to address critical indoor public safety mapping, tracking, and navigation challenges. The iSite approach brings together two key recommendations of the 2022 i-Axis Best Practices Guide (v2 draft). The first is a need for a systematic methodology to prepare pre-plans. The second recommendation is to employ an open format such as Indoor Mapping Data Format (IMDF). This project intersects with the workflows and methods described in section *2.5 How to capture 2D and 3D indoor maps* of the report.

The elusive goal of accurately tracking first responders indoors will require developing intelligent floor plans that can be integrated into standards-based IMS (Incident Management Software). The iSite Smart Pre-Plans offer a technology that can be paired with solutions developed by the FRST Challenge competitors as they seek to develop go-to-market product roadmaps and build out their custom solutions.

New Digital Pre-Plans for Public Safety

This project seeks to develop core components of a **Digital Pre-Plan EcoSystem** to support enhanced Next Generation 911 Emergency Services. The following perspectives are drawn from empirical experience in developing indoor maps for public safety. This background is provided as a starting point for discussing and defining the functional requirements for interoperable pre-plans. Later sections will describe the specific work in this project that fits within this ecosystem. These will be required to enable a shareable Outdoor Indoor Common Operating Picture (COP).

- **The Site Owner Role:** Indoor Mapping cannot be achieved without the consent, cooperation, contribution, and coordination of the site owner.
- **Site Owner Responsibilities:** The site owner must maintain the pre-plan currency and control the distribution and sharing.
- **Fiduciary Agency Having Jurisdiction**: A fiduciary agency with jurisdiction should catalog these pre-plans on a secure server.
- **Mutual Aid:** The agency having jurisdiction should be able to share such pre-plans with mutual aid partners at the local, state, and federal levels.
- **Unified Command System COP:** Distributed pre-plans should feed the Unified Command System (UCS) - Common Operating Picture.
- **Agency Apps of Choice:** Mutual aid partners should be able to access pre-plans through the in-house apps of their choice.
- **Interoperable COPs:** Mutual aid partners should be able to link their local apps to the UCS - COP.
- **Interoperable Pre-Plans:** Pre-plans need to be interoperable Web objects, not just graphic data format files.

Notable Features

The proposed **Digital Pre-Plan EcoSystem** has multiple notable features, as described below.

- **Browser-Based Independence** The smart pre-plans are constructed using web standard HTML and JavaScript. Each pre-plan is an independent “WebObject” that contains the interior floor plans and an API that provides component interoperability for integration into other higher-level web applications. In this way, the preplans can be displayed on smartphones, tablets, laptops, desktops, and large presentation screens.

- **Offline Operation** A significant emphasis of this smart pre-plan approach is to build as much functionality as possible into the responder application. In this way, responders can continue to operate even when disconnected. This will require persistent storage on the field device to record GPS tracks, photos, and markups. Search and rescue is a major "use case" where communications connectivity is severely compromised. This also protects the responder from being handicapped if a distant server goes down or is otherwise unavailable. A second advantage to pre-loading the smart pre-plans is that it greatly reduces the communication bandwidth required if these preplans do not have to be transmitted in real-time during an incident.
- **GPS Tracking** GPS positioning is important for both emergency vehicles and first responders.
    - **Emergency Vehicles** The initial response is for dispatch to locate the closest vehicles to the reported incident by checking a tracking map that includes the position of all active units. Then, dispatch will direct one or more units to respond to the incident address and provide routing instructions which can be displayed on the unit's MDT (Mobile Data Terminal, usually a Toughbook or an iPad). Reference to a site plan map can also indicate the most appropriate access approach and building entry/exit point.
    - **"Boots on the Ground"** First responders, once dismounted from the vehicles, need to be tracked individually both outdoors and inside the subject building(s). The transition from outside to inside is made particularly difficult because outside GPS does not work inside. Therefore, the responder's positioning technology must know when a specific building is entered and have a map-assisted indoor navigation capability. Both the incident commander and the responders themselves need to be able to see their own position, as well as all the other personnel, especially in the event of a "Fire Fighter Down."
    - **Incident Command Post** The incident commander needs to see the deployment of the vehicles and responders to make command decisions and route responders to the correct location. This GPS tracking data needs to be recorded to permanent storage to allow "After Action Replay."
- **Smartphone Dispatchable Location** In addition to emergency resource tracking, the GPS on a smartphone can provide a single point location for an NG-911 call. If the phone is provisioned with a Smart Pre-Plan, the raw GPS position can be translated into a "Dispatchable Location," which includes civic address, floor, and room identifier. This can unburden the dispatch center from having to do this translation.
- **DHS S&T NGFR Compatible** DHS S&T developed a Systems Architecture for the field app called Next Generation First Responder (NGFR). This design provides a framework for integrating many functions into the "Hub" unit carried by each responder. Where possible, the iSite project will follow their design, and interface guidelines are followed. These archived guidelines can be found on the DHS S&T website.
- **FirstNet Store Compliant** Also, the FirstNet Authority has set up standards for First Responder App Store Compliance. The Indiana University team is already working with FirstNet Authority on the FRST Challenge and will see their guidance and input into prototype and testbed development.

This vision for a Digital Pre-Plan Ecosystem has been proven with several implementations by SFC, with the most recent pilot on four buildings at Indiana University. The following section briefly describes two of these demonstrations.

Previous Demonstration Projects

The San Francisco Unitarian Church - Demonstration Testbed

As part of the Safe Sites Initiative, San Francisco Communications (SFC) has been working to develop a low-cost method for churches and schools to document their facilities for electronic exchange with first responder organizations. Major projects with Menlo Park Fire and Palo Alto Schools provided a foundational experience for public safety documentation requirements.

SFC has developed an advanced testbed with the San Francisco Unitarian Church in the last few years. The building has been thoroughly mapped, starting with scans of older hand-drawn floor plans. All the fire and life safety features and building controls have been located and depicted on the overview map (see Figure 1). In addition, the building has been mapped in the OGC Indoor Mapping Data Format (IMDF) and supports iOS Indoor Maps on iPhones and iPads (see Figure 2).

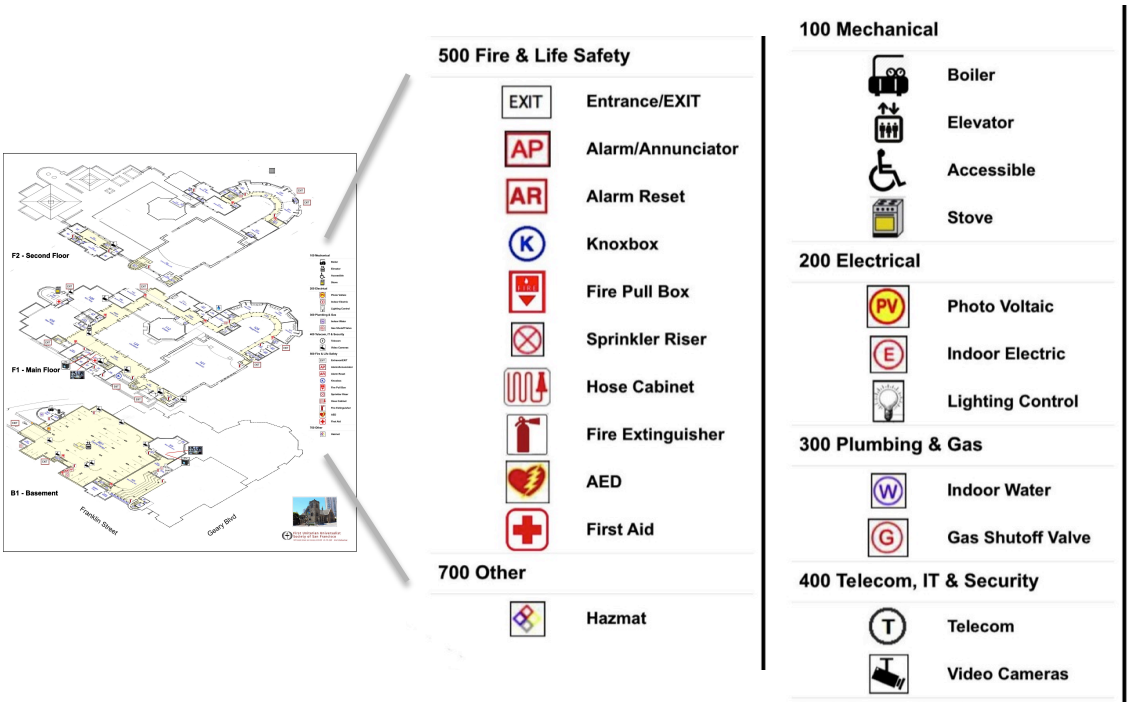


Figure 1. Example map produced in demonstration testbed with public safety and other features labeled in the resulting maps.

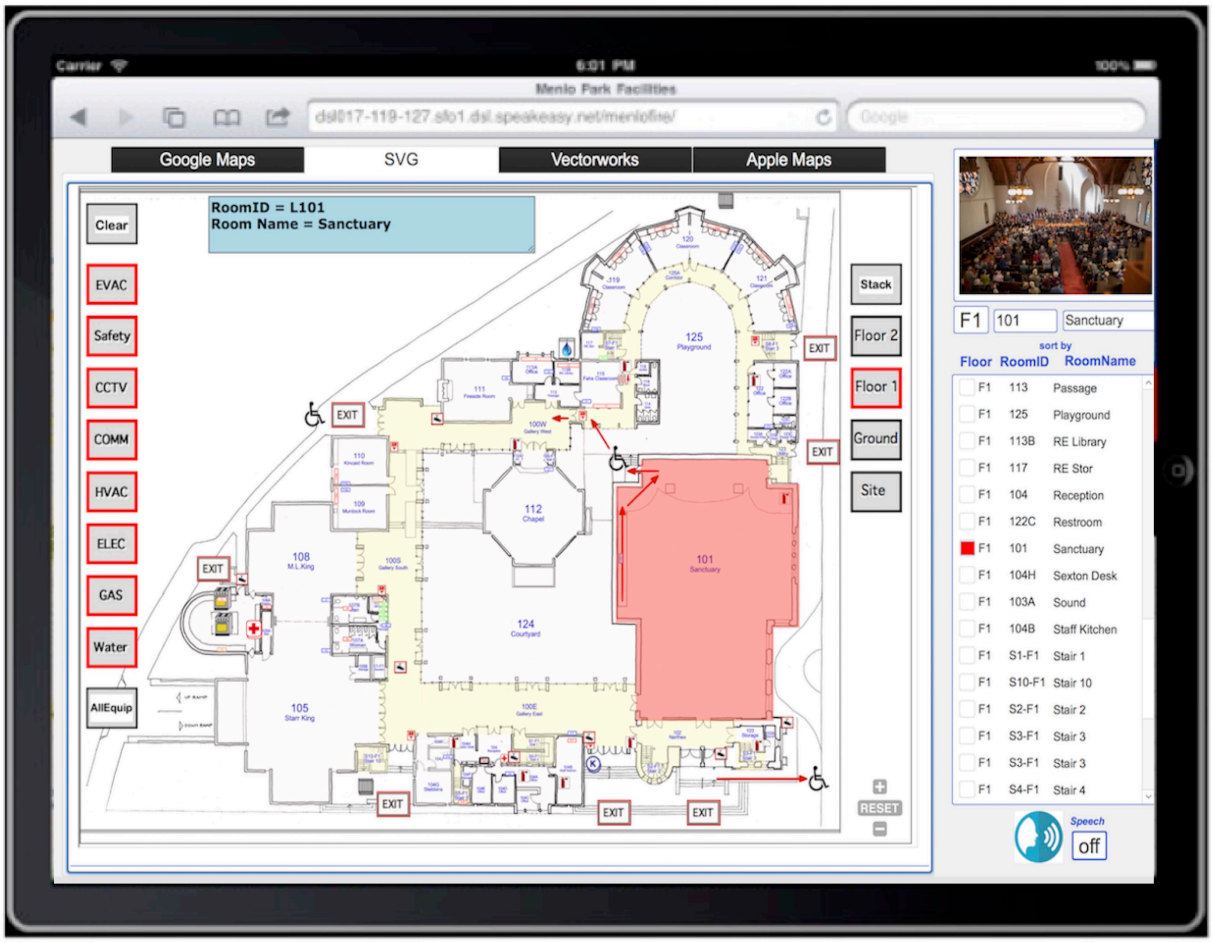


Figure 2. iPad Map including COP Map.

Indiana University - Demonstration Testbed

As a demonstration of capabilities for the FRST Challenge, SFC worked with Indiana University to utilize CAD models and PDF files of multiple buildings on campus. The resulting maps were overlaid on Google Maps to provide a proof-of-concept implementation and refine workflows (see Figure 3). A user can zoom out to campus level, see all buildings, zoom into specific buildings, and then interact with floor plans for each floor of the selected building.

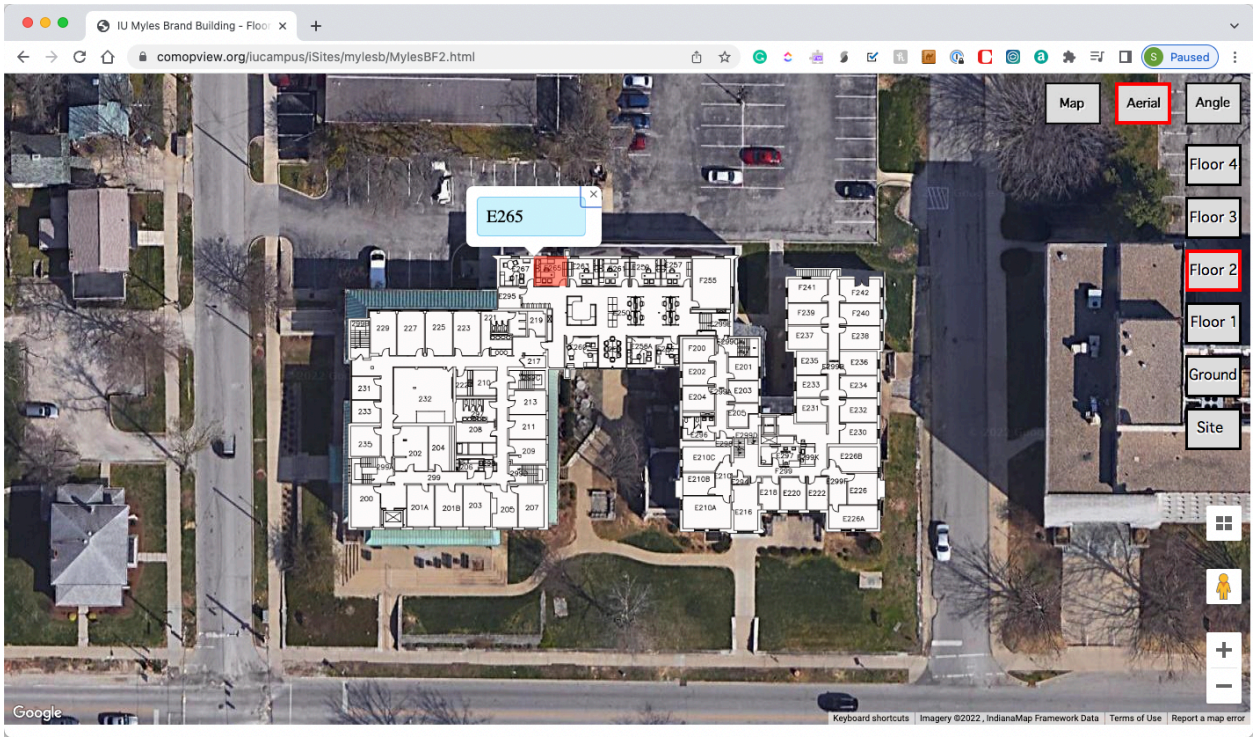


Figure 3. Example floor plans overlaid on Google Maps. The user has selected a room where more information is provided.

Technology Integration Assessment

Current State of the Art

Pre-incident plans are not standardized, nor are they mandated by the Fire Service. Best practice recommendations are offered by the NFPA (National Fire Protection Association) and NAPSG (National Alliance for Public Safety GIS); see the NIST-funded *i-Axis Best Practices Guide to Indoor Mapping, Tracking, and Navigation Version 2* (2022 draft release). Building floor plans are usually requested and collected for public facilities such as schools, universities, hospitals, and government buildings. Major corporate facilities are also pre-planned with the local fire service. Generally, those floor plans are static PDFs. Some fire agencies build electronic copies overlaid with key safety features. After the Sandy Hook mass shooting tragedy, a Federal cross-agency task force issued strong site and building plans guidelines. However, these were recommendations, not mandates, nor was there any funding available to produce this documentation. As a result, implementing these recommendations is rare and rendered in different vendor products that do not interoperate.

The Tactical COP concept of a common operating picture originated with naval and military strategic command and battlefield tactical command. In response to recent disasters like September 11th, Katrina, Super Storm Sandy, and others, DHS and FEMA have begun to adopt the common operating picture protocol for domestic events and incidents. Pre-planned events like the Presidential Inauguration or the Super Bowl provided large-scale testbed opportunities to

practice the technology integration required to connect sensors and cameras to responders and the command staff. There has been no emphasis on applying COP coordination protocols to local incidents such as a building fire or active shooter event.

iSite Smart Pre-Plan Project Outcome

The success of this project will demonstrate a new way forward to preparing for emergency response incidents. iSite Smart Pre-Plans provide a robust context for outdoor and indoor tracking. They can also underpin a shareable command view for mutual aid. Next Generation 911 dispatchable location will be significantly enabled by the smart pre-plan ability to translate indoor positions to the building floor and room identification. The power of an outdoor-indoor COP has not yet been explored because it has not yet been demonstrated. This project aspires to provide this capability in the form of an experimental testbed reference implementation. Lessons learned will inform efforts going forward.

Significance of this Smart Pre-Plan Project

NIST PSCR LBS Goal Alignment

There are several levels of goal alignment between this project and the NIST LBS program, including the following.

- **Open Systems Interoperability**. The smart pre-plan and the tactical COP applications will both be built with a minimum set of open Web standards. These include HTML5, JavaScript, PHP, Python, and others that are readily available on most computers. Special emphasis will be placed on testing and demonstrating the capabilities of OGC IMDF as an enabling exchange format for first responder tracking and navigation.
- **LBS Roadmap 2015 - Common Operating Picture**. The number one goal in the software and applications section of the LBS Roadmap reads as follows: “to optimize responders common operating picture and ensure the interoperability of location-aware applications.” This project will demonstrate a tactical COP scaled to the scope of a single Fire Service jurisdiction. This approach will be based on open system smart pre-plans.
- **NIST NOFO 2022 Specific LBS Goals**. The tactical COP will address most of the LBS NOFO goals, including Outdoor-Indoor Maps, Positioning of Responders and Equipment, and especially a Reference Indoor Measurement System. Such a system can be used to set up testbeds in various environments.
- **NAPSG i-Axis Project – Best Practices**. Over the last several years, NIST has partnered with NAPSG in the i-Axis Project, which has just published Version 2 (draft) of the i-Axis Best Practices Guide to Indoor Mapping, Tracking, and Navigation. The iSite Project is in harmony with these Best Practices. It will demonstrate several i-Axis goals for a systematic method for pre-planning and implementation of IMDF indoor tracking.
- **DHS S&T and FirstNet Compatibility**. This project will follow the system architecture lead of DHS S&T in the Next Generation First Responder Apex Program and the DHS NUSTL SAVER Program. Additionally, we will learn and comply with the FirstNet Authority First Responder Store App Requirements.

Potential Impact on First Responders

A NIST stated requirement from a recent solicitation states, *"Emergency responders have a compelling need to understand the physical environment in which they are working. Where are public safety personnel and equipment? What hazards and resources are present in the area? What entry and exit routes are available?" (from Notice of Funding Opportunity NIST Public Safety Innovation Accelerator Program 2022).*

This project will demonstrate the integration of the various LBS technologies into a cohesive Common Operating Picture made possible by the rapid availability of Smart Pre-Plans. Visual indoor building locations can be quickly messaged to all the different first responders involved in an emergency incident. These include the NG-911 call takers, CADispatch Operators, station and vehicle personnel, Incident Commanders, and "boots on the ground" First Responders.

In the last decade, Fire Services such as FDNY have begun to realize the need to have building floor plans in an electronically readable format. There are many different candidate formats such as PDF, JPEG, DWG/DXF, etc. For these drawings to be useful to the Fire Service, there needs to be a standardized method to incorporate the drawings into actual fire response procedures. Unfortunately, such methods have not yet been mandated by any regulatory agency, and implementation will vary from one agency to the next.

This project recognizes the many variations between fire department procedures and strives to provide an easy, cost-effective, and efficient way to integrate the proposed format into existing activities. Current Fire Codes require building owners to provide adequate information for the Fire Service to periodically inspect the building for safety element compliance. The new proposed format will have the best chance of success if it supports and simplifies this inspection and reporting activity.

We intend to conduct a major pilot test scenario to validate the new format and attendant procedures. In this case, the Fire Department will be a significant stakeholder in project activities to ensure the proposed system will integrate well with existing and anticipated firefighter systems. The value of being able to keep track of the location of firefighters in a burning building is self-evident and universally acknowledged. That is why there is so much interest and research into developing effective methods. It has been repeatedly referred to as the "Holy Grail" of firefighting technology development. Obvious benefits include saving lives through hazard avoidance and effective rescue efforts. Powerful location-based situation awareness will significantly improve the incident commander's ability to manage resources. More effective firefighting techniques can drastically reduce the loss of lives and property.

Approach

The iSite Smart Pre-Plan project is based on focused research, development, and testing conducted by SFC. For this TABA project, our team will utilize multiple tools and standards, follow established guidelines, and best practices. We will work with first responders, who will provide expert input and serve as a testbed. The outcomes will help provide tools and resources to serve this community of users.

Tools

The following tools will be used in the execution of this project:

- Web Browser Standards - HTML & JavaScript
- Publicly available building information and floor plans
- COTS Application Software
    - Vectorworks - BIM Capable CAD
    - Google Maps Developer JavaScript API
    - Claris FileMaker Application Platform
    - Apple iOS iPhone & iPad

Standards, Guidelines, and Best Practices

The following are standards and organizations that provide documentation, guidelines, and best practices that will be considered in the execution of this project:

- OGC Community Standard: IMDF - Indoor Mapping Data Format
- Federal Agencies - Open System Efforts including Department of Commerce (FCC – NTIA; FirstNet Authority; NIST – PSCR); Department of Homeland Security (Science and Technology; National Urban Security Technology Laboratory; FEMA – USAR); Department of Justice, National Institute of Justice
- NGO Public Safety Efforts and Publications (OGC - Open Geospatial Consortium; NFPA - National Fire Protection Association; NAPSG — National Alliance for Public Safety GIS); IJIS - Integrated Justice Information Systems
-

Software Performance Goals

The goal of this project is to extend current abilities in each of these areas and provide a reference implementation of the iSite Concept of Operation (see Figures 4 and 5).

Smart Pre-Plan Construction Methodology

a) Geo-referenced indoor topology of floors, rooms, and doors
b) Uncluttered floor plans with Room ID and Name labels
c) Clearly marked Exits and circulation routes
d) Fire Safety and Building Systems equipment locations
e) Onboard intelligence to transmit Dispatchable and Depictable Location (the ability to generate a snapshot of the floor plan which highlights the subject room location)

Responsive, User-Friendly Personal Map Buddy

a) Familiar Web map interface with additional custom controls to navigate between building floors
b) Searchable Room ID and Name index
c) Ability to self-locate the user's "blue dot" on an outdoor-indoor map
d) Ability to adjust positioning to the known location
e) Ability to transmit location in both GPS coordinates and semantic civic address resolution (street address, floor, room)
f) Ability to take photos that are tagged with both types of location in e)

Testbed Demonstration(s) of a Tactical Common Operating Picture

a) "Ground Truth-ed" proving ground for testing, training, and exercises
b) GPS Team Tracking of emergency vehicles and "boots on the ground"
c) First Responders equipped with a personal MapBuddy
d) Mobile network configuration to provide a Shared Command View
e) Demonstration of operation during typical incident scenarios

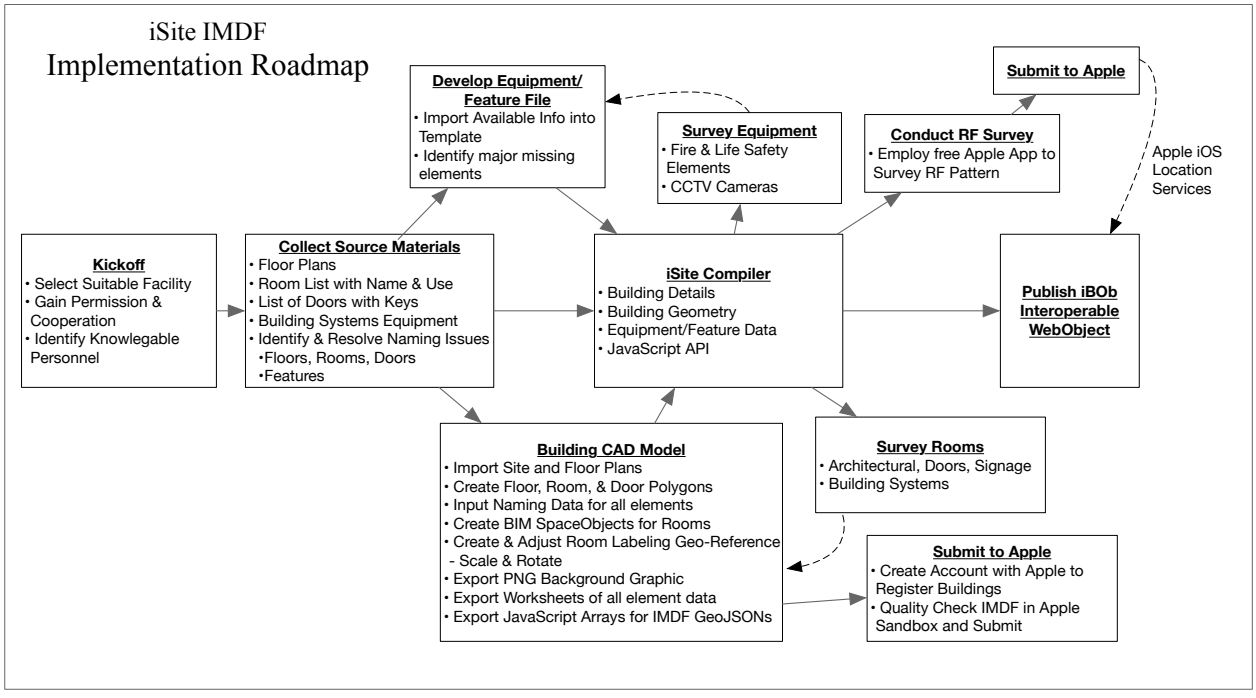


Figure 4. IMDF Implementation RoadMap for iSite Smart Pre-Plans is a variation of the existing iSite Methodology, as seen in Figure 5.

(next page) Figure 5. iSite Methodology Workflow Schematic provides an overview of the existing workflow to create iSite Smart Pre-Plans.

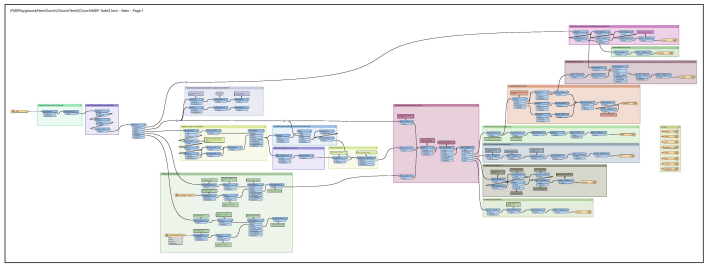
iSite Methodology
Work Flow Schematic

September 2020

Phase I

- Vectorworks
- FileMaker
- Safe FME
- SuperCard

Safe FME iSite Transformer

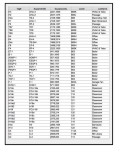


Phase II

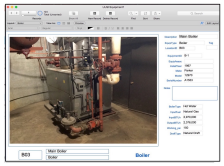
- OGC GeoPackage
- REVIT
- ArcGIS
- Safe FME-AR

Site Owner Input Documentation

Equipment Lists

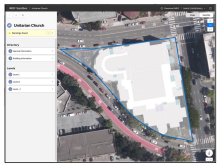


Equipment Database



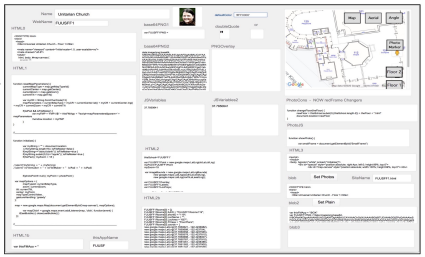
iBOX Survey

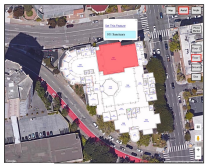
San Francisco Communications



Apple IMDF

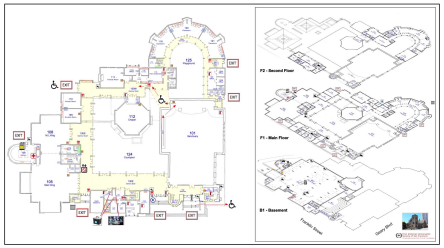
iSite Compiler





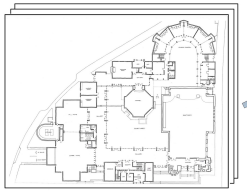
Google Maps API

Rooms & Keys

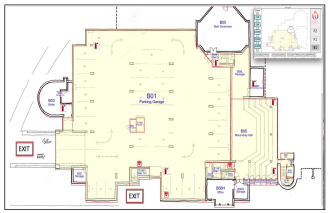


Vectorworks

Floor Plans



iBOX Translator



iSite CAD Model

SVG- Scalable Vector Graphics

Outcomes and Dissemination

Best Case Outcomes

Demonstrate an Open System approach to Smart Pre-Plan based Tactical Common Operating Picture that can then be replicated by alternative construction and delivery tools, including the benefits of an interoperable Building Object Model.

It should be noted that these are "early days" of this aspirational attempt to change/modernize the Fire Service procedures in the over 27,000 Fire Departments nationwide. Our long-term goal is to mature an initial set of tools and raise awareness of the many potential benefits of further developing tools and techniques to address the many challenges ahead.

Smart- Pre-Plan Preparation Software

- Demonstrate the utility of lightweight interactive floorplans in activities such as surveys, inspections, and emergency response navigation.
- Document a generic construction methodology that can be achieved with simple COTS desktop software.

Testbed Establishment and Commissioning

- Demonstrate the efficacy and accuracy of IMDF for "ground truthing" indoor floorplans for integration with other location and tracking technologies.
- Demonstrate First Responder Training and Exercise functionality in the testbed environment through multiple Incident Type Scenarios.

Final Engineering Report and Developed Resources

- Geometric and Data Templates for Building Object Models
- Example reference application for a mobile tablet indoor survey app.

Dissemination to Broader Public Safety and R&D Community

The project team will make all the technologies, processes, and procedures produced under this project available to the stakeholder community with no restrictions. Indiana University CITL will work with SFC to maintain a public project website for a minimum of five years and add relevant materials to IU ScholarWorks, a perpetual database of scholarly efforts conducted at the university (see Data Management Plan). The team will present at the annual PSCR Stakeholder Meeting and produce a public project report on the effort and findings.

The team will seek to share findings with core federal and state agencies as well as standards organizations. These include the Department of Homeland Security, Department of Commerce (FirstNet, NIST), and Open Geospatial Consortium. IU CTIL and SFC will continue efforts to introduce these methods and techniques to state and local public safety agencies who are interested in setting up their own testbed/training ground. SFC will also provide consultation in

test site selection and initial goals and tasks required to experiment with and demonstrate emerging technologies.

Tracking Adoption

When the stakeholders download the technologies, documentation, and reports, they will be asked to complete a preliminary survey via a Qualtrics survey, including contact information, potential project locations, and other relevant data. The system will be set up to periodically contact these users via email with a follow-up survey on how they have used the materials and impact, as well as general feedback for further improvement. These survey results will be utilized by SFC and IU to further refine the iSite effort beyond this project's scope and serve as the basis for future reports and publications.

Staff, Facilities, and Support

The IU CTIL team has access to multiple professional technicians, programmers, designers, and other experts skilled in the various technologies used in this project. In addition, the lab regularly employs numerous graduate and undergraduate students to assist professional staff in completing grant-funded work. As described in Facilities, the university provides access to state-of-the-art computing capabilities, including cloud-based servers and collaboration tools. SFC has all the core technologies and tools described in this proposal and used in the initial testbeds. We do not anticipate needing additional software to complete this project.

(6c) Project Execution

To address the project objectives and activities described above, the three partner organizations have divided the work effort into four key overlapping phases: Software development, testbed development, testbed demonstration, and documentation and dissemination. In addition, the team will manage risk by engaging in risk tracking via project management and team structures.

Phase Structure

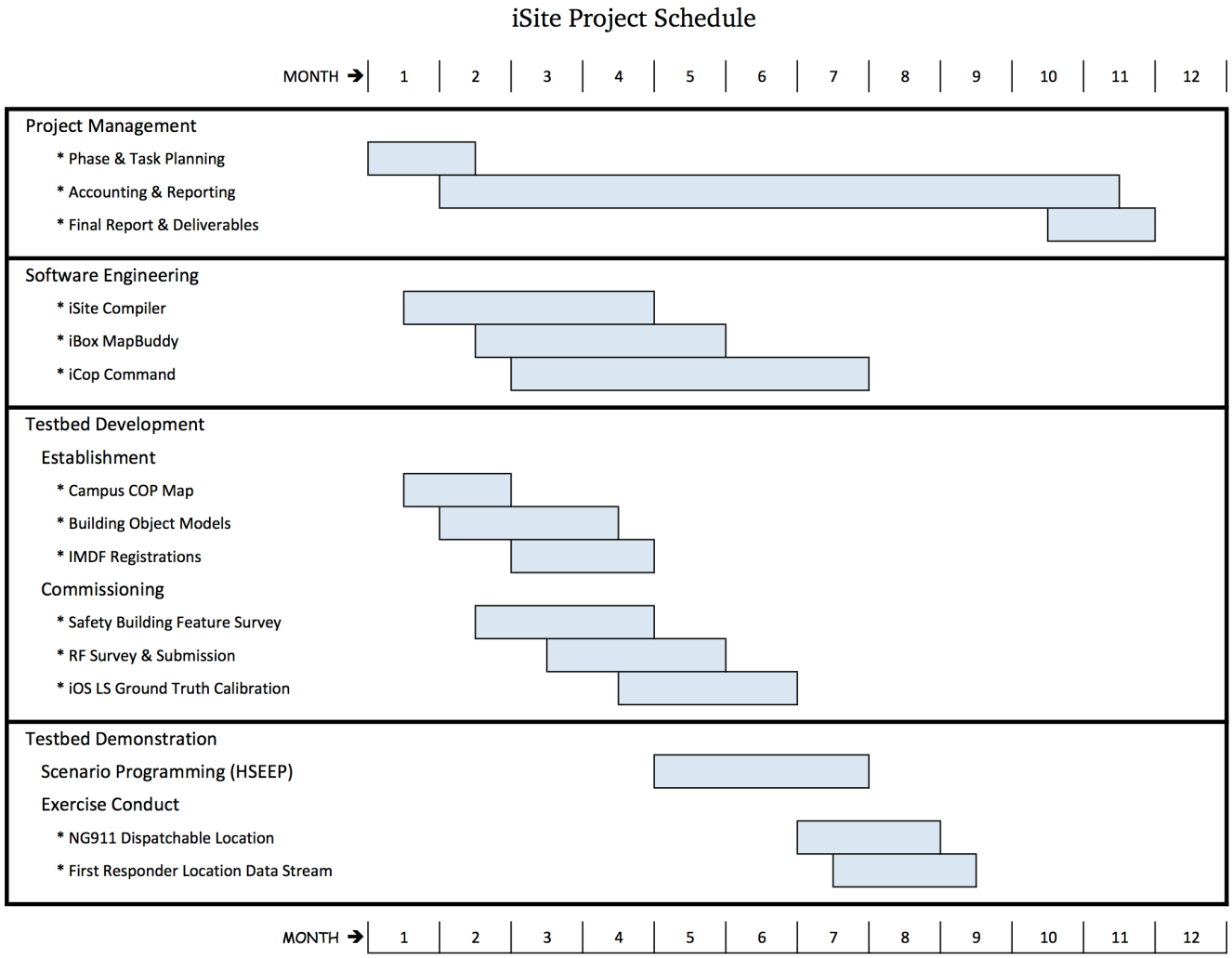
The project will proceed in three overlapping phases, as depicted in Figure 1. The major phase objectives are as follows:

Phase I Software Development - Refine, Document, and Test the existing operational Smart Pre-Plan prototype to include construction methodology, user interface, and mobile readiness.

Phase 2 Testbed Development - Assemble one or more tests to demonstrate a tactical common operating picture capability to include GPS tracking, field device performance, and a shareable command view.

Phase 3 Testbed Demonstration, Documentation, and Dissemination – 1) Develop tools, templates, and training aids to instruct site owners in preparation of smart pre-plans, and to instruct fire service personnel in the establishment of training testbeds. 2) Develop required reports for NIST, set up a website for long-term dissemination, and create survey capability for ongoing data collection.

Phase Schedule



Proposed Project Timeline with Public Safety Agency

The Indianapolis Fire Department, represented by CTO Dale Rolfson, will participate in all phases of the project execution. Team coordination meetings will be held with the three core partners at least twice monthly via Zoom. The IU team will work in the Indianapolis HQ building with IFD personnel on the development of the testbed and testing. IFD will be a full participant in developing all products disseminated from this project.

Key Deliverables

Deliverables	*Description*	*Project Week*
Initial Project Plan	Project plan with Gantt chart detailing project phases, key activities with start and end dates, dependencies between tasks, and project milestones	3
Risks and Mitigations Register	Risk register spreadsheet that identifies project risks, nature, and level of risk, who owns the risk, and mitigation measures	3
Initial Interviews of Key Stakeholders	Conduct interviews with key stakeholders mentioned in the proposal including PSCR, FirstNet Authoring, OGC, NAPSG Foundation, and others to obtain project guidance and alignment	4
Testbed Materials	All testbed materials developed, including IFD campus floor plans, safety building feature survey, IMDF registrations, RF survey, and ground truth calibration	26
Software Technology Finalized	Refinement of processes and procedures for testbed implementation finalized, including development of new software components	30
Testbed Demonstration Complete	Testbed implementation and scenario testing completed	39
Website Launched	Dissemination website developed and launched with initial information available; continual refinement for the remainder of the project	40
Focus Group Recruited	A focus group of diverse stakeholders from the public safety community will be recruited to provide input on the Best Practices Guide, processes and procedures developed	36
Public Best Practices Guide (draft)	A draft version of documentation of processes, procedures, and best practices for iSite Smart Pre-Plans ready for focus group review	40
Focus Group Review	An asynchronous focus group of public safety experts providing a review of the draft Best Practices Guide	44
Public Best Practices Guide	The final version of documentation of processes, procedures, and best practices for iSite Smart Pre-Plans (added to the website; added to IU ScholarWorks)	50
Tracking and Continuous Improvement Survey	The semi-automated survey added to the project website to track ongoing usage of materials and to obtain user feedback	50
NIST Final Project Report	Project final report and documentation submitted to NIST	52

*The project is planned for 52 weeks. The Project Week is calculated from the project award date (e.g., week 3 is the third week after the project start).

Risk Summary

The team will develop a risk mitigation register in the initial weeks of the project, along with the detailed project plan. This register will document the key risks of the project, planned mitigations for each threat, and the responsible organization or individual. While all projects entail risk, the key risks in this project do not appear technological. The existing technologies and capabilities are at a collective TRL 5 and use several TRL 9 commercial-off-the-shelf and government-off-the-shelf technologies. The more significant risks involve the logistics of implementing the

project and primarily relate to personnel availability and facilities access for development and testing. While the team does not anticipate any significant impact in any of these areas, scheduling these resources and locations will be critical.

(6d) Qualifications of Principal Investigator and Key Personnel

The iSite Smart Pre-Plans Public Safety Demonstration Testbed project team consists of a collaboration among an academic research lab, a mapping technology company, and public safety organization. Our team and partners will provide program management and technical infrastructure; technology development; evaluation; field testing and experimentation site; and broad dissemination support.

Indiana University has a very broad experience operating and administering large and complex federal projects. In particular, the IU Office of Research Administration will administer the award and reporting in compliance with institutional and federal policy. In FY19, IU received and administered $680M in new funding for more than 2800 new awards [9]. IU has run other prize events and has the expertise necessary to administer and award prizes.

Indiana University Crisis Technologies Innovation Lab (CTIL) is a collaboration between the IU Luddy School of Informatics, Computing and Engineering (SICE) and University Information Technology Services (UITS) to accelerate research and practice on the use of next-generation technologies in the front lines of emergency and crisis response. The CTIL was instituted to address the urgent need for new approaches to using technology to manage crises that are reliable, scalable, and affordable; that can interoperate between emergency professionals and the public; and that can help save lives in a complex, challenging environment. CTIL will provide core organization for this project, with support from the following units:

- **IU Advanced Visualization Lab (AVL):** This division is dedicated to supporting the innovative application of visual technologies to enhance research, education, creative activity, and community outreach missions of Indiana University. AVL also provides expert consulting services, training opportunities, and learning resources related to visualization.
- **IU Pervasive Technology Institute (PTI):** This group works with researchers across disciplines to create high-quality and robust computer science, informatics, and cyberinfrastructure tools usable by IU, national, and international research communities.
- **IU University Information Technology Services (UITS):** This organization serves IU's vision for excellence in research, teaching, outreach, and lifelong learning. Overseen by the Office of the Vice President for IT (OVPIT), UITS provides technical and user support for the IU community. Both the Research Technologies and Advance Visualization Lab are divisions of UITS offer critical services that will support this project. Within UITS, several groups provide us with technical and consulting services.
- **IU Research Technologies:** This group provides training, consultation, and world-class research computers. RT's latest supercomputing investment is Big Red 200, a Cray Shasta supercomputer designed for advanced research in AI and machine learning.

Principal Investigator **Sonny Kirkley** has extensive experience in researching and developing innovative technologies in academic and business settings. He has managed $21M in federal and state-funded research and development contracts (e.g., NIST, DoD, NSF, NIH, DHS, DOT) focused on cutting-edge technologies such as augmented reality. Several of these contracts focused on hazmat and public safety training. He has been a participant in two NIST prize challenges: Tech to Protect (2 regional events and national competition) and CHARIoT Challenge (AR component). Within these competitions, he and his team worked with first responders to design prototypes for Zenext voice AI, ALIKE 3D home scanning, and Secure Matrix mobile security dashboard. He also teaches courses in user-centered design for IUPUI's School of Informatics.

San Francisco Communications was formed in 1980 as a privately held California Corporation. For the last 20 years, we have been dedicated to public benefit projects with an emphasis on Emergency First Response. As Managing Director of SFC, **David Coggeshall** is the principal consultant for projects in software applications development. David graduated from Penn State University with an Electrical Engineering degree and worked in the Apollo Applications Program that later became known as SkyLab. David worked for Honeywell Information Systems in the early 70s and then formed San Francisco Consulting Group, a custom software development firm. The largest SFCG project was designing and constructing the original network administration software for SPRINT. In the 1980s and 1990s, SFC did work in Intelligent Buildings with Pacific Telesis, Kajima Construction, and Genentech.

After 9/11, David helped form the Golden Gate Safety Network, an informal coalition of government safety agencies and involved private organizations. This work has focused on establishing Common Operating Picture techniques to enhance mutual aid for emergency response. Since the Sandy Hook tragedy, SFC has focused on developing modern methods for preparing Pre-Incident Plans for Emergency Response. Over the last decade, we have worked with Menlo Park Fire District, Marin County Fire Chiefs, Palo Alto Office of Emergency Services, and several other First Responder organizations.

The most extensive demonstration of our iSite Smart Pre-Planning Methodology is the San Francisco Unitarian Church built in 1864. This building is fully mapped, including all the fire, life safety, and other major building systems. The OGC Community Standard IMDF (Indoor Mapping Data Format) has been implemented, and iOS Indoor Tracking is operational.

Indianapolis Fire Department is the public safety partner on this project. Battalion Chief **Dale Rolfson** is the CTO of the Indianapolis Fire Department. He has been a firefighter in Indianapolis since 1988. He has experience and education in computer science, starting in 1975. Chief Rolfson has managed Information Technology for the IFD for the last ten years and has been heavily involved in IT projects and decision-making for Indianapolis and Marion County for the past 22 years. He has 34+ years in the Fire Service and 14+ years as a member of IN-TF1.

Differences in PI and Key Personnel. The solicitation asks for clarification on any changes in key personnel between the original qualifying award and this proposal. Dr. Kirkley was included in the original qualifying proposal as the Project Director, not the Principal Investigator, because he was not yet employed at IU when the proposal was submitted. He currently manages the day-to-day operations of the original project and is the principal lead for the related technology in this

proposal. Mr. Coggeshall of San Francisco Communications was not included in the original proposal but has been the key collaborator on the efforts being leveraged in this testbed. Mr. Rolfson and the Indianapolis Fire Department are key collaborators on the original project.

IP Ownership Disclosure

There are no IP ownership issues. All technologies used in this project are open standards, open-source, or off-the-shelf technologies. The team intends to release all materials as open systems/open source.

Biographical Sketch

Name: Sonny Kirkley, Ph.D.

A. Professional Preparation

Univ of North Carolina Pembroke	Political Science	B.A. 1986
Indiana University Bloomington	Instructional Systems Technology	M.S. 1996
Indiana University Bloomington	Instructional Systems Technology	Ph.D., 2003

B. Appointments

2021-present Director of User Experience, Crisis Technologies Innovation Lab, Indiana University Bloomington

Project Director, First Responder Smart Tracking (FRST) Challenge

2020-present President, Zenext LLC (created by Tech to Protect Challenge team)

2017-present Adjunct Faculty, School of Informatics and Computing, Indiana University Purdue University Indianapolis

2003-present Adjunct Faculty, School of Informatics, Computing and Engineering, Indiana University Bloomington

1999-2015 CEO & Co-Founder, WisdomTools, Inc. (f/k/a Information in Place, Inc.)

1999-2006 Director, WorldBoard Forum (XR research lab)

1995-1999 Assistant Director, Laboratory for Research and Development in Teaching and Learning, Center for Excellence in Education, Indiana University Bloomington

C. Products (Most closely related to project)

a. Participant in two NIST PSCR prize challenges:
   i. Tech to Protect (2 regional events and national competition): Designed prototypes included Zenext voice AI, ALIKE 3D home scanning, and Secure Matrix mobile security dashboard
   ii. CHARIoT Challenge iMixedReality AR team
b. Designed and Managed the IUPUI COVID-19 Challenge where contestants competed for prize funds by designing apps for COVID-19 behavior changes and data tracking

D. Products (Other)

Kirkley, S, Majumdar, S., Srivastava, M., Khan, A., Tseng, I., Ejanthkar, B. (2020). Zenext - A Voice Command Virtual Assistant for Law Enforcement and Emergency Responders. IEEE CCWC 2020, Las Vegas, NV.

Kirkley, S, Majumdar, S., Srivastava, M., Khan, A., Tseng, I., Ejanthkar, B. (2020). Alike Cloud Services-Fire Safety in 3D. IEEE CCWC 2020, Las Vegas, NV.

Kirkley, S., Borland, S., Tomblin, S., Nelson, A., Pendleton, W., Kirkley, J., Turner, L., & Waite, T. (2005). Object oriented mixed reality and video game authoring tool system and method. Chinese Patent No. 101048210; India Patent No. 246489

Kirkley, J., Duffy, T., Kirkley, S., & Kremer, D. (2011). Implications of constructivism for the design and use of serious games. In S. Tobias & J. D. Fletcher (Eds.), *Computer Games and Instruction.* Charlotte, NC: Information Age Publishing.

Kirkley, J. & Kirkley, S. (2006). Expanding the boundaries of blended learning. In C. Bonk and C. Graham (Eds.), Handbook Blended Learning Environments. New York: Jossey- Bass.

Kirkley, S., Kirkley, J. & Tomblin, S. (2005). Fun, meaningful and authentic learning environments: Authoring support for the design and development of serious games. *TechTrends: Linking Research and Practice to Improve Learning, 49*(2).

Kirkley, J. R., Kirkley, S. E., Lindsay, N., Myers, T. M., & Barclay, M. (2003). Embedded training for designing mixed reality based military training systems. Proceedings of the Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) 2003, Orlando, FL

E. Synergistic Activities

a. Project Director, First Responder Smart Tracking (FRST) Challenge
b. PI/Co-PI on $13 million in research grants and contracts
c. Example federally funded contracts/projects developed:
    i. HAZMAT Training Using a Problem-based Methodology and Serious Games Approach. A National Institutes of Health-funded project to develop training games for HAZMAT training.
    ii. CSI: CRASH - Using Immersive Learning and Cross-Platform Mobile Solutions to Address Accident Investigations from a Multi-Perspective Standpoint. A National Institutes of Health-funded project to develop training focused on accident investigation.
    iii. Viyant Hazmat Skilled Support Personnel Just in Place Performance Support. A National Institutes of Health-funded project to build a mobile performance support system for workers on job sites.
    iv. Innovative Training Technology for Preventive Rad/Nuc Detection. A Department of Homeland Security-funded project to research the use of video games to train police officers in detecting potential radiological and nuclear threats.
d. State funded contracts/projects developed:
    i. Viyant: A Mobile Mixed Reality Distance Support, Performance Aid, and Collaboration Technology. A grant-funded by the Indiana 21st Century Research and Technology Fund to develop mobile performance support tools.

RESUME

Name: **David Coggeshall**

Position: **Lead Software Engineer**

A. PROFESSIONAL PREPARATION

Penn State University - State College, PA BS Electrical Engineering 1968

B. APPOINTMENTS

Year From	— To	Position Title	Organization and Location
1980	present	Principal Consultant	San Francisco Communications - SF, CA
2010	2012	Adjunct Professor	Carnegie Mellon University - Mtn View, CA
2002	present	CoFounder/Lead Developer	Golden Gate Safety Network - SF Bay Area
1974	1979	President	San Francisco Consulting Group - SF Bay
1970	1973	Technical Support	Honeywell ISD – SF, CA
1968	1969	Junior Engineer, Skylab	Martin Marietta – Denver, CO

C. PRODUCTS RELATED TO THE PROJECT

a. Closely related to project

i. 2007 - NIST Exercise Control System
Collaborative Research with NIST Modeling and Simulation

ii. 2008 - Open Floor Plan Display Format
NIST Presentation to NG911 Workshop

iii. 2009 - OFPD for Fire Fighter Tracking
Assistance to Fire Fighters Grant Application

iv. 2011 - Common Operating Picture Framework
Carnegie Mellon Disaster Management Initiative

v. 2013 - NIST Technical Note 1648
Delivering Building Intelligence to First Responders
SFC OFPD Citations on pages 12, 13, 16 & 17

b. Other significant products

i. 2004 – Golden Gate Safety Network MOU

ii. 2016 – OGC Safe School Sites Initiative

D. OTHER ACTIVITIES

a. Organized Documentation and Logistical Support for three major multi-agency anti-terrorist exercises at the Golden Gate Bridge (2002, 03, & 04)

b. Provided GPS Tracking Support for multiple emergency agency events such as:

BART Exercise (SFPD & SFFD)
GG Ferry Exercise (SFPD & SFFD)
Coastguard Fleet Week GPS Tracking (3 years)
Urban Shield GPS Tracking 2007
Urban Shield SWAT Team Exercise 2015

c. Multiple Presentations at Carnegie Mellon – Disaster Management Initiative

Biographical Sketch

Name: Dale Rolfson

Position: Battalion Chief – I.T. Manager

A. Professional Preparation

Institution	Location	Major/Area of Study	Degree	Year (YYYY)
ITT Business Institute	Indianapolis	MIS		1983-1985
Ivy Tech	Indianapolis	Fire Science		2002-2004
U of Indianapolis	Indianapolis	Command College		2007

B. Appointments

From-To	Position Title	Organization and Location
1/1/2018-present	Battalion Chief	Indianapolis Fire Department
6/30/12-12/31/17	Captain	Indianapolis Fire Department
01/01/11-06/29/12	Engineer	Indianapolis Fire Department
01/15/07-12/31/10	Division Chief	Lawrence Township Fire Department
01/07/03-01/14/07	Captain	Lawrence Township Fire Department
01/14/01-01/07/03	Lieutenant	Lawrence Township Fire Department
06/01/90-01/13/01	Engineer	Lawrence Township Fire Department
06/01/89-05/31/90	Private	Lawrence Township Fire Department
06/01/88-05/31/89	Probationary FF	Lawrence Township Fire Department

C. Products
   a. Most closely related to project
      i. Survey123
      ii. Arc GIS
      iii. ATAC
   b. Other significant products
      i. Garmin Connect
      ii. Garmin Basecamp
      iii. Google Earth

D. Synergistic Activities
   a. During Hurricane Dorian Response, I was able to connect iPad and Android tablets to our Garmin GPS units, while using Survey123, to allow for GPS location, without access to cellular infrastructure.
   b. Conducted public demonstrations on the use of small robotic platforms at the DARPA Robotics Challenge in 2016 in their use in the Search and Rescue environment.
   c. Chaired Marion County committees responsible for brining technology solutions to Indianapolis and Marion County, including:
      i. TeleStaff – A Public Safety scheduling tool
      ii. 24Seven RMS – An emergency incident data collection and reporting tool

INDIANAPOLIS FIRE DEPARTMENT

Dale A Rolfson
Battalion Chief – CTO
955 Fort Wayne Avenue
Indianapolis, Indiana 46202
317-327-6065 Office
Dale.Rolfson@indy.gov

May 30, 2022

We look forward to the opportunity to participate in the Indiana University's project proposal to NIST, *iSite Smart Pre-Plans Public Safety Demonstration Testbed.*

Indiana Fire Department provides emergency firefighting and fire protection services for Indianapolis and surrounding areas. Firefighters are also trained as paramedics, emergency medical technicians, rescue divers, and hazardous materials technicians to help save lives, protect property, and the environment. The IFD has 44 fire stations serving 282 square miles. Its 1,249 sown personnel responded to 106,538 emergencies with 166,296 apparatus responses in 2021. IFD partners with area public safety agencies to staff the city of Indianapolis' Regional Operations Center (ROC). The ROC was opened prior to the 2012 Super Bowl hosted by the Indianapolis.

For this project, we will help ensure the public safety community's perspective is included throughout the prototype testing, design refinement, and execution. Our team will provide floor plans and facility access to the headquarters building and adjacent fire station. We will recruit professionals from the public safety community across the region as needed for various components of the project including providing reviews and input on project progress and final recommendations.

From our team, Battalion Chief Dale Rolfson, will be the lead point of contact. He has been a firefighter in Indianapolis since 1988. He has experience and education in computer science starting in 1975. Chief Rolfson computerized small businesses that operated in the 1980s and 90s. He has managed Information Technology for the IFD for the last 10 years and has been heavily involved in IT projects and decision making for Indianapolis and Marion County for the past 20 years. He has 34+ years in the Fire Service, 14+ years as member of IN-TF1. He is certified as: Fire Officer IV, Fire Investigator, EMT, Fire Inspector II-III, Strategy and Tactics, Driver/Operator, Rope Rescue Technician. He is also an NFPA Incident Safety Officer, NIMS 100, 200, 300, 400, 700, & 800, Command College, Logistics Specialist, Communications Specialist, Planning Team Specialist.

Within the IFD, assorted firefighters can help meet specific project needs, including planning, consulting, and other SME related activities. We estimate a budget of $8,000 for participation in this effort by Chief Rolfson.

With the successful completion of this project, we anticipate a positive impact on our professional community. The iSite project meets an important need to provide the first response community with tools that help them efficiently and effectively create low cost, standards-based maps for pre-incident planning and other related uses.

Sincerely,

Dale A. Rolfson, Battalion Chief – CTO, Indianapolis Fire Department

"Our Family Serving Your Family"