DMA Webinar Series

R.E.S.C.U.M.E. Bundle

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Intelligent Transportation Systems Joint Program Office

February 18, 2015

TODAY'S AGENDA

- DMA Program Overview
- Prototype Design and Demonstration
  - R.E.S.C.U.M.E. Bundle Overview
  - Prototype Description and Current Project Status
- Impact Assessment
  - Current Project Status of Impact Assessment
  - Testing Results and Impacts/Benefits from IA
- Stakeholder Q&A
  - We can only answer the questions related to the DMA program.
  - We cannot answer any questions related to the CV Pilots.

DMA Program Overview

Dynamic Mobility Applications Program

- **Vision**
  - Expedite development, testing, commercialization, and deployment of innovative mobility application
    - maximize system productivity
    - enhance mobility of individuals within the system
- **Objectives**
  - Create applications using frequently collected and rapidly disseminated multi-source data from connected travelers, vehicles (automobiles, transit, freight) and infrastructure
  - Develop and assess applications showing potential to improve nature, accuracy, precision and/or speed of dynamic decision
  - Demonstrate promising applications predicted to significantly improve capability of transportation system
  - Determine required infrastructure for transformative applications implementation, along with associated costs and benefits
- **Project Partners**
  - Strong internal and external participation
    - ITS JPO, FTA, FHWA R&D, FHWA Office of Operations, FMCSA, NHTSA, FHWA Office of Safety

DMA Program Approach To Overcoming Two Key Challenges To Application Deployment

- **Challenge 1 (Technical Soundness)**
  Are the DMA bundles technically sound and deployment-ready?
  - Create a “trail” of systems engineering documents (e.g., ConOps, SyRs)
  - Share code from open source bundle prototype development (OSADP website: http://www.itsforge.net/)
  - Demonstrate bundle prototypes (in isolation)
  - Field test integrated deployment concepts from across CV programs

- **Challenge 2 (Transformative Impact)**
  Are DMA bundle-related benefits big enough to warrant deployment?
  - Engage stakeholders to set transformative impact measures and goals
  - Assess whether prototype show impact when demonstrated
  - Estimate benefits associated with broader deployment
  - Utilize analytic testbeds to identify synergistic bundle combinations

DMA Bundles and Applications

FRATIS: Freight Advanced Traveler Information Systems

Apps: Freight-Specific Dynamic Travel Planning and Performance, Drayage Optimization (DR-OPT)

IDTO: Integrated Dynamic Transit Operations

Apps: Connection Protection (T-CONNECT), Dynamic Transit Operations (T-DISP)
Dynamic Ridesharing (D-RIDE)

R.E.S.C.U.M.E.: Response, Emergency Staging and Communications, Uniform Management, and Evacuation

Apps: Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
Emergency Communications and Evacuation (EVAC)

MMITSS: Multimodal Intelligent Traffic Signal System

Apps: Intelligent Traffic Signal System (I-SIG), Transit and Freight Signal Priority (TSP and FSP)
Mobile Accessible Pedestrian Signal System (PED-SIG), Emergency Vehicle Preemption (PREEMPT)

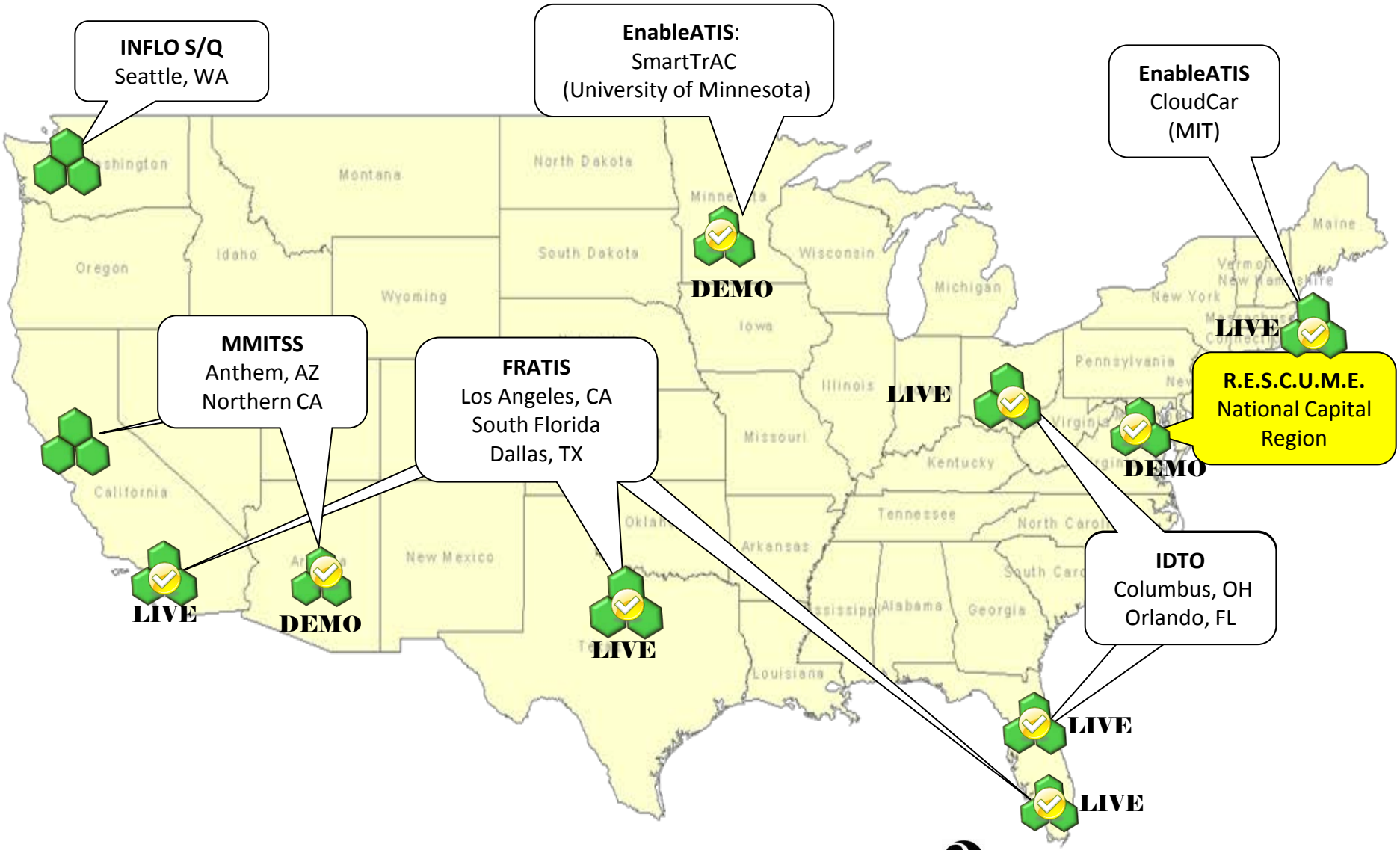
INFLO: Intelligent Network Flow Optimization

Apps: Dynamic Speed Harmonization (SPD-HARM), Queue Warning (Q-WARN)
Cooperative Adaptive Cruise Control (CACC)

Enable ATIS: Enable Advanced Traveler Information Systems

Apps: EnableATIS (Advanced Traveler Information System 2.0)

DMA Prototype Development Activity



R.E.S.C.U.M.E.
Bundle Overview

R.E.S.C.U.M.E. Bundle Descriptions

- Objectives
  - Transform the response, emergency staging and communications, uniform management, and evacuation (R.E.S.C.U.M.E.) process associated with incidents.
  - Leverage wireless connectivity, center-to-center communications, and center-to-field communications to solve problems faced by emergency management agencies, emergency medical services (EMS), public agencies, and emergency care givers, as well as persons requiring assistance.

- Applications
  - Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)
  - Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
  - Emergency Communications and Evacuation (EVAC)

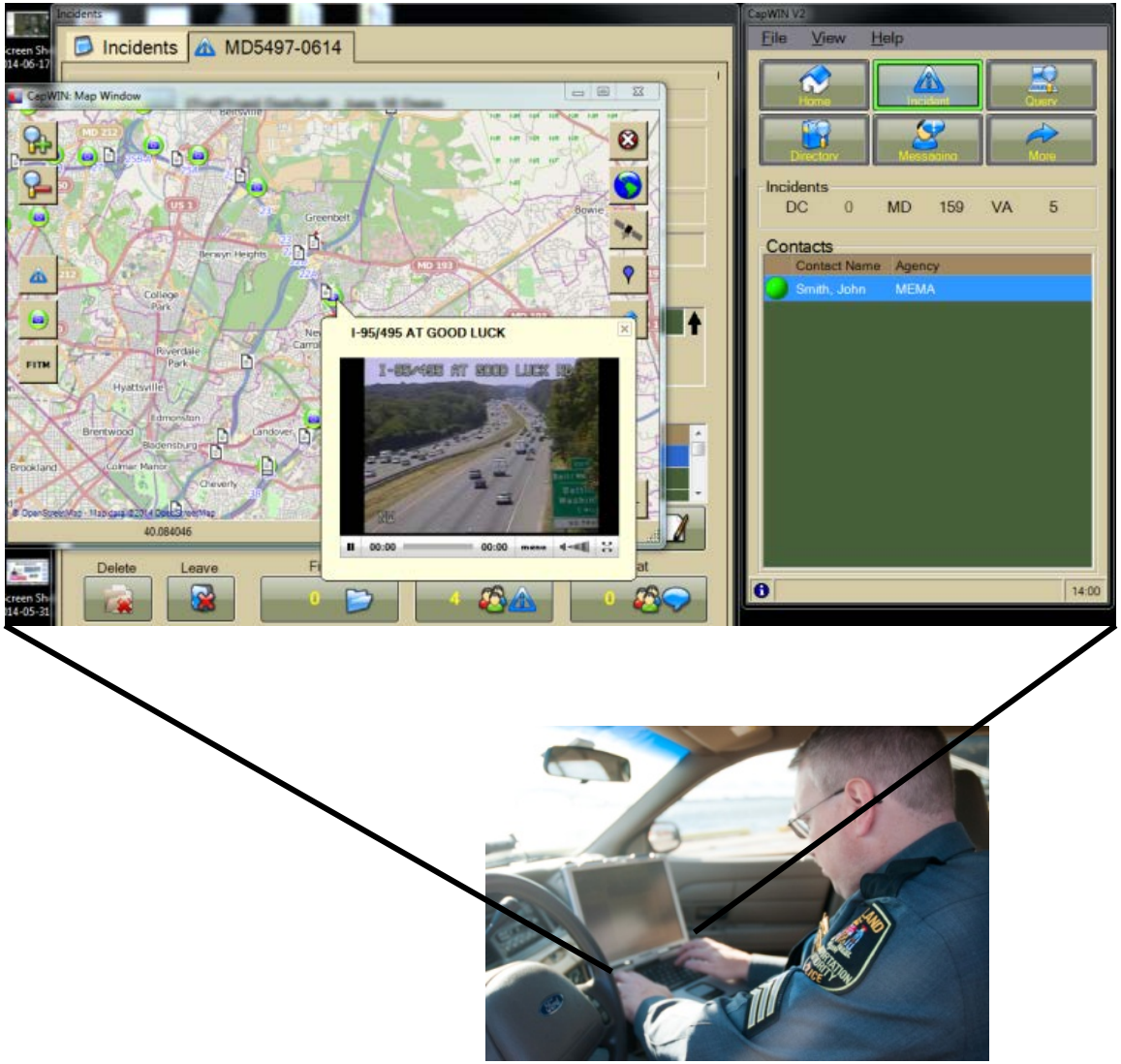
R.E.S.C.U.M.E. Prototype

R.E.S.C.U.M.E. Prototype Objectives

- Design and develop prototype R.E.S.C.U.M.E. Applications
- Conduct a small-scale demonstration of the prototypes
- Collect data to support
  - Assessment of the impacts of the prototype
  - Regional deployment of the two applications
- Project Team
  - Battelle
  - University of Maryland – Center for Advanced Transportation Technology (CATT) / Capital Wireless Integrated Network (CapWIN)

Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)

- Situational awareness info to responders while en route
- Enabled through enhancements in existing public safety communications systems
- Input to responder vehicle routing, staging and secondary dispatch decisions



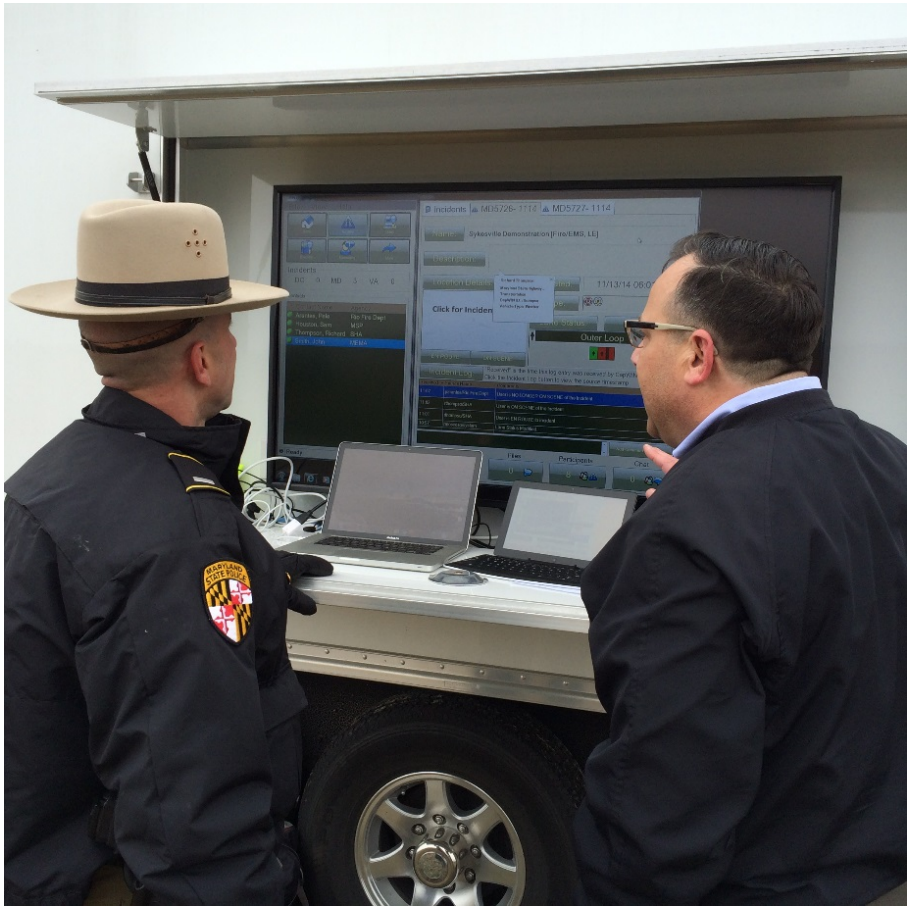
Incident Scene Work Zone Alerts for Drivers and Workers (INC–ZONE)

- In-vehicle messaging system, provides motorists with:
  - Merging and speed guidance as they approach an incident scene
  - Warnings if they approach the incident scene at an unsafe speed or trajectory
  -
- Provides a warning for on-scene workers.

Source: Ron Moore

R.E.S.C.U.M.E. Prototype Development Activities

- System prototype developed and demonstrated
  - June 17, 2014 in Columbus, OH
  - November 13, 2014 at Maryland Police and Correctional Training Commission's Driver Training Facility
  - February 2015 Small-scale demonstration for RESP-STG
- Potential inclusion in Connected Vehicle Regional Pilots (2015)



Lt. Michael Tagliaferri, ***Maryland State Police***

Sgt. Dan Dytchkowskyi, ***Erie County, New York Sheriff's Office***

R.E.S.C.U.M.E. Prototype
November 13, 2014 Demonstration Participants

- State and local agencies
  - Maryland State Highway Administration (MDSHA)
  - Maryland State Police (MSP)
  - University of Maryland – Center for Advanced Transportation Technology (CATT) / Capital Wireless Integrated Network CapWIN
  - Maryland Emergency Management Agency (MEMA)
  - Sykesville – Freedom District Fire Department
- Federal Agencies
  - ITS Joint Program Office (ITS-JPO)
  - Federal Highway Administration (FHWA)
  - National Highway Traffic Safety Administration (NHTSA)
  - Federal Motor Carrier Safety Administration (FMCSA)
- Other organizations
  - Transportation Research Board - Standing Committee on Traffic Law Enforcement (ANB40)
  - Transportation Safety Advancement Group (TSAG)
  - International Association of Chiefs of Police (IACP)
  - Intelligent Transportation Society of America (ITSA)
  - National Sherriff's Association (NSA)
- Local public safety agencies
  - Erie County New York Sheriff’s Office

DEMONSTRATION LAYOUT

Blind Curve Incident Zone (Final Vehicle Circuit Only)

Staging Location for Oncoming Vehicles

Staging Location for Responder Vehicles

Incident Zone

Position A Trailer CapWIN Display

Position B Responder Vehicle Display

NOVEMBER 13, 2014 DEMONSTRATION

- 12 scenarios showing functionality of RESP-STG and INC-ZONE applications, viewed from three different perspectives

CapWIN Perspective
(Position A)

Responder Perspective
(Position B)

Example message displayed to driver

Oncoming Vehicle Perspective

INC-ZONE – THE DRIVER'S PERSPECTIVE

Note: Initial warnings purposely ignored to demonstrate full-functionality of the application

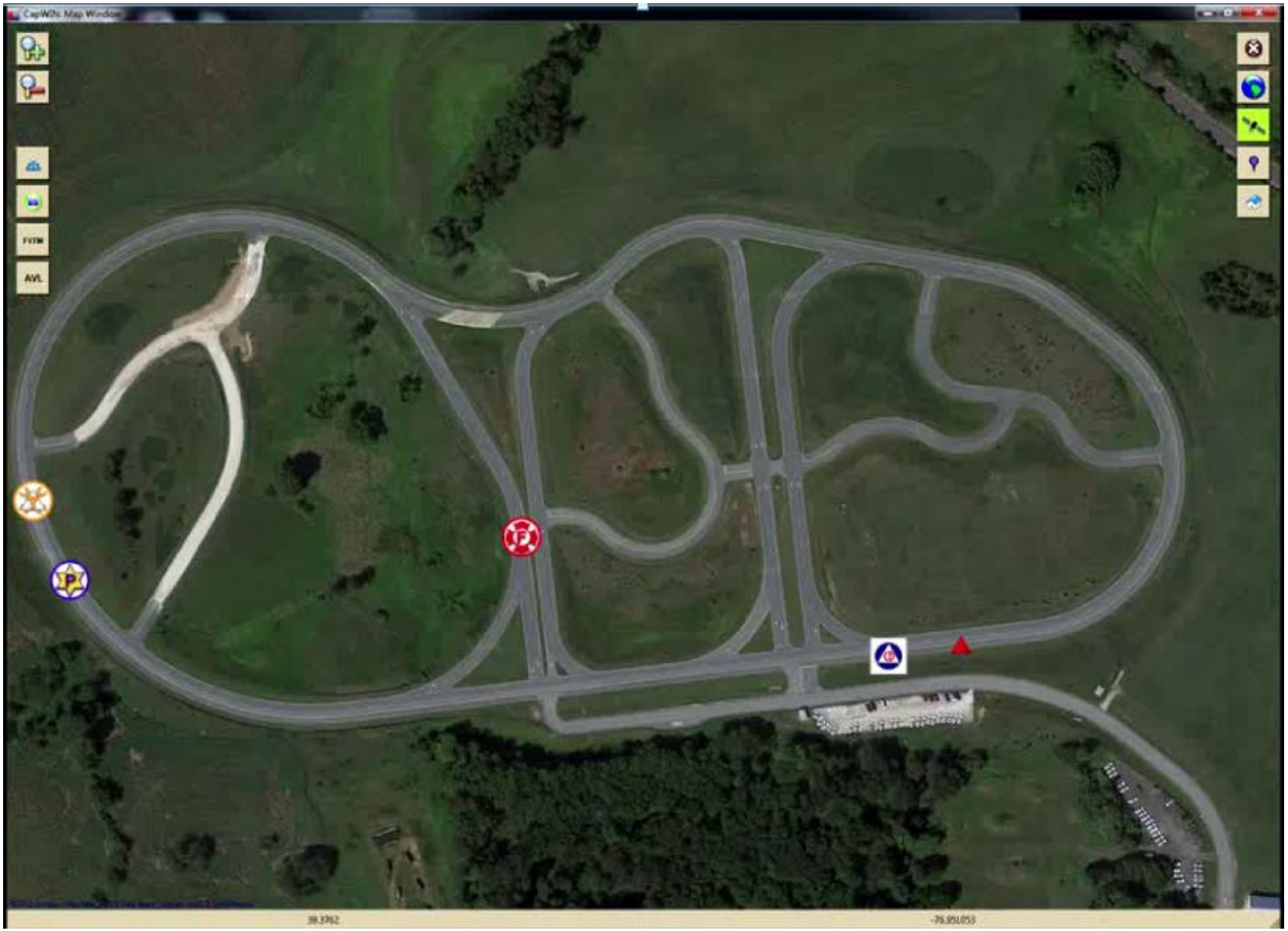
INC-ZONE – The Responder's Perspective (Position B)

RESP-STG Prototype Summary

- CapWIN represents one platform in which to integrate RESP-STG application

- Current Functionality Includes:
  - AVL Broadcasting and Receipt from CapWIN Mobile Client
  - User-Controlled “On Scene” Broadcasting Option for First Responders at the Incident Scene and En Route to Scene
  - New Mapping Engine and Mapping Data
  - New Freeway Incident Traffic Management Plan (FITM) Layer
  - Enhanced User Control of GIS Layers

The CapWIN Perspective (Position A)



R.E.S.C.U.M.E. Prototype Development Challenges and Solutions

- Developed the connected vehicle applications, which reside on separate vehicles (responder and oncoming).
- Implemented Dedicated Short-Range Communications (DSRC) Messaging between responder and oncoming vehicles to support threat and imminent crash warnings
- Implemented lane level mapping and Global Positioning System (GPS) positioning accuracy system.

R.E.S.C.U.M.E. Prototype Development Challenges and Solutions

- Developed and integrated DSRC, Cellular, and Bluetooth communications in both oncoming vehicle and responder vehicle systems.

- Range of integration activities:
  - Applications onto existing responder portable laptop and existing consumer smart phones
  - Responder alerts and warnings in existing systems
  - RESP-STG and INC-ZONE applications for compatibility and coordination

- Use of existing public safety communications equipment

R.E.S.C.U.M.E. Prototype Description Documentation and Data Available

- Applications being prepared for posting on the Open Source Application Development Portal (OSADP) :
  - Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)
    - Responder Vehicle Application
    - Oncoming Vehicle Application

- Data being prepared for posting on the Research Data Exchange (RDE)
  - Maryland Demonstration Message Exchange

R.E.S.C.U.M.E. Prototype Description
High Value Enhancements

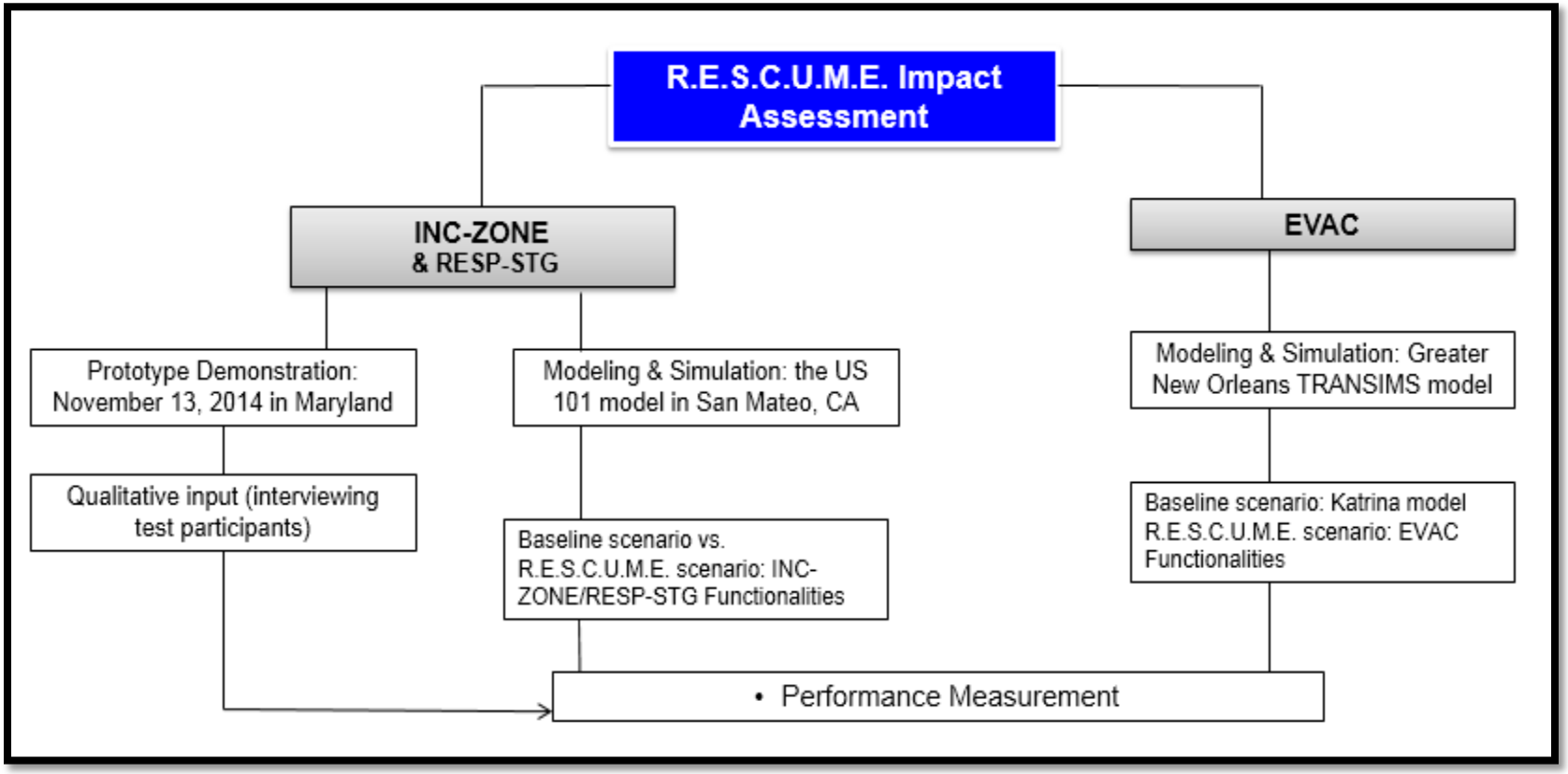
- Further refinements are suggested to more fully capture benefits.
- Address human factors components if delivering information, alerts, and warnings.
- Investigate timing and nature of alerts and warnings during highway incidents.
- Current prototype development efforts do not restrict development of future enhancements for additional safety benefits.

R.E.S.C.U.M.E.
Impact Assessment

R.E.S.C.U.M.E. Impact Assessment Framework

R.E.S.C.U.M.E. Impact Assessment Team:

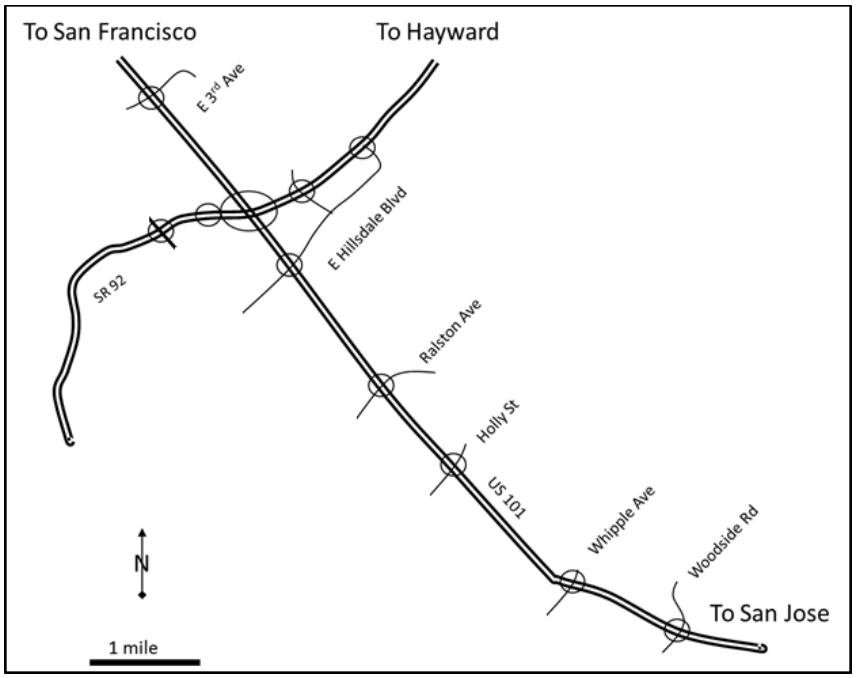
- Assessment of INC-ZONE and RESP-STG: **Booz Allen Hamilton**
- Assessment of EVAC: **Booz Allen/AECOM/Prof. Brian Wolshon (LSU)**
- Overall R.E.S.C.U.M.E. IA Team Lead: **Gustave Cordahi (Booz Allen Hamilton)**



ASSESSMENT OF INC-ZONE & RESP-STG

MODELING AND SIMULATION

- INC-ZONE and RESP-STG functionalities simulated.
- Simulation Conditions
  - Roadway Conditions:
    - Dry
    - Rainy
  - Operational Scenarios:
    - Short Incident (30-minutes)
    - Long Incident (60-minutes)
  - Market Penetration:
    - 10%, 25%, 50% and 100%
- Primary functionalities used:
  - Lane-changes prior to incident zone to avoid incident-lane.
  - Speed-changes around incident zone to enhance safety.



- US-101 freeway in San Mateo, California.
- 5-hour PM peak simulation (2:30PM to 7:30PM) with NB congestion.
- VISSIM 7.00 Model used

ASSESSMENT OF INC-ZONE & RESP-STG

SIMULATION FUNCTIONALITIES

Functionality	Corresponding Modeling Strategy
INC-ZONE	
1. Threat determination	Using instantaneous vehicle-positions, link ID, and lane ID.
2. Oncoming Vehicle Alerts and Warnings	Vehicle ‘commands’ are used instead of alerts and warnings and a compliance rate is used to specify compliance to alerts and warnings.
3. Responder Alerts and Warnings	Surrogate safety measures are analyzed.
RESP-STG	
1. Staging Plans	Modeled using vehicle commands to stage the emergency vehicle to the incident zone.
2. Emergency Responder Status Reporting	Modeled as a performance monitoring variable.

ASSESSMENT OF INC-ZONE & RESP-STG

PERFORMANCE MEASURES

Direct Performance Measures:

- These measures are collected directly from the simulation:
  - Network mobility measures such as latent demand served etc.
  - Average Vehicle Delay
  - Average Number of Stops
  - Average Travel-Speed of Vehicles
  - Throughput of Incident Zones
  - Average Fuel Consumption
  - Average Emissions

Indirect Performance Measures:

- These measures are computed from direct simulation results using post-processing:
  - Surrogate safety measures derived from trajectory analysis.
  - Lane-changes in the vicinity of the incident-zone.
  - Speed-differential in the vicinity of the incident zone.
  - Improvement of response vehicle travel-time.

Performance Measurement:

- Comparison of Baseline measures (without R.E.S.C.U.M.E.) to measures with R.E.S.C.U.M.E.
- Regional extrapolation of impacts using RITIS Incident Statistics

Assessment of EVAC

Emergency Communications for Evacuation in Greater New Orleans

ASSESSMENT OF EVAC

EMERGENCY COMMUNICATIONS FOR EVACUATION IN GREATER NEW ORLEANS

- The overall objective is to estimate the potential impacts of Emergency Communications and Evacuation (EVAC) strategies on evacuees' mobility and evacuation clearance time

- The hurricane Katrina evacuation model of the Greater New Orleans area is used as a baseline for the assessment of EVAC

- Transformative targets
  - EVAC is expected to expedite the evacuation process, improve the mobility of transit-based evacuees, and reduce congestion and fuel consumption

ASSESSMENT OF EVAC

KEY HYPOTHESES AND PERFORMANCE MEASURES

- Key Hypotheses
  - A percentage of evacuees will follow the EVAC recommendations and adjust their behavior accordingly;
  - EVAC will enable evacuees to reach destinations faster;
  - EVAC will reduce the overall congestion level and delay;
  - EVAC will enable evacuees to find hotel accommodations faster;
  - EVAC will reduce the number of stops for re-fueling vehicles

- Performance Measures
  - Network congestion measures: total travel time; congestion duration; total delay
  - Strategy effectiveness measures: average travel time to lodging; number of fueling failures; average wait time for buses

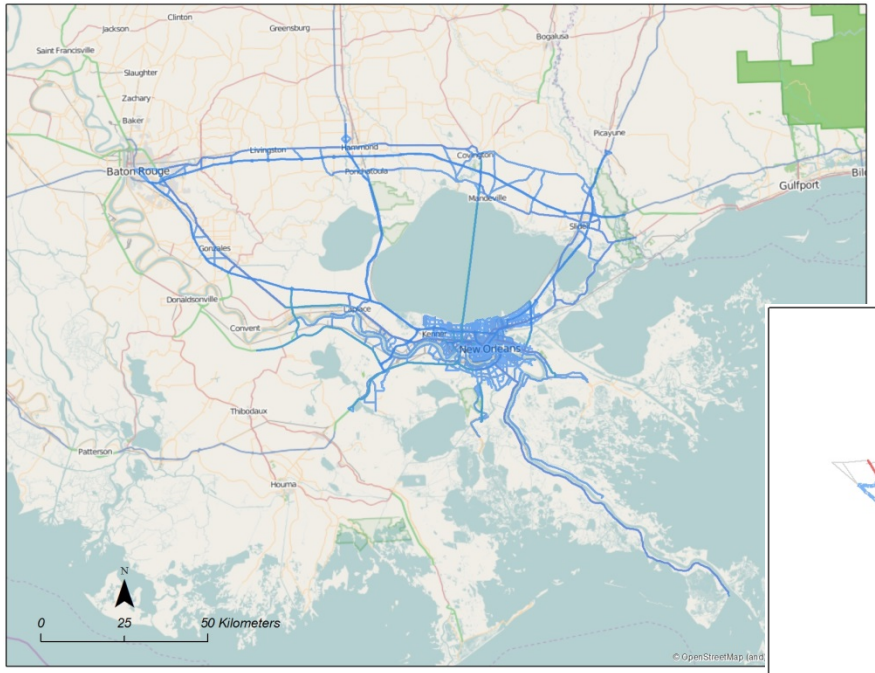
ASSESSMENT OF EVAC

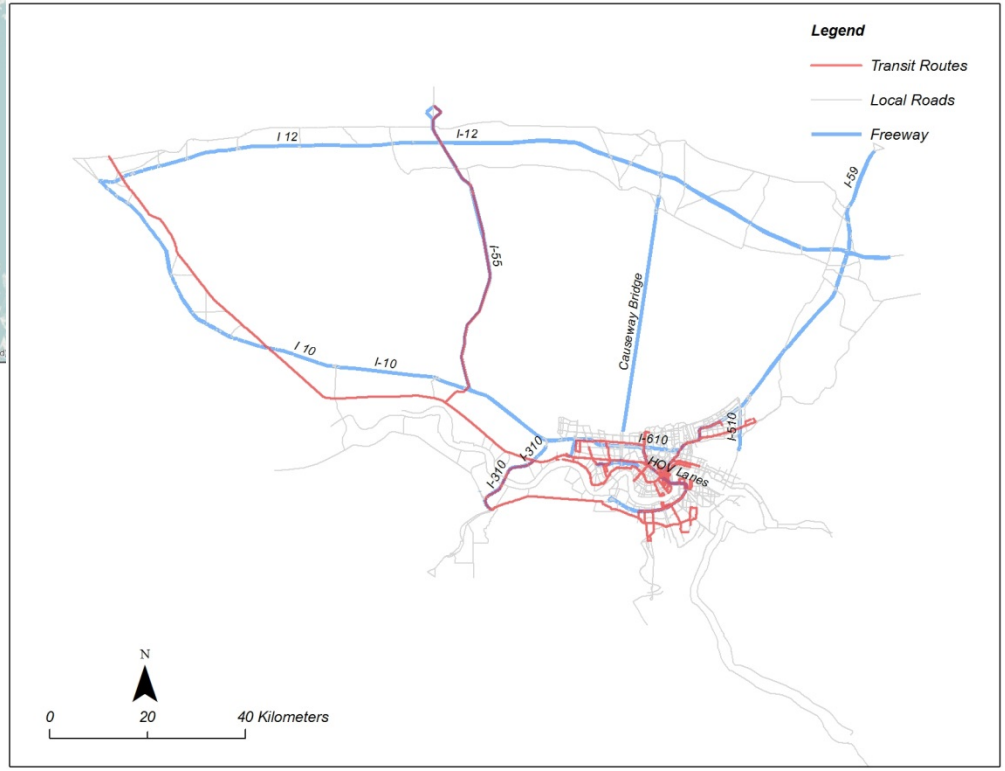
TESTBED AND ANALYSIS TOOLS

- Testbed specifications
  - The hurricane Katrina evacuation model of the Greater New Orleans area was originally developed by LSU
  - About 400,000 evacuees over a 48 hour period
    - 96% auto-based and 4% assisted transit evacuations
  - Evacuation destinations, departure times and mode shares are derived from observed data collected during the Katrina evacuation

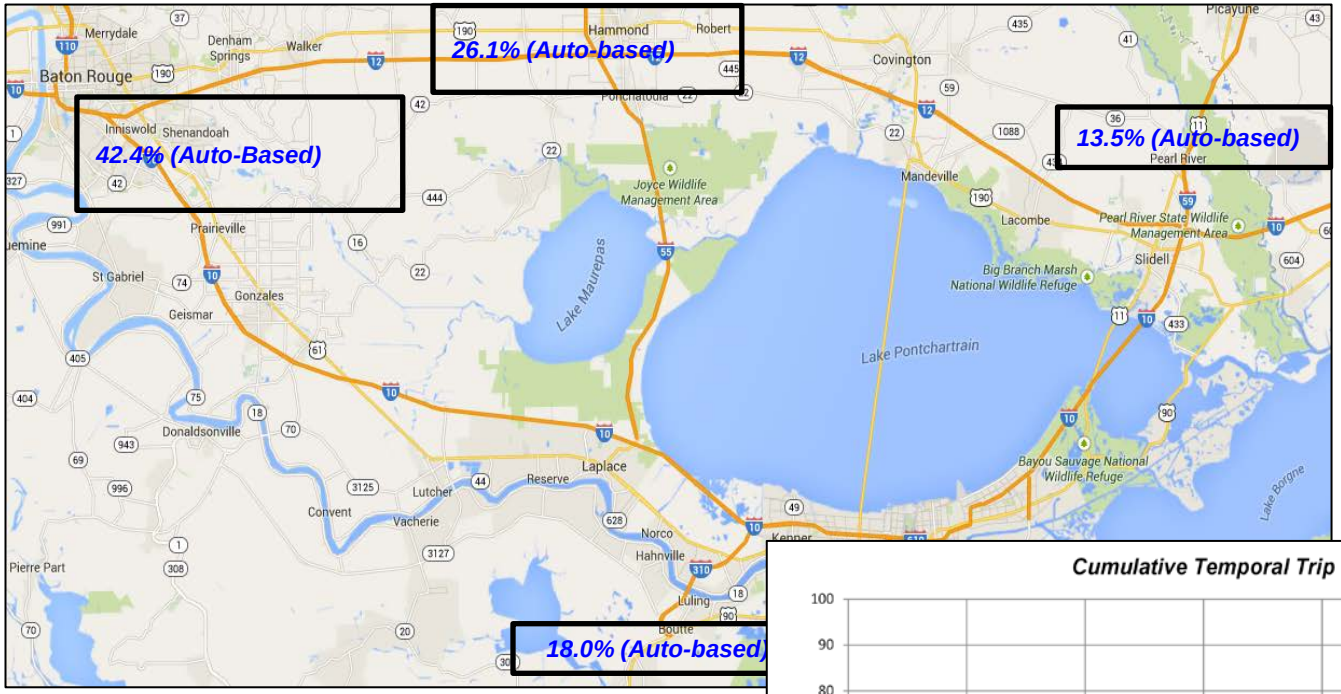
- Modeling Tool: TRANSIMS
  - An open-source dynamic transportation modeling tool developed and maintained by AECOM for FHWA
    - Dynamic routing of individual travelers and 48 hour regional simulations
    - Randomly select travelers to receive and act on EVAC information
    - Vehicle trajectories, traveler plans, disaggregate travel times and flow rates
    - Outputs can be visualized in geospatial packages such as ArcGIS

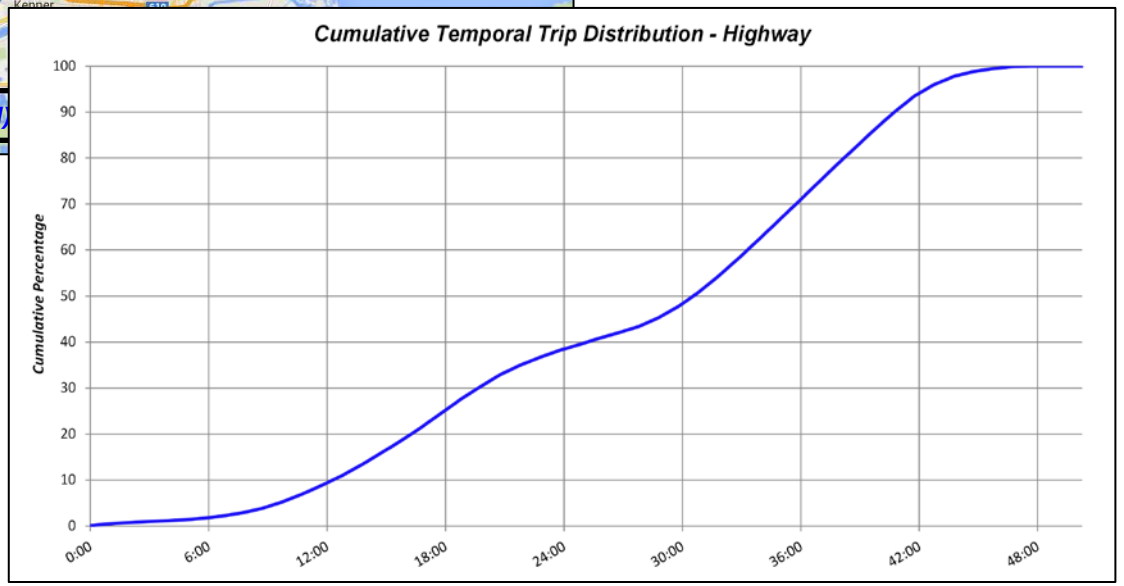
GREATER NEW ORLEANS TESTBED: NETWORK





Evacuation Destinations and Departure Times





ASSESSMENT OF EVAC

IMPACT ASSESSMENT APPROACH

- Use the Katrina evacuation data as the baseline scenario
- Assume that a percentage of evacuees will follow the EVAC recommendations or use EVAC information to adjust their travel plans; other travelers will not change their travel plans (i.e., route, destination or departure time)
- Multiple percentage assumptions will be used to estimate a range of potential impacts
- Assume no gaps in EVAC communications
- Calculate the performance measure differences between the EVAC strategy and the baseline conditions

ASSESSMENT OF EVAC

IMPACT ASSESSMENT SCENARIOS

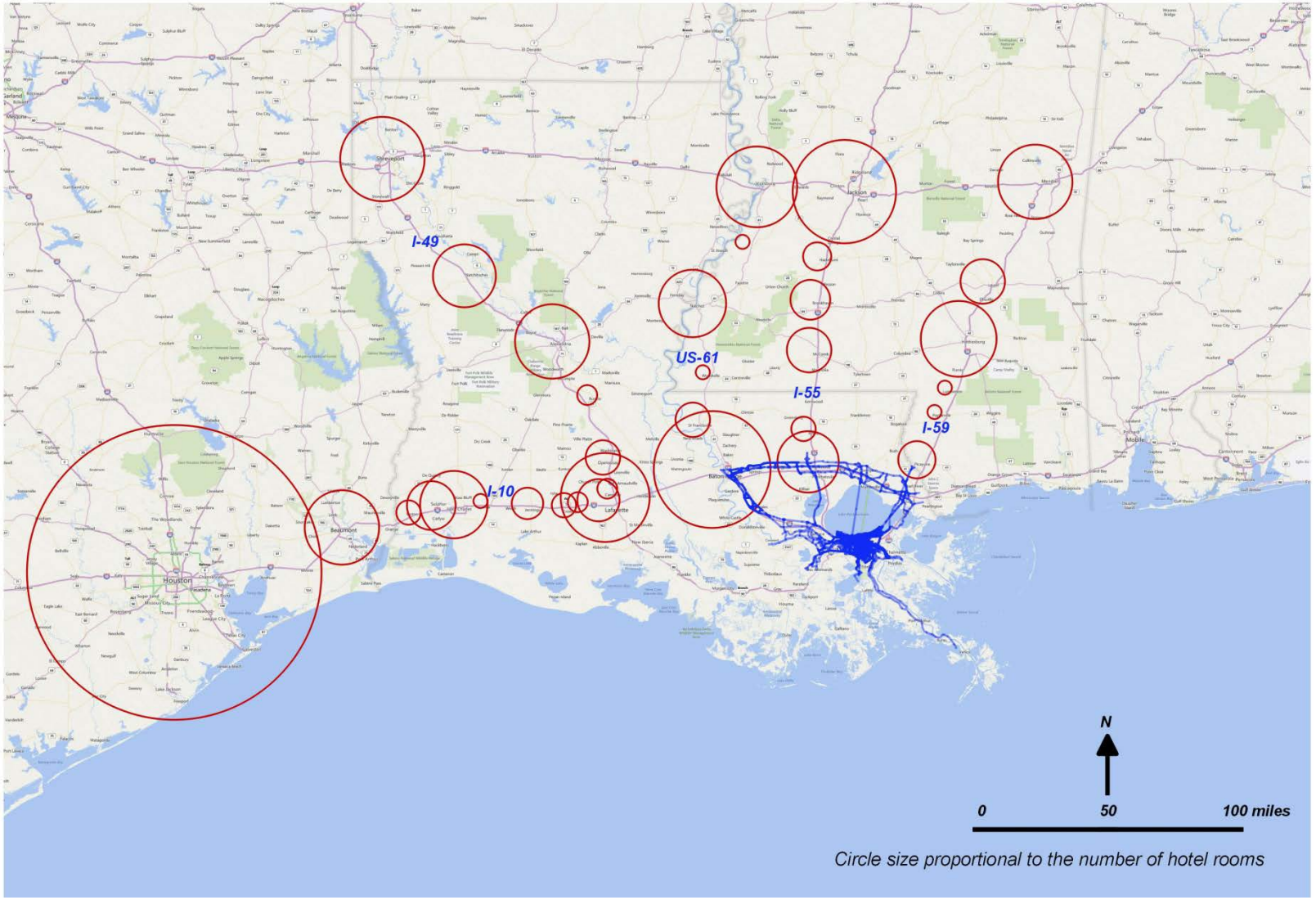
- Seven scenarios will be tested to quantify the effects of individual strategies and the synergetic effects of combining strategies.
  - *Scenario 1 ~ Baseline Scenario (i.e. the Katrina scenario without EVAC)*
  - *Scenario 2 ~ EVAC route information and guidance under no-incident conditions*
  - *Scenario 3 ~ Incidents and road closures are added to Scenario 2*
  - *Scenario 4 ~ EVAC assistance in locating lodging and shelter options*
  - *Scenario 5 ~ EVAC assistance in locating fuel, food, water, cash machines and other necessities (current phase only considers fueling locations)*
  - *Scenario 6 ~ EVAC communications about pickup time and location options for special needs evacuees (i.e., transit services)*
  - *Scenario 7 ~ A combination of route information and guidance, location of available lodging and shelter; location of fuel; and transit pickup time and location options*

ASSESSMENT OF EVAC

LODGING ASSUMPTIONS

- The literature suggests that 25% of auto-based evacuees require hotel accommodations
- Hotel accommodations must be found outside of the study area in towns along major interstates up to 300 miles from New Orleans
  - I-10, I-55, I-59 and I-49
  - Baton Rouge, Lafayette, Alexandria, Shreveport, Jackson, Hattiesburg, Houston, etc.
- Travelers will select a hotel that minimizes their total trip time
- EVAC is capable of obtaining accommodation information outside of the study area and directing travelers to destinations with available capacity

EXTERNAL HOTEL CAPACITY



Assessment of EVAC

Fuel Assumptions

- Fuel consumption rates are based on travel speed
- Some evacuees will not have a full tank of gas when they start
- Evacuees start seeking fuel when the tank is one quarter full
- Fueling locations are assumed at each interstate interchange, but some locations will no longer have fuel available
- EVAC can direct travelers to locations with available fuel
- Other travelers may fail to acquire fuel after one or more attempts
- Travelers that fail to acquire fuel before running out will block a travel lane for a period of time
- EVAC will provide and position fuel trucks for emergency re-fueling

Stakeholder Q&A

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