DMA Webinar Series

DMA-ATDM Analysis, Modeling, and Simulation (AMS) Testbed Project

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February 26, 2015

TODAY'S AGENDA

- DMA Program Overview
- ATDM Program Overview
- DMA-ATDM AMS Testbed Project Overview
- AMS Testbeds: Status, Next Steps, and Challenges
- Project Next Steps and Expected Outcomes
- Stakeholder Q&A
  - 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 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

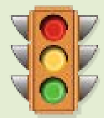
Apps: Connection Protection (T-CONNECT), Dynamic Transit Operations (T-DISP)
Dynamic Ridesharing (D-RIDE)

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)

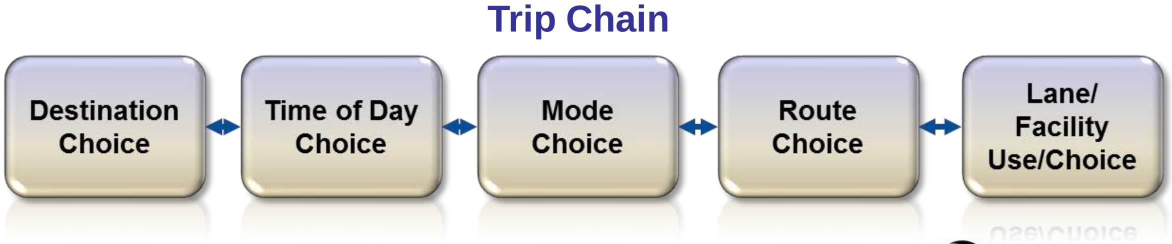
Enable ATIS: Enable Advanced Traveler Information Systems

Apps: EnableATIS (Advanced Traveler Information System 2.0)

ATDM Program Overview

Active Transportation and Demand Management (ATDM)

- Active Management is the fundamental concept of taking a dynamic approach to a performance based process
- Dynamically monitor, control, and influence travel, traffic, and facility demand of the entire transportation system and over a traveler's entire trip chain.
- ATDM leverages existing infrastructure to evolve from Static to Active Management



Active Transportation and Demand Management (ATDM) Categories

Active Demand Management

- A suite of strategies intended to reduce or redistribute travel demand to alternate modes or routes.
- Examples: comparative multi-modal travel times, dynamic ride-sharing, pricing and incentive approaches.

Active Traffic Management

- A suite of strategies that actively manage traffic on a facility.
- Examples: variable speed limits, dynamic shoulder use, queue warning, lane control.

Active Parking Management

- A suite of strategies designed to affect the demand, distribution, availability, and management of parking.
- Examples: parking pricing, real-time parking availability and reservation systems.

DMA-ATDM AMS Testbed Project Overview

DMA Program has Several Efforts Underway but Several Questions Still Remain

- The DMA Program currently sponsoring several small-scale **Prototype Demonstrations (PDs)** of each of the six bundles to test if the bundles can be successfully deployed in the future
- The DMA Program also sponsoring separate, multiple efforts (one for each bundle) to conduct **Impact Assessments (IAs)** of the impacts of the prototype as well as local/regional impacts of the various bundles
- The data and findings from the PDs and IAs are helping U.S. DOT make more informed decisions regarding the technical feasibility and potential impacts of deploying the bundles more widely
- **However, there are several outstanding questions** that the DMA Program is seeking to answer before justifying large-scale demonstrations and pilot deployments

Key Research Questions for DMA Program

ID	DMA Research Question
1	Will DMA applications yield more cost-effective mobility benefits with **connected vehicle technology** than with **legacy systems**?
2	What **DMA bundles or combinations of bundles** yield the most benefits?
3	What DMA applications, bundles, or combinations of bundles **complement or conflict with each other**?
4	Under what **operational conditions** are specific bundles the most beneficial?
5	Which DMA bundle or combinations of bundles will be most beneficial for certain **facility types**?
6	Which DMA bundle or combinations of bundles will have the most benefits for **individual facilities vs corridor-wide vs region-wide deployment**?
7	At what levels of **market penetration** of connected vehicle technology do the DMA bundles (collectively or independently) become effective?
8	What are the **impacts of future deployments** of the DMA bundles in the near, mid, and long term (varying market penetration, RSE deployment density, and other connected vehicle assumptions)?
9	To what extent are connected vehicle data beyond BSM Part 1 instrumental to realizing a near-term implementation of DMA applications?
10	Is BSM Part 1 transmitted via DSRC every **10th of a second critical** for the effectiveness of the DMA bundles? Will alternate messaging protocols, such as PDM, BMM, etc., suffice?

Need for a Joint DMA-ATDM AMS Testbed

- The more active forms of control envisioned by the ATDM Program will rely on new forms of data from vehicles, travelers, and infrastructure to hone predictions and tailor management responses
- Likewise, the transformative applications developed in the DMA Program must be incorporated within current and future dynamic system-wide management practices in order to realize their full potential
- In order to explore potential transformations in transportation systems performance, both programs require an AMS capability
- AMS Testbeds will support a detailed and integrated evaluation of DMA and ATDM concepts before initiating costly large-scale field deployments
- Provide modeling results (i.e., impacts) to the USDOT's DMA National Program and Mobility Impacts Estimation project

KEY ASPECTS OF AN AMS TESTBED

- A virtual computer-based environment, **not** a physical field deployment
- **Combination of computer models/tools** that can capture impacts of implementing concepts, bundles, and strategies associated with the DMA and ATDM Programs
  - As close to real-world as possible by modeling an actual metropolitan region's transportation system and transportation demand (e.g., persons, vehicles, transit)
  - Not directly connected to field operational systems or personnel (e.g., traffic management systems, TMC operators, etc.)
  - Developed by building on existing and previous AMS capabilities and modeling efforts
- Multiple AMS tools/components are required to be integrated
  - Prediction Engine
  - Communications Emulator
  - Scenario Generator
  - Systems Manager Emulator
  - Performance Data Capture and Storage

AMS Testbed Project Team

U.S. DOT Task Manager
James Colyar

Project Core Review Team
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John Halkias (FHWA)
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Eric Pihl (FHWA)

noblis
For the best of reasons

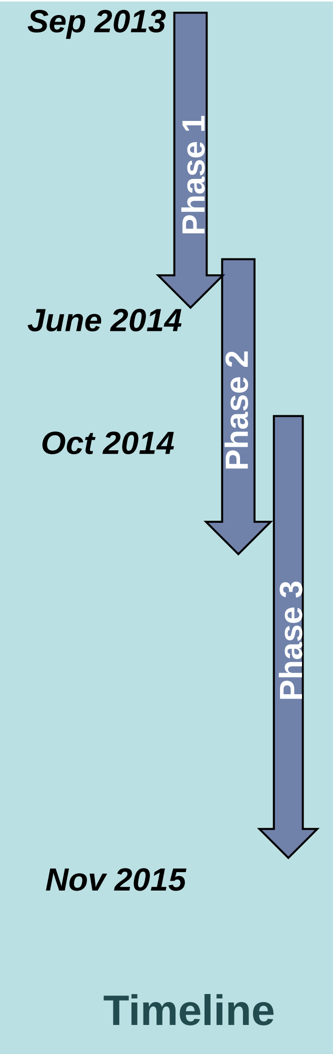
Prime Contractor Booz | Allen | Hamilton

AECOM
ASU Arizona State University
tts Traffic Technology Services
SMU
The University of Arizona
Kittelson & Associates, Inc.
Transportation Engineering/Planning
NC State
Northwestern University

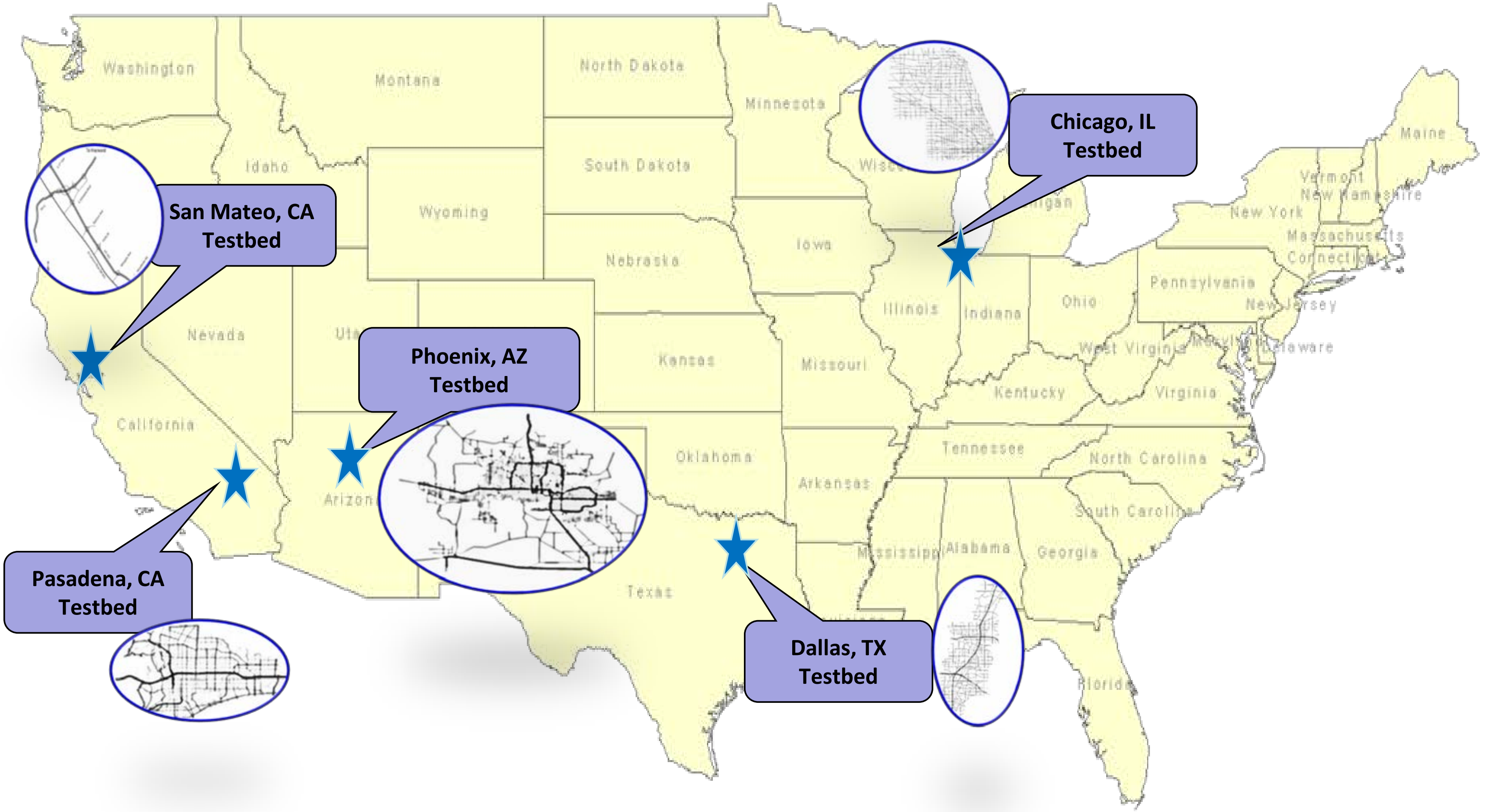
AMS Testbed Project Phases and Timeline

- **Phase 1: AMS Testbed Selection**
  - Develop Testbed requirements and selection criteria
  - Conduct preliminary and final selection of AMS Testbed
- **Phase 2: Develop Evaluation Methodology**
  - Develop Testbed specific Analysis Plans
  - Combine Testbed specific plans to develop an overarching Evaluation Plan
- **Phase 3: Modeling, Analysis, and Reporting**
  - Develop and calibrate Testbed models, including data collection
  - Evaluate DMA and ATDM strategies using calibrated Testbeds
  - Report the relevant findings, produce documentation, and make them publicly available
  - Recommend further research for continuation of the DMA / ATDM future projects

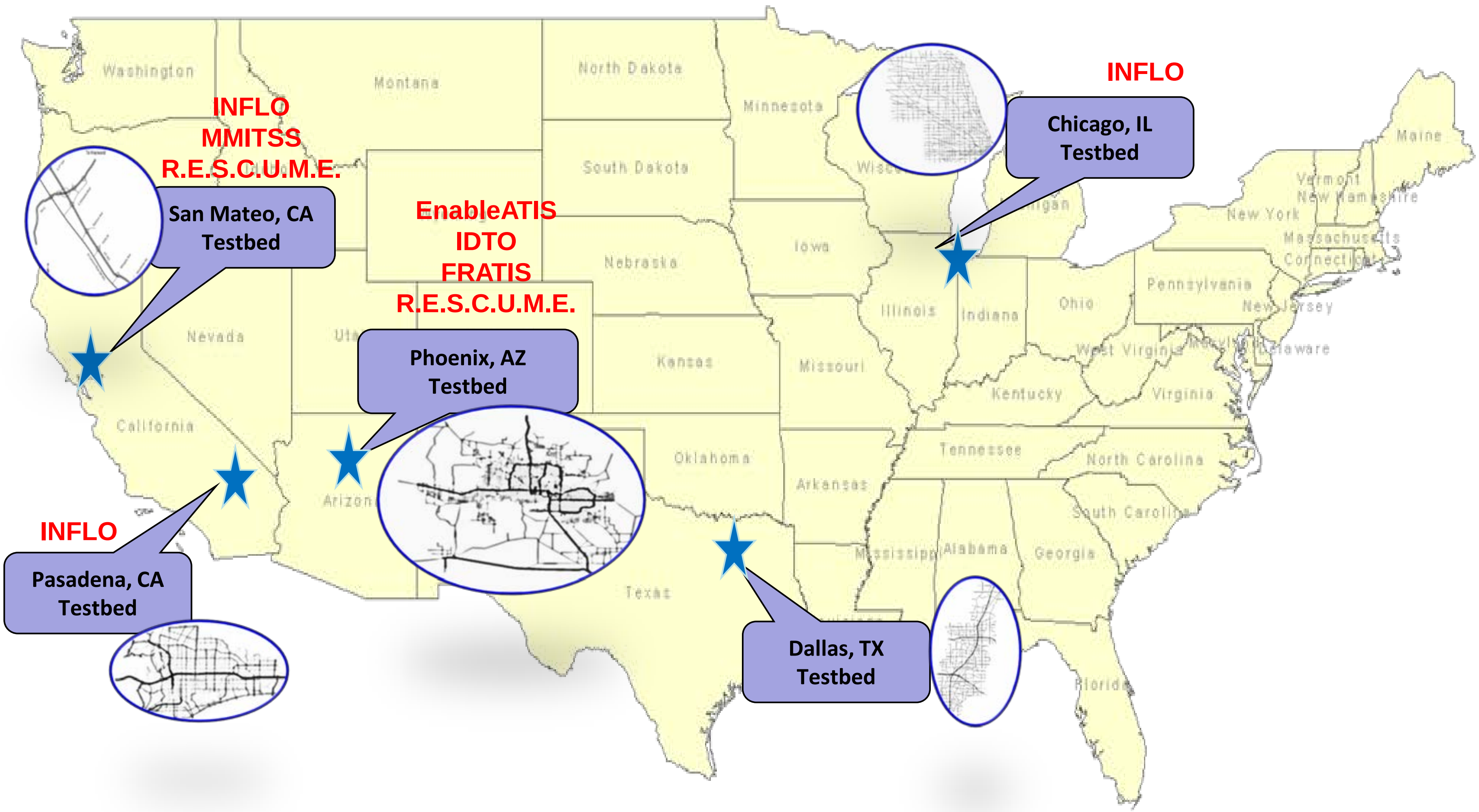
Ongoing Work



AMS TESTBEDS SELECTED



DMA Bundles to be analyzed in each AMS Testbed



Overview of DMA Applications to be Tested using Different Testbeds

Bundle	Application	San Mateo	Phoenix	Pasadena	Chicago	Dallas
Enable ATIS	Multimodal Real-Time Traveler Information (ATIS)	-	√	-		-
	Smart Park-and-Ride (S-PARK)					
	Universal Map Application (T-MAP)					
	Real-Time Route-Specific Weather Information (WX-INFO)					
INFLO	Queue Warning (Q-WARN)	√	-	√	-	-
	Dynamic Speed Harmonization (SPD-HARM)	√	-	√	√	-
	Cooperative Adaptive Cruise Control (CACC)	√	-	-	-	-
MMITSS	Intelligent Traffic Signal System (ISIG)	√	-	-	-	-
	Transit Signal Priority (TSP)	√	-	-	-	-
	Mobile Accessible Pedestrian Signal System (PED-SIG)	√	-	-	-	-
	Emergency Vehicle Preemption (PREEMPT)	√	-	-	-	-
	Freight Signal Priority (FSP)	√	-	-	-	-
IDTO	Connection Protection (T-CONNECT)					
	Dynamic Transit Operations (T-DISP)	-	√	-	-	-
	Dynamic Ridesharing (D-RIDE)	-	√	-	-	-
FRATIS	Freight Real-Time Traveler Information with Performance Monitoring (F-ATIS)	-	√	-	-	-
	Drayage Optimization (DR-OPT)					
	Freight Dynamic Route Guidance (F-DRG)	-	√	-		-
R.E.S.C.U.M.E.	Emergency Communications and Evacuation (EVAC)					
	Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESPSTG)	√	√	-	-	-
	Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)	√	√	-	-	-

Enhancing Prototyped DMA Applications for Use in AMS Testbeds

- Coordinating closely with the DMA Bundle leads and Prototype Development (PD)/Impact Assessment (IA) Contractors
- Most DMA applications are being prototyped, but not all
  - Developing new algorithms for some that are not prototyped
- Customization to form and format of the DMA algorithms in some cases is needed to implement in AMS Testbed
  - Linkages to proprietary software require workaround, involving new development to mimic the functions of proprietary software
- Implementing Transit/Freight applications in AMS Testbeds is complex and requires tool enhancements

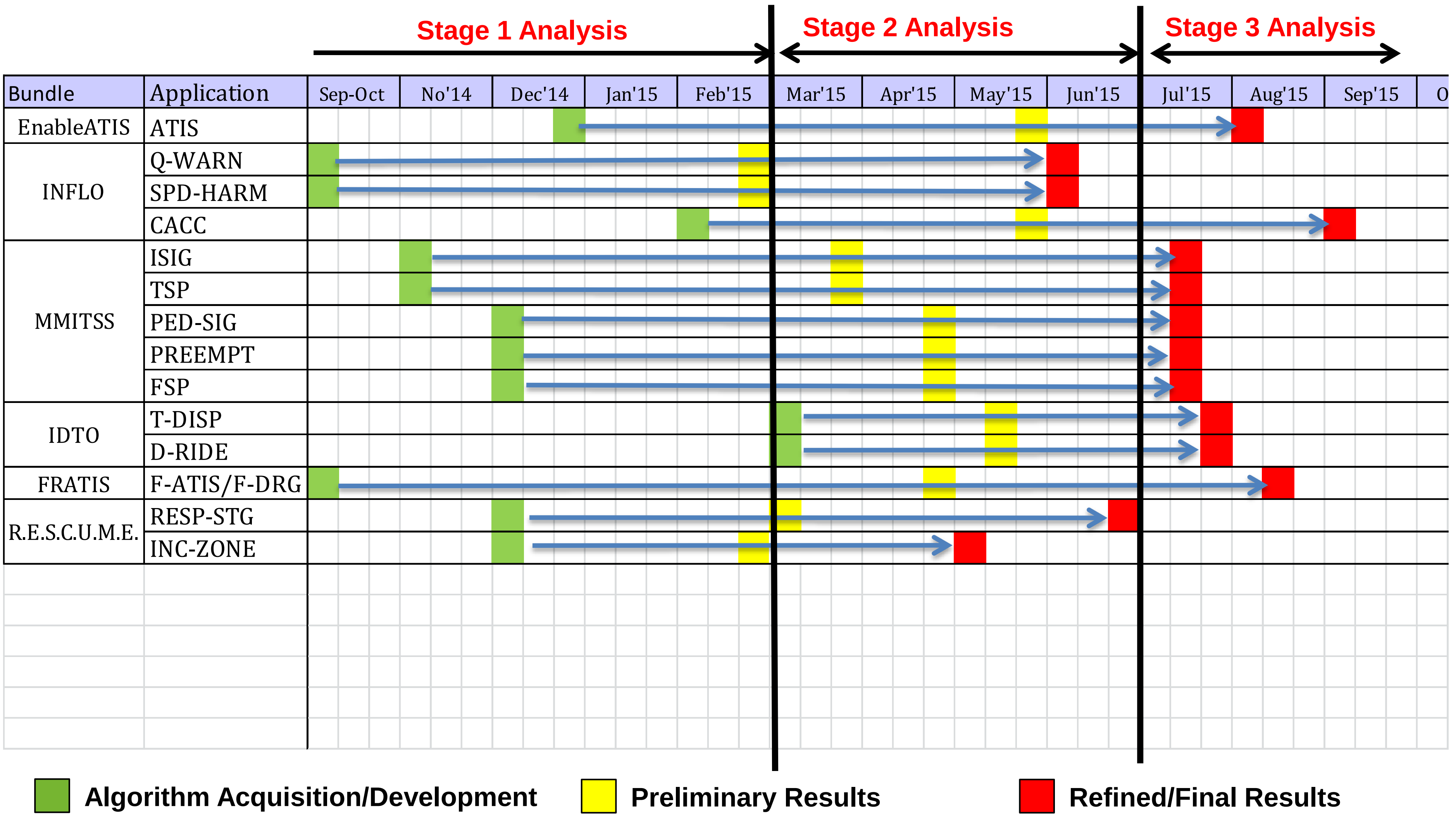
FRAMEWORK FOR MODELING COMBINATIONS OF DMA APPLICATIONS

Stage 1 Scenarios → ← Stage 2 Scenarios → ← Stage 3 Scenarios →

Scenarios (S) →		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Enable ATIS	(ATIS)						√		√	√				√
INFLO	(Q-WARN)	√	√		√	√								
	(SPD-HARM)	√	√		√	√								
	(CACC)		√			√								
MMITSS	(ISIG)			√		√								
	(TSP)			√		√								
	(PED-SIG)			√		√								
	(PREEMPT)			√		√								
	(FSP)			√		√								
IDTO	(T-DISP)							√	√	√		√		√
	(D-RIDE)							√	√	√		√		√
FRATIS	(F-ATIS)								√	√			√	√
	(F-DRG)									√			√	√
R.E.S.C.U.M.E	(RESPSTG)										√			√
	(INC-ZONE)				√						√			√

- The simulation scenarios will be conducted in three stages based on the algorithm acquisition/development timeline.
- Selected logical combinations through a systematic analysis
  - Several combinations will be analyzed, and results will be documented for the individual as well as multiple combinations at an aggregate level
- Results are expected to help address the research questions and provide insights into potential impacts from real-world deployments of a portfolio of DMA applications

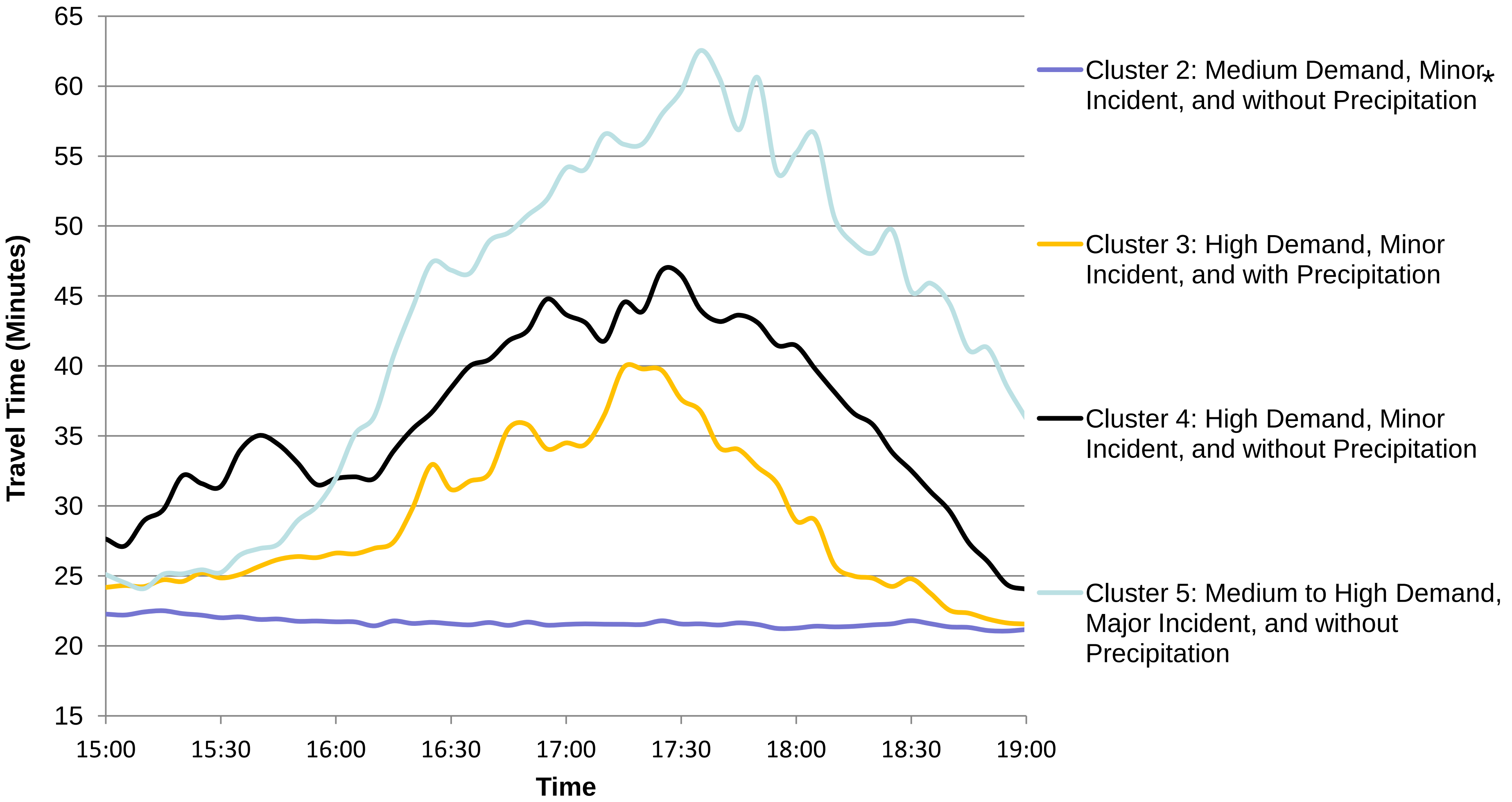
DMA Applications Modeling Timeline



Modeling Reliability and Different Operational Conditions

- DMA/ATDM applications are anticipated to generate some benefits under "recurring" conditions and significant benefits under "non-recurring" conditions
  - The frequency of "recurring" and "non-recurring" conditions defines total benefits
  - Use AMS Testbeds to quantify the benefits of DMA / ATDM strategies under multiple operational conditions
- Operational conditions define specific combinations of traffic/travel conditions
  - Demand levels and patterns (e.g., low, medium or high demand)
  - Weather (e.g., clear, rain, snow, ice, fog, poor visibility)
  - Incident (e.g., no impact, medium impact, high impact)
  - Other planned disruptions (e.g., work zones, sporting events, etc.)
- **Cluster analysis** uses observed data from each Testbed to identify conditions with similar characteristics and their frequency of occurrence
  - Observed data from the selected condition clusters will be used to calibrate and validate the input demand and traffic performance of the operational condition

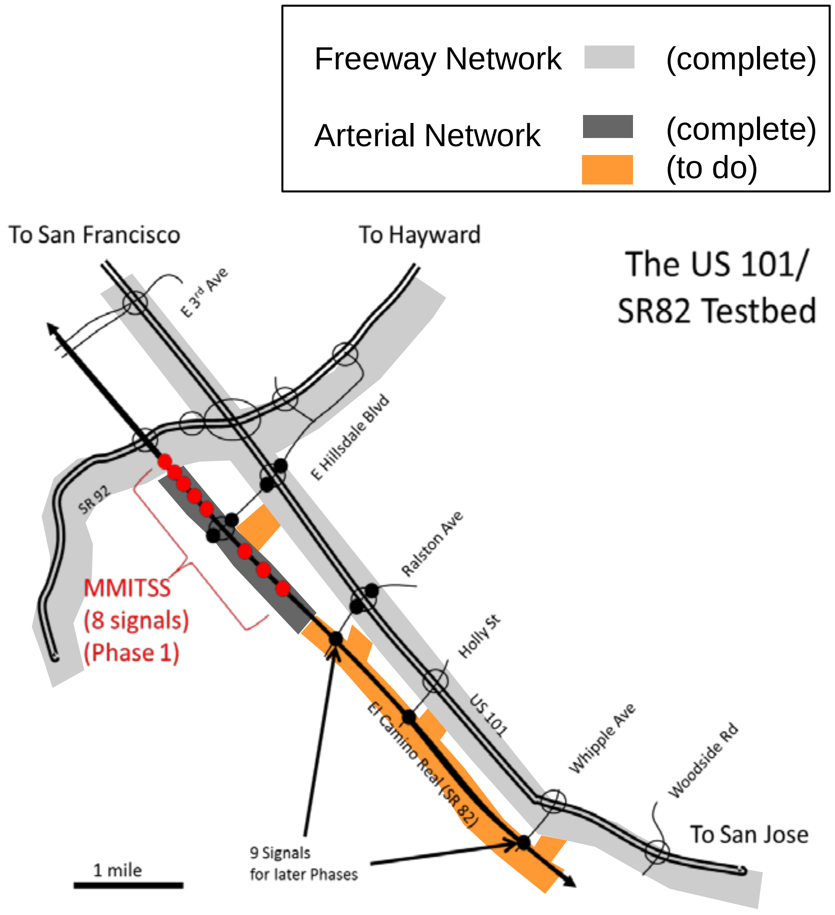
Cluster Analysis for Dallas Testbed



AMS Testbeds: Status, Next Steps, and Challenges

San Mateo Testbed: Overview

- 8.5 mile long stretch of the US 101 freeway and State Route 82 (El Camino Real) in San Mateo County, California
  - The US 101 freeway is an 8 lane freeway, transitioning to 6 mixed flow lanes plus 2 peak period HOV 2+ lanes south of Whipple Avenue
  - El Camino Real is a 4 to 6 lane signalized divided arterial with a posted 35 mph speed limit
- US 101 carries between 200,000 and 250,000 Average Annual Daily Traffic (AADT) of which 15-25% are HOV 2+ vehicles
- El Camino Real carries between 25,000 and 50,000 AADT
- A microsimulation network coded in VISSIM software.

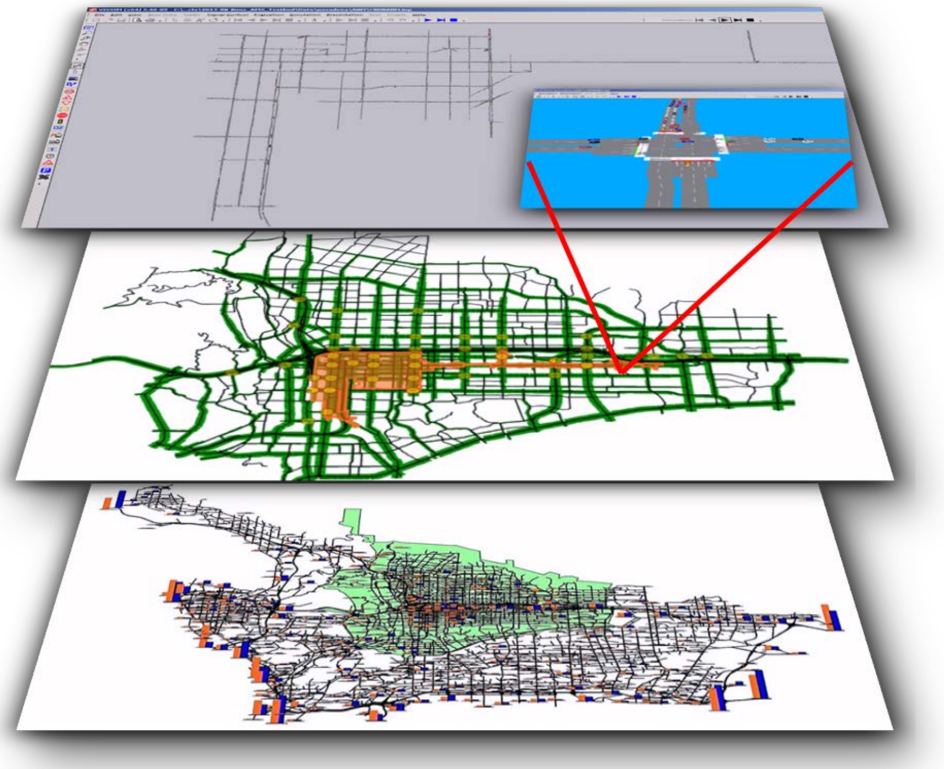


San Mateo Testbed: Status and Next Steps

- Current Status
  - SPD-HARM and Q-WARN Applications acquired and implemented
  - Interim version of MMITSS, INC-ZONE and RESPSTG developed and implemented
  - A common simulation platform that enables data-sharing between different applications developed for modeling application combinations
  - USDOTs Trajectory Convertor Application (TCA) Emulator tool added to the Testbed to enable communication modeling for INFLO and R.E.S.C.U.M.E. bundles
- Next Steps
  - Refine preliminary results of the applications algorithms
  - Test of other modules of MMITSS as they become available
  - Pilot Test operation of MMITSS and SPD-HARM in combination

PASADENA TESTBED: OVERVIEW

- Four major freeway segments in the city of Pasadena: I-210, I-710, CA-134 and CA-110
  - 11 miles of HOV lanes on I-210 and CA-134 for both directions
- AADT between 210,000 and 294,000, of which 8-15% are HOV 2+ vehicles. Major east-west arterials carry daily traffic between 8,000 and 13,000.
- Multi-resolution approach using VISSIM microsimulation software and Visum's dynamic traffic assignment (DTA) along with custom tools to emulate operation control of the Testbed
- Modeling SPD-HARM and Q-WARN on DMA side, but primarily used for ATDM analysis

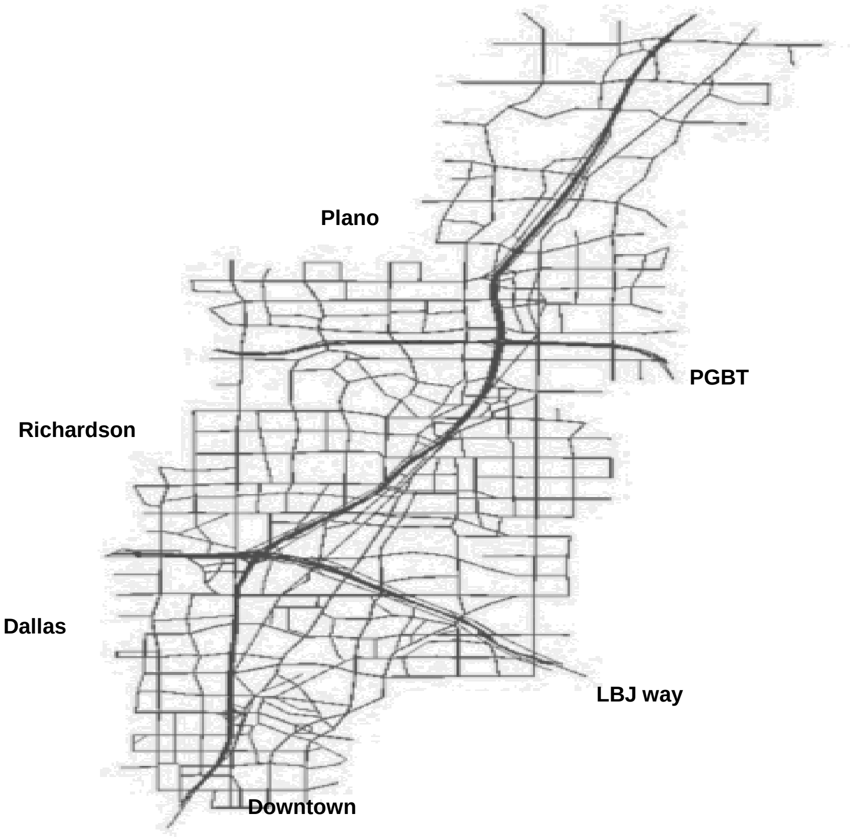


Pasadena Testbed: Status and Next Steps

- Current Status
  - Identified the Operational Conditions to conduct DMA-ATDM analysis
  - Built the base model for better representation of supply side, including intersection geometries, and traffic controls
  - Started the calibration process for the multi-resolution models in Visum and VISSIM. The calibration of the baseline operational condition included: i) bottleneck and queuing location, formation and dissipation durations; and ii) driving behavior model parameter calibration.
- Next Steps
  - Add ATDM and DMA applications to the Testbed
  - Finalize the baseline operational conditions calibration
  - Integrate demand and network performance prediction tools

DALLAS TESTBED: OVERVIEW

- US-75 corridor – Dallas
  - A 20-mile long stretch of the US-75 freeway with several parallel and crossing major regional arterial streets.
  - One parallel light rail line (the Red Line), and an arterial network which extends over multiple cities (Dallas, Richardson and Plano).
  - 1.8 million daily trips – 90 zones
- Modeled using a mesoscopic dynamic traffic assignment simulation model: *DIRECT* (Dynamic Intermodal Routing Environment for Control and Telematics)
  - DIRECT consists of several interconnected components including demand generation, travel behavior and vehicle simulation.
- No DMA modeling, only used for ATDM analysis

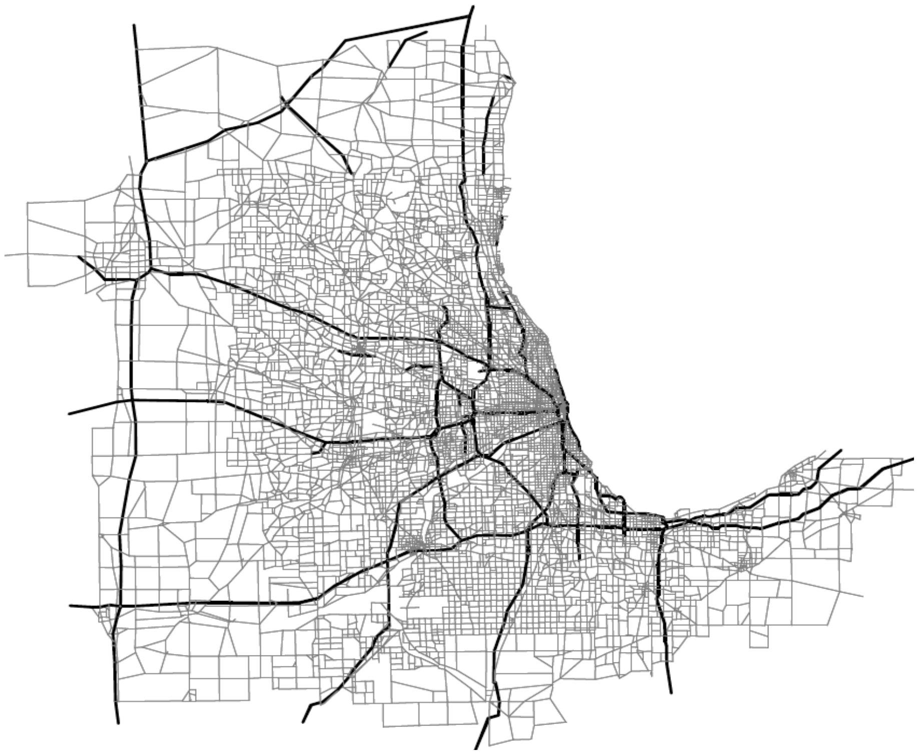


DALLAS TESTBED: STATUS AND NEXT STEPS

- Current Status
  - Identified the Operational Conditions to conduct ATDM analysis
  - Started the calibration process for the network
  - Developed an interim version of the demand estimation and the prediction module as part of the ATDM strategies evaluation
- Next Steps
  - Adjust the model parameters (demand pattern and flow propagation functions) to be able to represent each of the selected clusters
  - Build the system management module which emulates the decision making process at a typical traffic management center (TMC)

CHICAGO TESTBED: OVERVIEW

- The Chicago downtown area
  - Located in the central part of the regional network, Kennedy Expressway (I90), Edens Expressway (I94), Eisenhower Expressway (I290), and Lakeshore Drive
- Dedicated to testing weather-related applications under different weather conditions
  - Congestion becomes much worse in snow season
- Developed using the enhanced, weather-sensitive DYNASMART (**DY**namic **N**etwork **A**ssignment-**S**imulation **M**odel for **A**dvanced **R**oad **T**elematics) platform
  - A discrete time mesoscopic simulation-assignment tool developed and applied for intelligent transportation system applications
- Modeling SPD-HARM, but primarily used for ATDM analysis

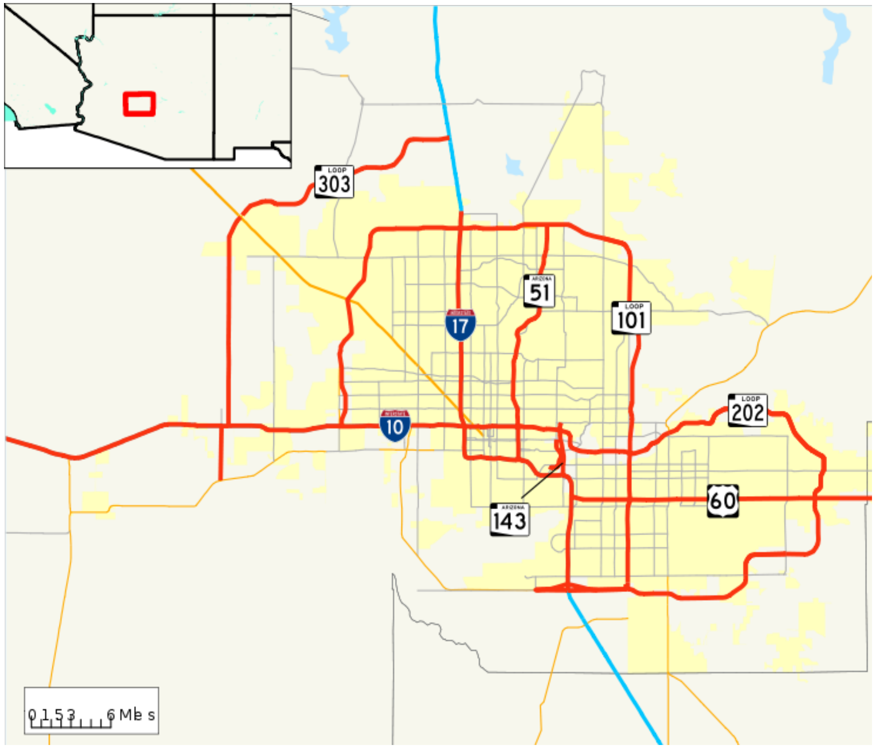


Chicago Testbed: Status and Next Steps

- Current Status
  - Completed draft Analysis Plan
  - Identified preliminary Operational Conditions that cover different demand levels and snow severity to evaluate DMA/ATDM weather related applications
  - Developed a plan for collecting additional data needed for modeling snowplow strategies
- Next Steps
  - Finalize the Analysis Plan
  - Begin network calibration for the selected Operational Conditions
  - Develop algorithms for weather-specific applications/strategies

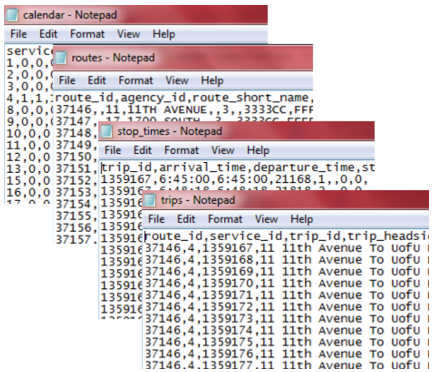
Phoenix Testbed: Overview

- Includes the Greater Phoenix metropolitan area (MPO boundary)
  - 9,200 square miles
  - 440 Centerline miles of Freeway
- The Testbed contains:
  - A grid-pattern highway network with extensive network of arterials
  - An extensive freeway system with HOV lanes
  - Ramp metering system
  - Light rail line operating in mixed traffic
  - Extensive bus service throughout the region with a mix of service types (express, local, circulator)
- Multi-resolution simulation Testbed that consists of Activity-based travel demand, Dynamic Traffic Assignment, VISSIM microsimulation models
- Modeling multiple applications from EnableATIS, IDTO, FRATIS, and R.E.S.C.U.M.E.



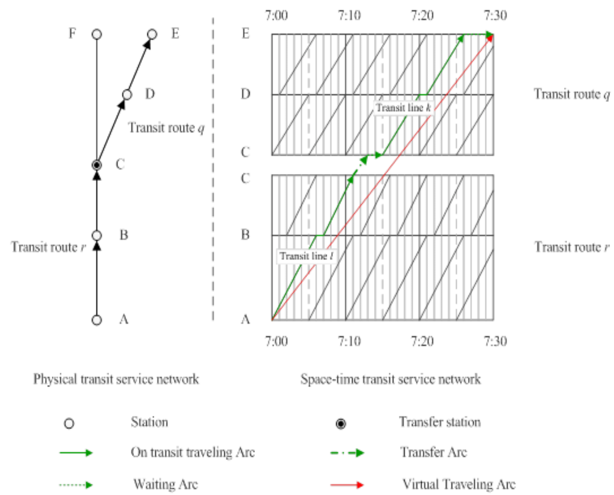
Phoenix Testbed Key Algorithms: D-RIDE, T-DISP, and ATIS

Transit Data Source: Google Transit Feed

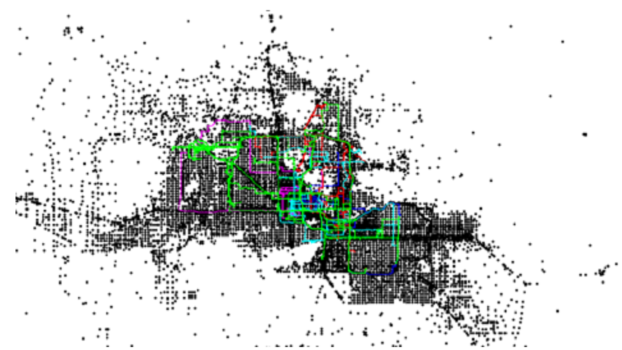


RubyRide, an App-based transportation network and taxi company in Phoenix, provides actual trip requests and driving data in 2014

Dynamic intermodal shortest path calculation Space-time-line representation:



Assignment Results: Person-based, Transit Vehicle-based Routing, Person-to-vehicle assignment Simulated vs. Real-world conditions



Phoenix Testbed: Status and Next Steps

- Current Status
  - Gathered diverse data types (travel survey data, traffic control data, loop detector data and transit data) needed to identify the tested operational conditions
  - Developed a common (preliminary) platform to connect the different levels of modeling (i.e., Activity based model, dynamic traffic assignment and traffic microsimulation) in the Testbed
- Next Steps
  - Finalize baseline operational conditions
  - Develop preliminary FRATIS and IDTO algorithms
  - Conduct DMA and ATDM analysis

PROJECT MODELING CHALLENGES

- SPDHARM/QWARN prototype not designed for arterial implementation
- Significant effort to adapt MMITSS to El Camino Real, therefore full functionality not expected until May 2015
  - MMITSS functionality for weather and incident effects on street operations is not yet available
- Dependencies on other critical components that are under parallel development as part of other projects (e.g., FHWA Prediction tool)
- Large scale model (e.g., Phoenix Testbed) and needs extensive calibration process to replicate real-time operations and system management capabilities
- Some algorithms are not available (e.g., EVAC application) or are dependent on commercial third party software (e.g., dynamic routing component of FRATIS application)
- Evaluating transit applications is complex and needs new tool development

Project Next Steps and Expected Outcomes

PROJECT NEXT STEPS

- Continue Testbed development, calibration, and modeling efforts
- Continue Stakeholder engagement throughout 2015
  - Conferences and webinars
  - Let us know if you are interested in participating
- Reporting Timeline
  - March 2015 – Stage 1 (early) findings
  - June 2015 - Stage 2 findings/reports
  - October 2015 – Stage 3 findings/reports
  - November 2015 – Final reports
    - Final Report for each Testbed
    - Final Report on Overall DMA Evaluation
    - Final Report on Overall ATDM Evaluation

Project Outcomes

- In addition to Final Reports which will summarize analysis results, several resources will be made available for use by others:
  - Testbed Analysis Plans
  - Methodology used for evaluating DMA Applications
  - DMA Algorithms and Testbed input & output files (APIs, code, tools, files) posted on **Open Source Application Development Portal (OSADP)**
  - Cleaned and documented Testbed-related data posted on **Research Data Exchange (RDE)**

- Serve as examples for transportation agencies to set up their own Testbed and evaluate DMA and ATDM strategies/applications in their regions

- Provide tools and techniques for Decision Support Systems to TMC managers and operators for proactive, real-time operations

Stakeholder Q&A

DMA Program Manager

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DMA Website

www.its.dot.gov/dma/

Booz Allen Hamilton

Balaji Yelchuru, AMS Testbed Principal Investigator