Information Technology Applications in TSM&O Projects

Presented at

Annual Joint Meeting of Florida Section of ITE and ITS-FL

Theme: Mobility has no Boundaries – All play a role in TSM&O

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Presentation Overview

- History of TSM&O
- Current and emerging IT Tools
- Some Key Concepts
  - Data Management
  - Big data and Artificial Intelligence/Machine Learning Overview
- Project examples
- Q&A

Evolution of TSM&O

Traffic Operations Program to Increase Capacity and Safety **(TOPICS)**

Transportation System Management **(TSM)**

Intelligent Vehicle Highway System **(IVHS)**

Intelligent Transportation System **(ITS)**

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TOPICS (Traffic Operations Program to Increase Capacity and Safety)

- The U.S. Congress established a program known as TOPICS in the 1968 Federal-Aid Highway Act.
- The TOPICS program is designed to improve capacity and safety of the existing city arterial networks by a systematic application of traffic operational types of improvements.
- The improvements must be based on an areawide plan based on prioritization of goals.
- TOPICS does not include major construction except to eliminate bottlenecks which prevent full use of existing capacity of the street.

TSM (Transportation System Management)

- Since 1981, FHWA and FTA have mandated that Regional Transportation Plans must have TSM element which describes how a region improves efficiency and effectiveness of the total transportation system in moving people and goods.

- TSM is often used interchangeably as TCM and TDM to describe a series of techniques designed to maximize the efficiency of the existing transportation system by reducing dependence on single occupant vehicles. The concept of HOL emerged.

- The goals of TSM are to reduce traffic congestion, improve air quality, and reduce or eliminate the need for new and expensive transportation infrastructure.

- The TSM techniques, under this mandate, are generally low-cost measures to reduce travel demand or to improve the utilization of existing transportation facilities.

(IVHS/ITS) Intelligent Vehicle Highway System/Intelligent Transportation System

Technological advances brought many innovations in vehicles such as cruise control and then gradually transferring the control of vehicles from humans to computers inside and outside of vehicles. The progress we could see is in:

- Automated Highway System (AHS)
- Automated Vehicle Identification and Location (AVIL)
- Electronic Toll Collection (ETC)
- Intelligent Vehicle Highway System (IVHS)
- Intelligent Transportation System (ITS)

TSM&O (Transportation Systems Management & Operation)

The past processes, improvements, and developments as well as emerging technologies in transportation systems are now included in:

TSM&O is an **integrated program** to optimize the performance of existing multimodal infrastructure through implementation of systems, services, and projects to preserve capacity and improve the security, safety and reliability of the transportation system.

Improve communications, coordination, and collaboration amongst transportation partners leading to more effective leveraging of existing infrastructure

http://www.cflsmartroads.com/tsmo.html

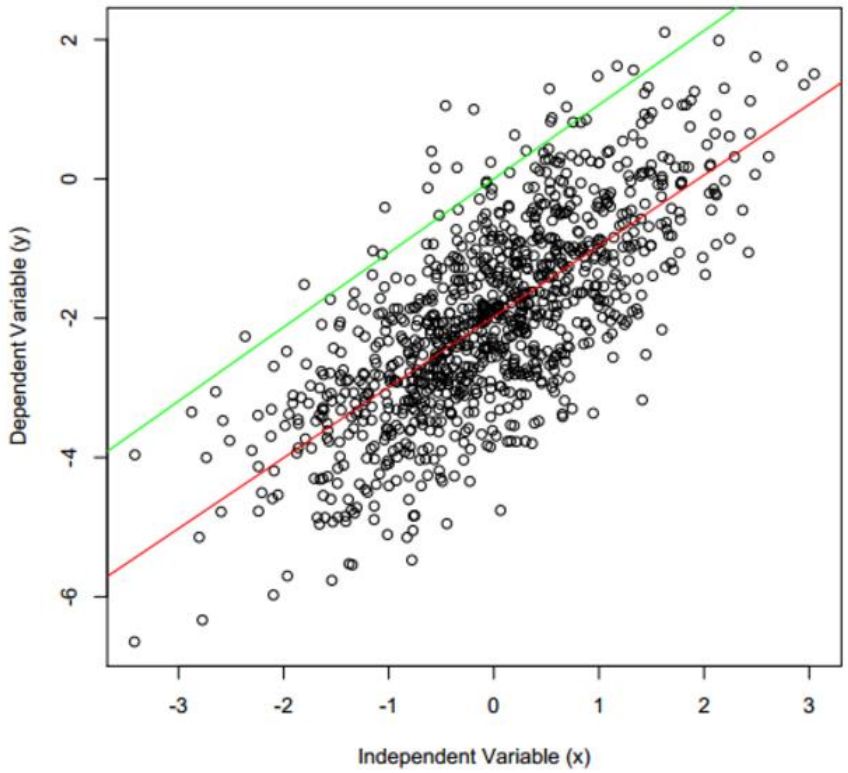
A walk down memory lane…

- Here is a brief overview of how thing were done in the past…

Data Collection

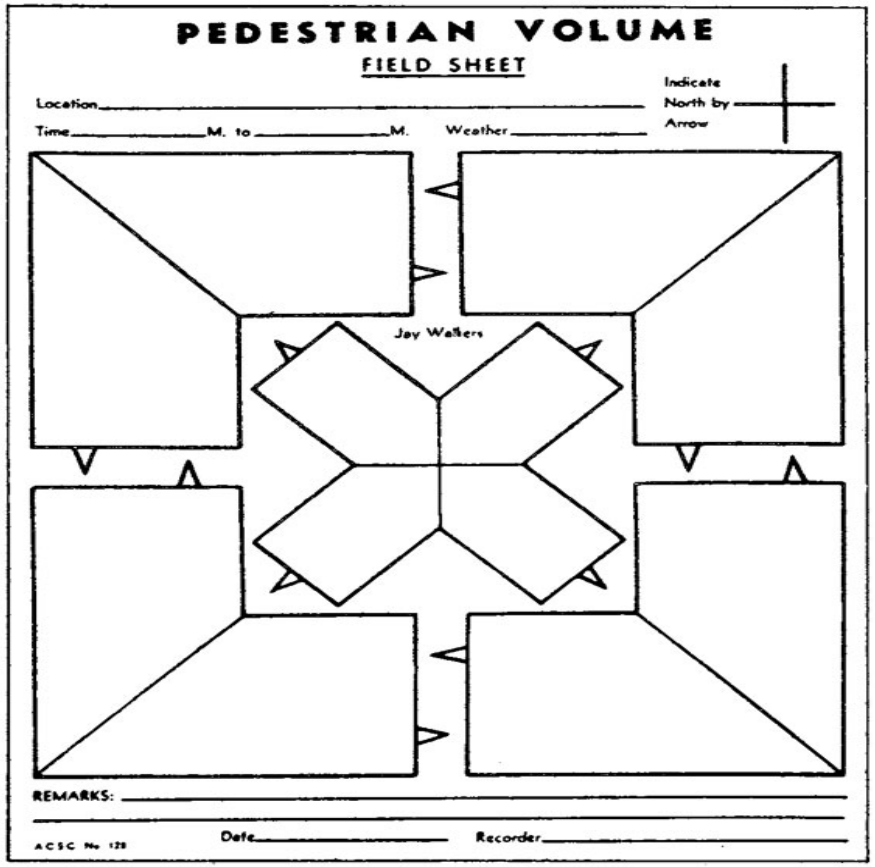
- Data Collection such as traffic counts, turn counts at intersections, screenline counts, etc. were done manually using hand counters and people standing at intersections and screenlines.

- Input data collection for transportation models were limited to the parameters that could be analyzed manually.



Regression Analysis

Pedestrian Counts at Intersections



PEDESTRIAN VOLUME

FIELD SHEET

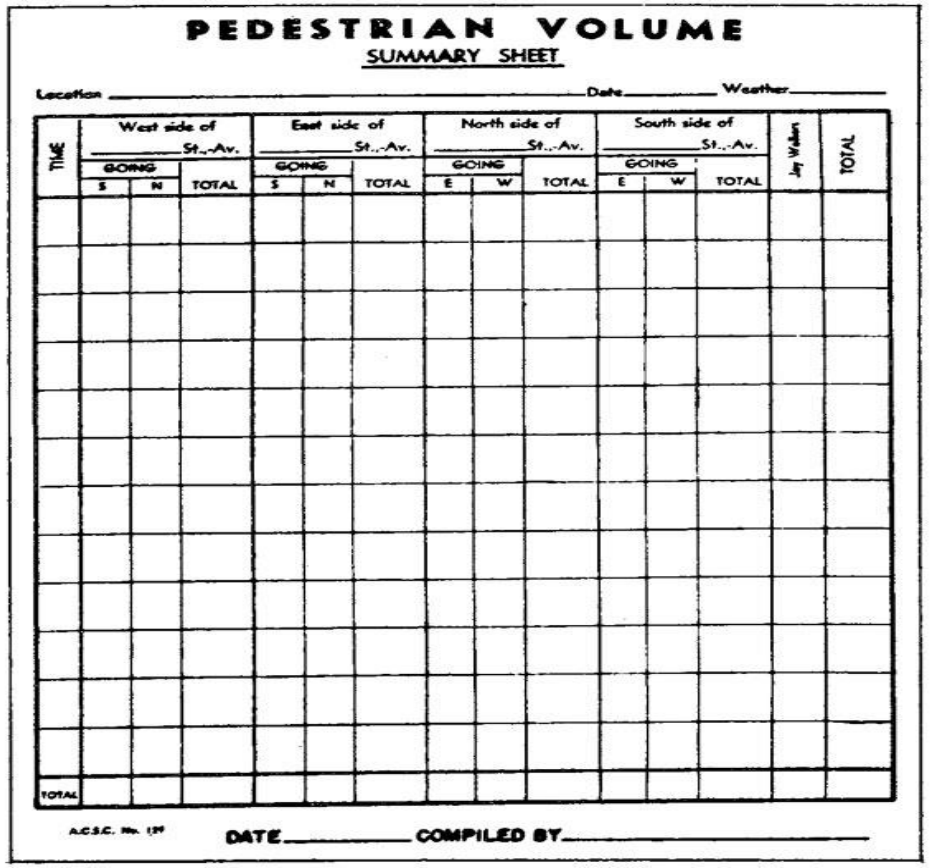
Location_____ Indicate North by Arrow

Time_____ M. to _____ M. Weather_____

Jay Walkers

REMARKS: _____

ACSC No 128 Date_____ Recorder_____



PEDESTRIAN VOLUME

SUMMARY SHEET

Location _____ Date_____ Weather_____

TIME	West side of _____ St.,-Av.			East side of _____ St.,-Av.			North side of _____ St.,-Av.			South side of _____ St.,-Av.			Jay Walkers	TOTAL
	GOING			GOING			GOING			GOING				
	S	N	TOTAL	S	N	TOTAL	E	W	TOTAL	E	W	TOTAL		
TOTAL														

A.C.S.C. No. 129 DATE_____ COMPILED BY_____

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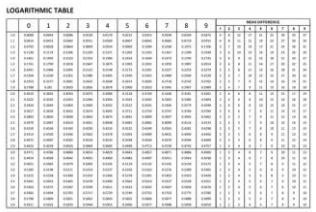
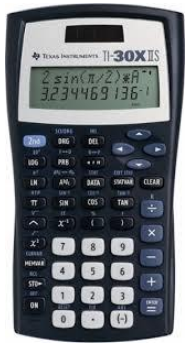
Technological Advancements

- Accurate and usable data is the basis for **reliable and dependable** transportation planning, traffic engineering, and transit operations.

- Higher computing capabilities brought a **revolution** in collecting, analyzing, and appropriately documenting complex and almost unlimited data for the use of decision makers.





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Information Technology Tools in Transportation

Past

- CAD
- Spreadsheets/Manual Calculations
- Fortran/Mainframe Programs

Present

- GIS
- Sophisticated Micro, Meso, Macro-scale Models
- Web and Mobile Technologies
- Reactive Management based on historical data analysis

Future

- Big Data, Data Analytics
- Machine Learning/Artificial Intelligence
- Integrated Infrastructure Intelligence® (i3)

IT Innovations are Revolutionizing Transportation

Breaking down communication barriers

- Overcoming the organizational silos
- Data hoarding is no longer the norm
- Decision making based on a holistic view of infrastructure information

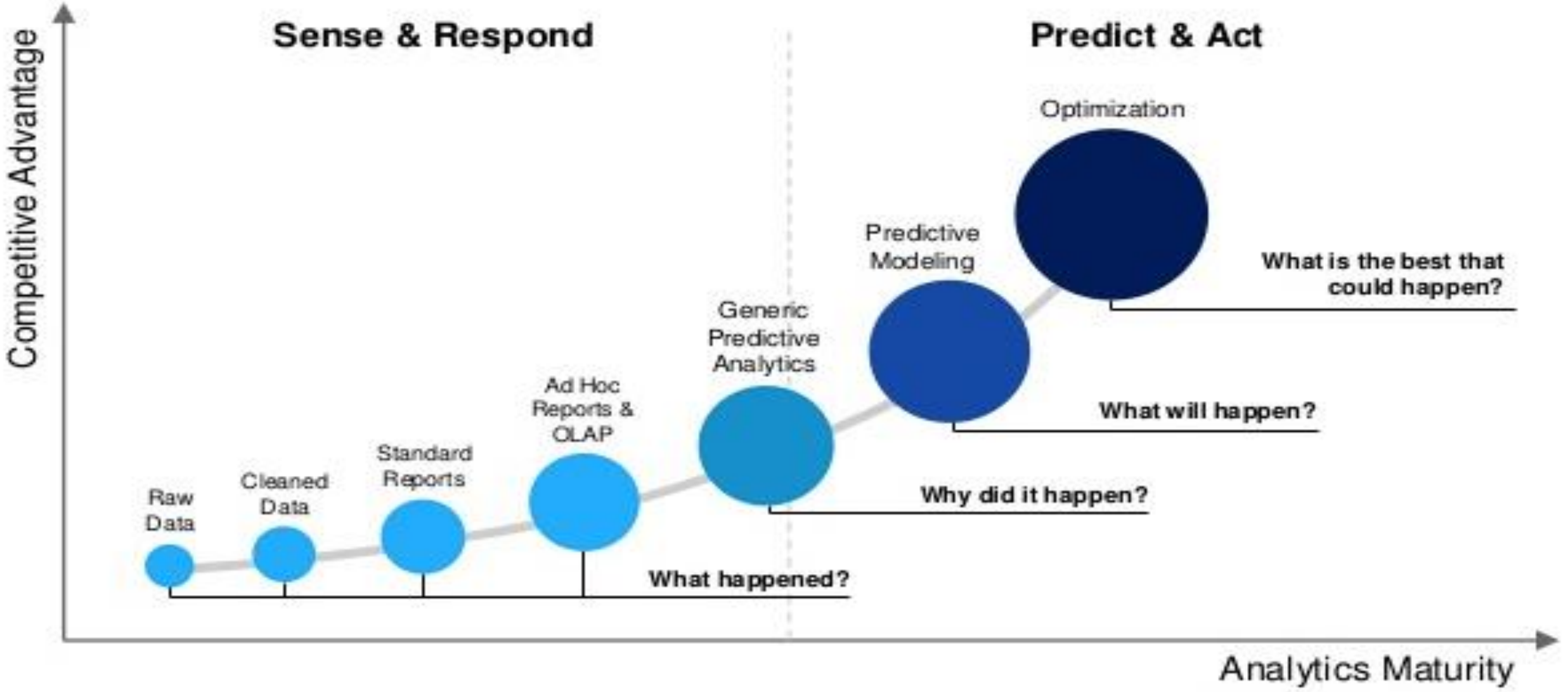
Learning from historical data

- Visualizing spatial and temporal patterns
- Better input data for models
- Multivariate analysis

Where do we go from here

- Predictive Tools for Proactive Infrastructure Management and Operations
- **Integrated Infrastructure Intelligence (i3®)**
- Automated Vehicles/Connected Vehicles

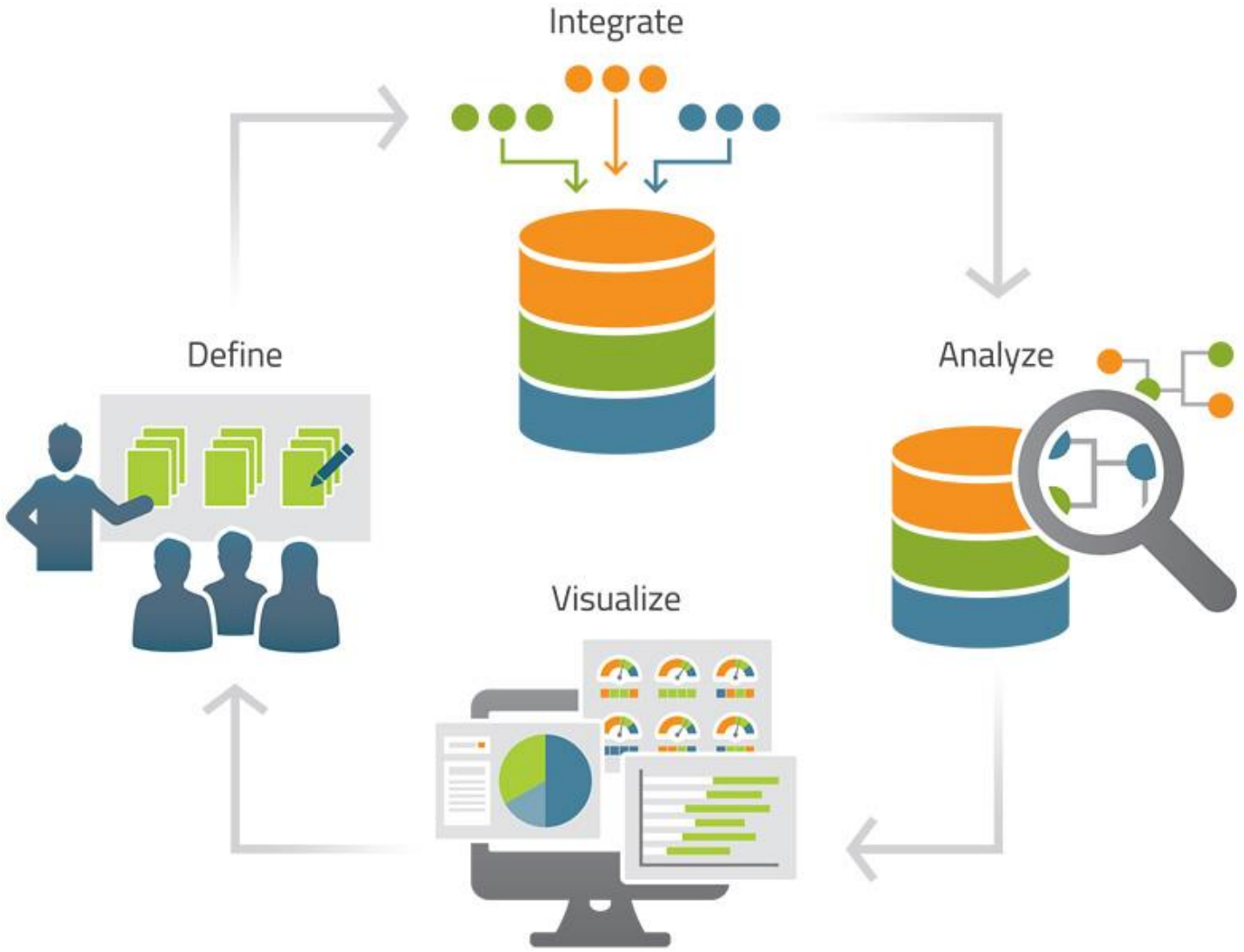
Putting Data to Use with Analytics



Potential Applications of AI/ML

- Planning
  - Predict budgets and outcomes at macro level
- Safety
  - Improve safety of transportation network
- Operations
  - Predict traffic speeds and traffic counts
- Maintenance
  - Predict infrastructure useful life/failures

Enterprise Reporting/BI/Data Analytics Solutions



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Project Examples

Recent Projects

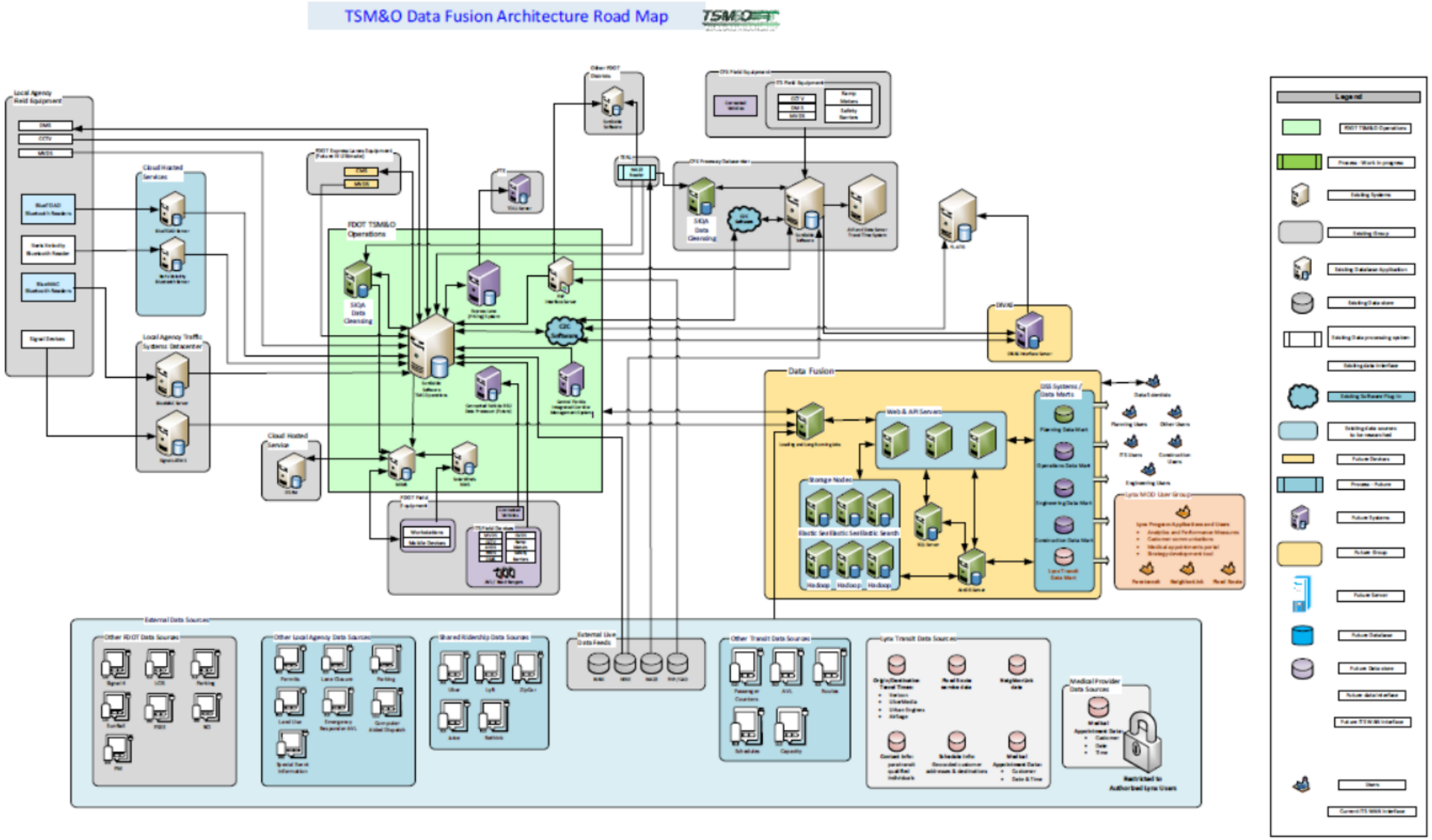
- TSM&O Architecture Development
- Active Arterial Management Dashboards
- Enterprise Data Repository
- Enterprise Information Portals
- Integrated Project Information Systems (iPro)
- Address Data Management Application (ADMA)

Upcoming Projects

- Integrated Corridor Management
- ATMS Data Integration
- Integrated Infrastructure Intelligence (i3®)

TSM&O Data Fusion Architecture

Source: FDOT ITN-DOT-16-17-5004-ICMS
DESCRIPTION: Central Florida Regional Corridor Management System; February 16, 2017



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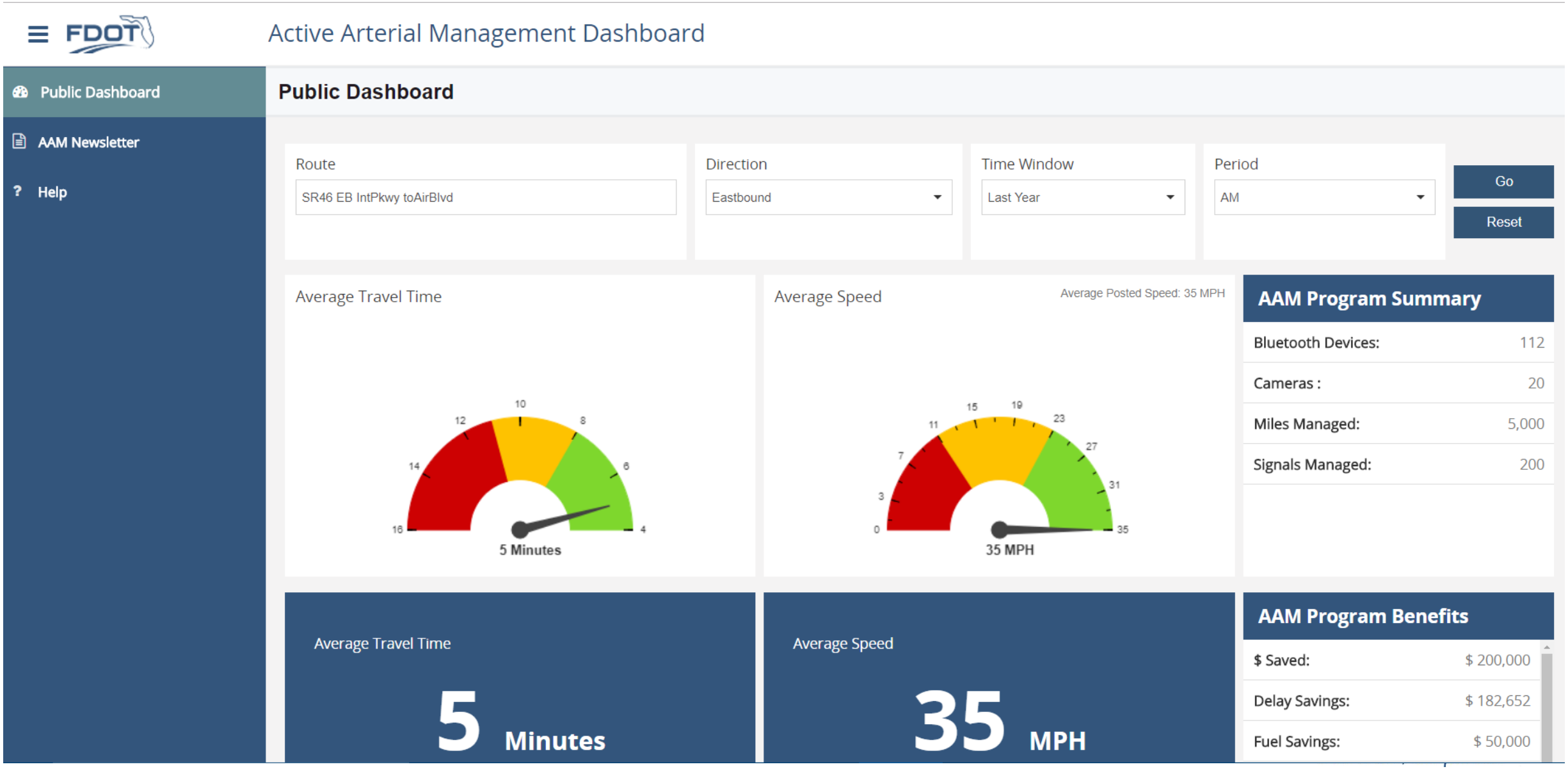
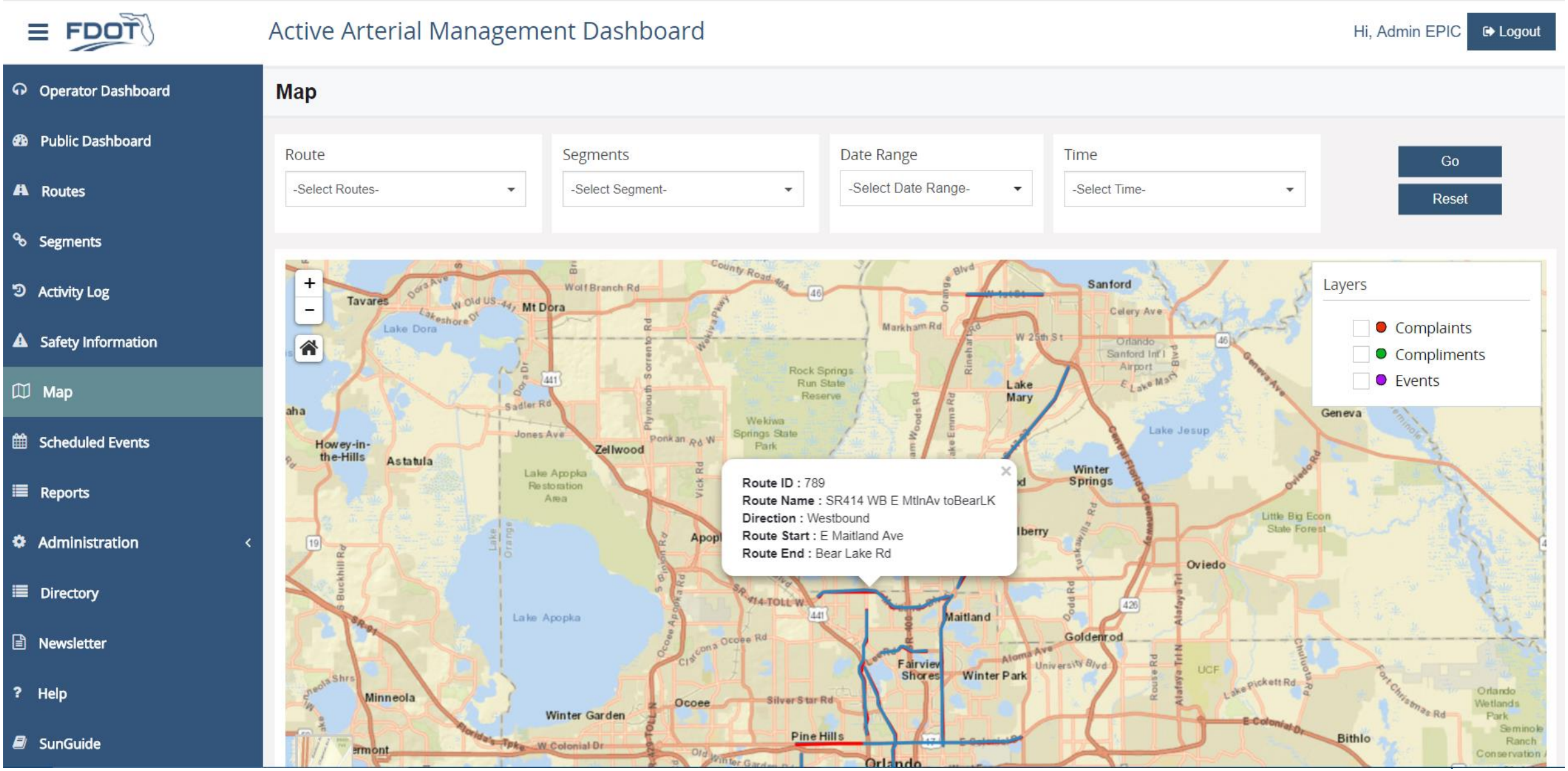
Active Arterial Management Dashboard

- Compiles near-real time data from Bluetooth Sensors
- Provides AAM Corridor Manager and Operators with access to historical and current data
- Public access to historical travel time information
- Ability to add more data sources as needed

Active Arterial Management Dashboard



Active Arterial Management Dashboard

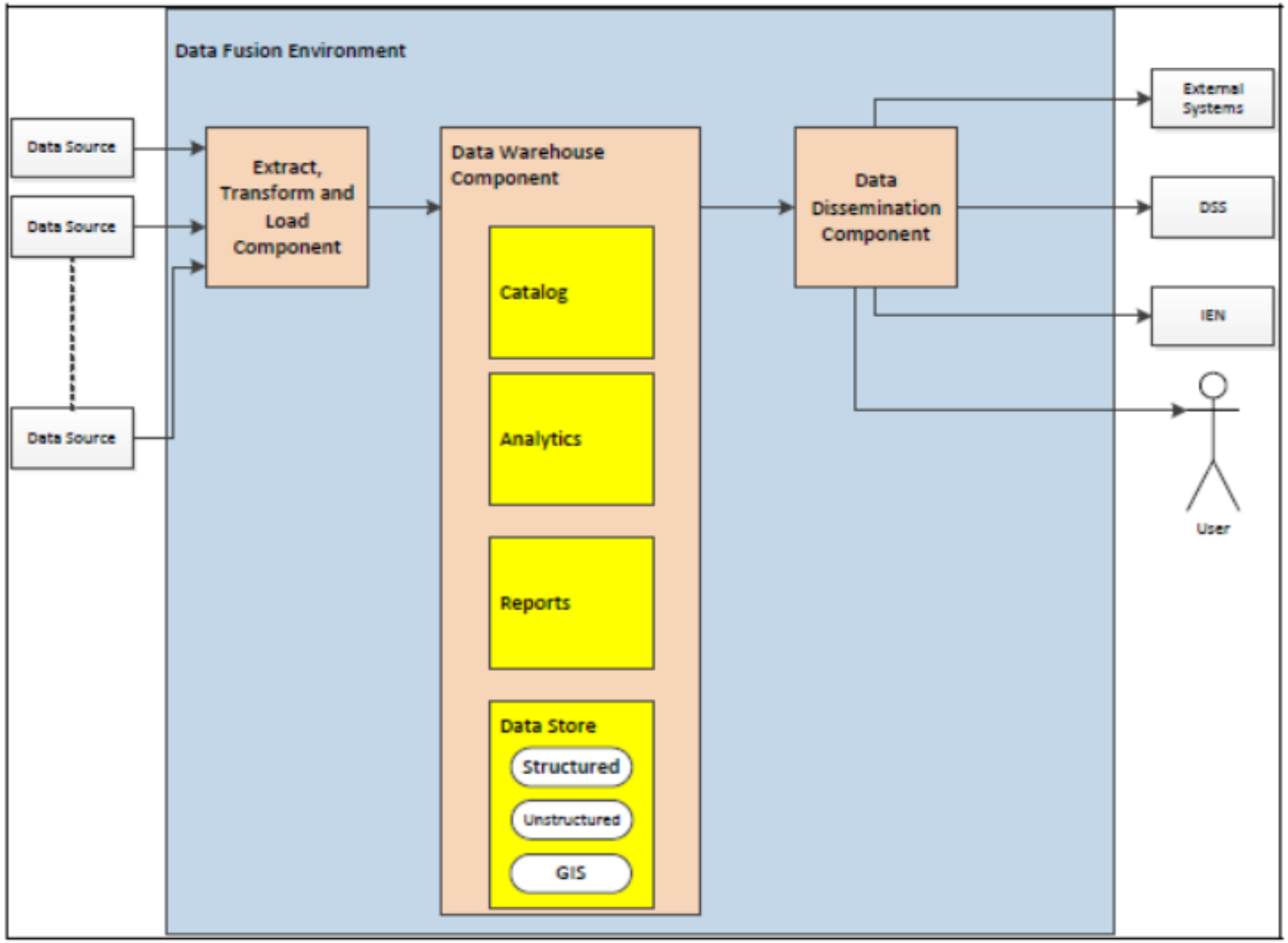


Integrated Corridor Management (ICM)

- Leveraging big data and analytics tools to revolutionize traffic operations
- Bringing together valuable data from multiple sources
- Facilitating communication among diverse stakeholders
- Providing near-real time signalization plans to operations staff
- Provide historical data access and analytics

ICM Data Fusion

Source: FDOT ITN-DOT-16-17-5004-ICMS
DESCRIPTION: Central Florida Regional Corridor Management System; DATE: February 16, 2017



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ICM Roles & Responsibilities

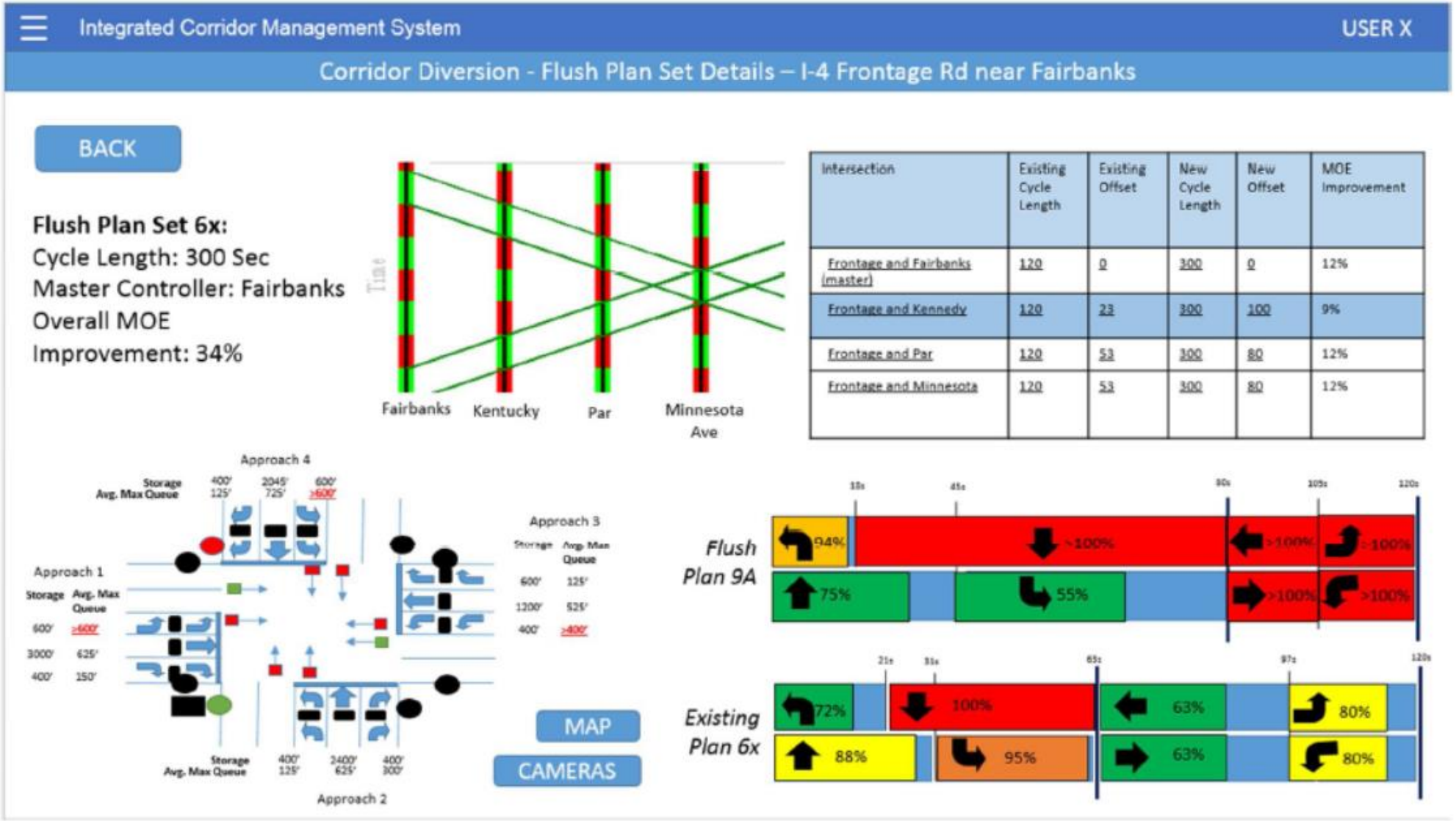
Source:

FDOT ITN-DOT-16-17-5004-ICMS
DESCRIPTION: Central Florida Regional Corridor Management System
DATE: February 16, 2017

Traffic-Related Roles	FDOT Central Office	FDOT D5	FTE	MetroPlan	CFX	SunRail	Orange County	Osceola County	Seminole County	City of Kissimmee	City of Maitland	City of Orlando	City of Winter Park	Florida Highway Patrol	LYNX	Universities
Police											X	X		X		
Fire							X	X	X	X	X	X	X			
Emergency Services							X	X	X	X	X	X	X	X		
Road Ranger/ Courtesy Patrol		X	X		X											
Traffic Signal System		X					X	X	X	X	X	X	X			
Detectors		X	X		X		X	X	X	X	X	X	X			
Dynamic Message Sign		X	X		X		X	X	X	X	X	X	X			
Public Works							X	X	X	X	X	X	X			
Closed-circuit Television		X	X		X		X	X	X	X	X	X	X			
Electronic Toll /Fare /Parking equipment			X		X	X						X			X	
Transit – Bus/ Commuter Rail						X									X	
Parking Management												X				
Maintenance/ Construction		X	X		X	X	X	X	X	X	X	X	X		X	
Data Warehouse/ Analytics	X	X		X												X
Modeling		X	X	X	X											
Internet Traveler Information	X	X	X		X	X									X	
Congestion Pricing		X	X													

ICM Flush Plans

Source: FDOT ITN-DOT-16-17-5004-ICMS
DESCRIPTION: Central Florida Regional Corridor Management System; February 16, 2017



Intersection	Existing Cycle Length	Existing Offset	New Cycle Length	New Offset	MOE Improvement
Frontage and Fairbanks (master)	120	0	300	0	12%
Frontage and Kennedy	120	23	300	100	9%
Frontage and Par	120	53	300	80	12%
Frontage and Minnesota	120	53	300	80	12%

Figure 19: Corridor Diversion - Flush Plan Set Details

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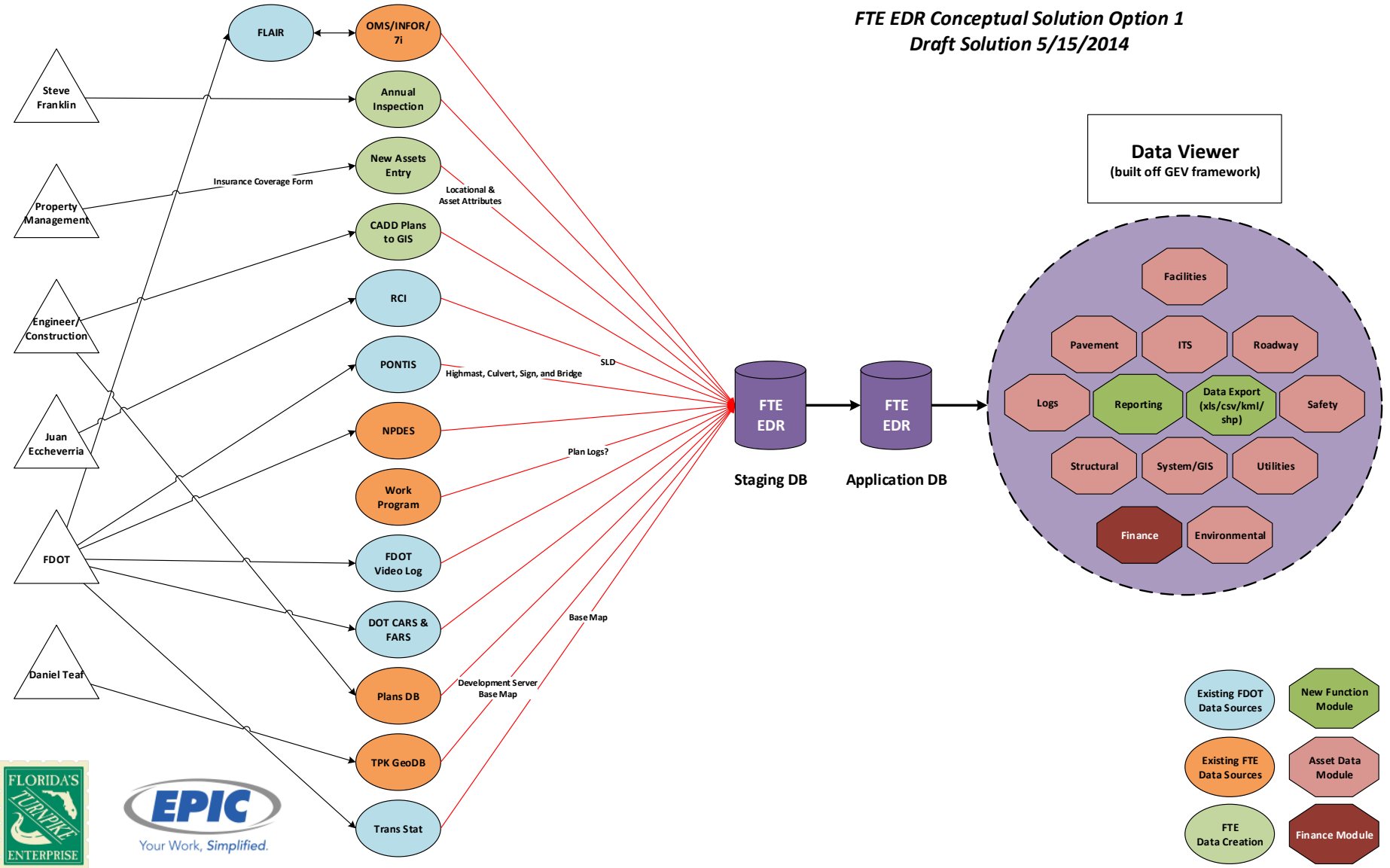
FTE - EDR



FLORIDA'S TURNPIKE ENTERPRISE

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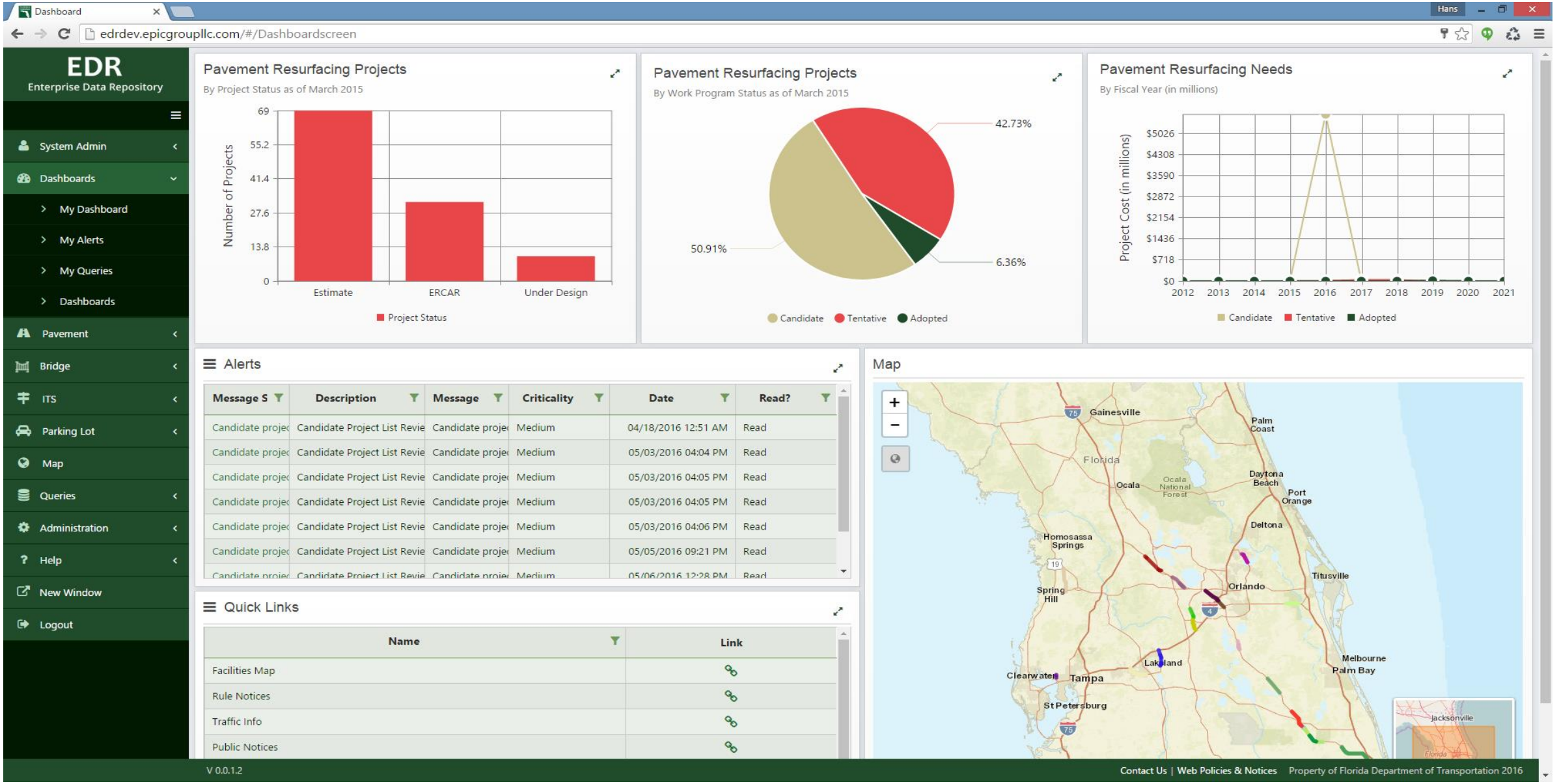
FTE Enterprise Data Repository



Integrated Infrastructure Intelligence (i3®)

What is it?

- The power to make intelligence decision based on a holistic view of infrastructure information
- Bridge the organizational silos
- Look at the complete life cycle of infrastructure from concept to completion and through operations and maintenance

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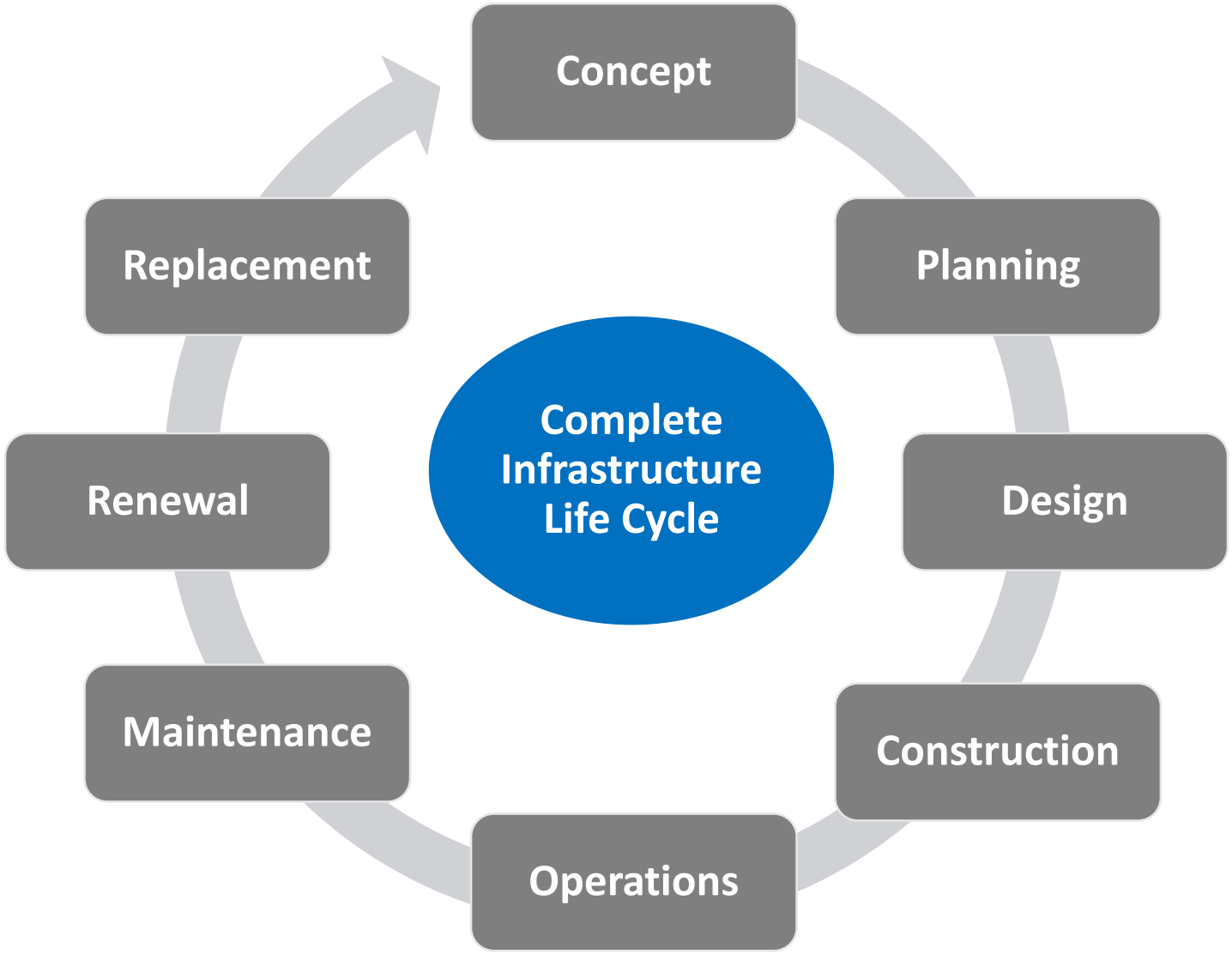
Complete Infrastructure Lifecycle Management



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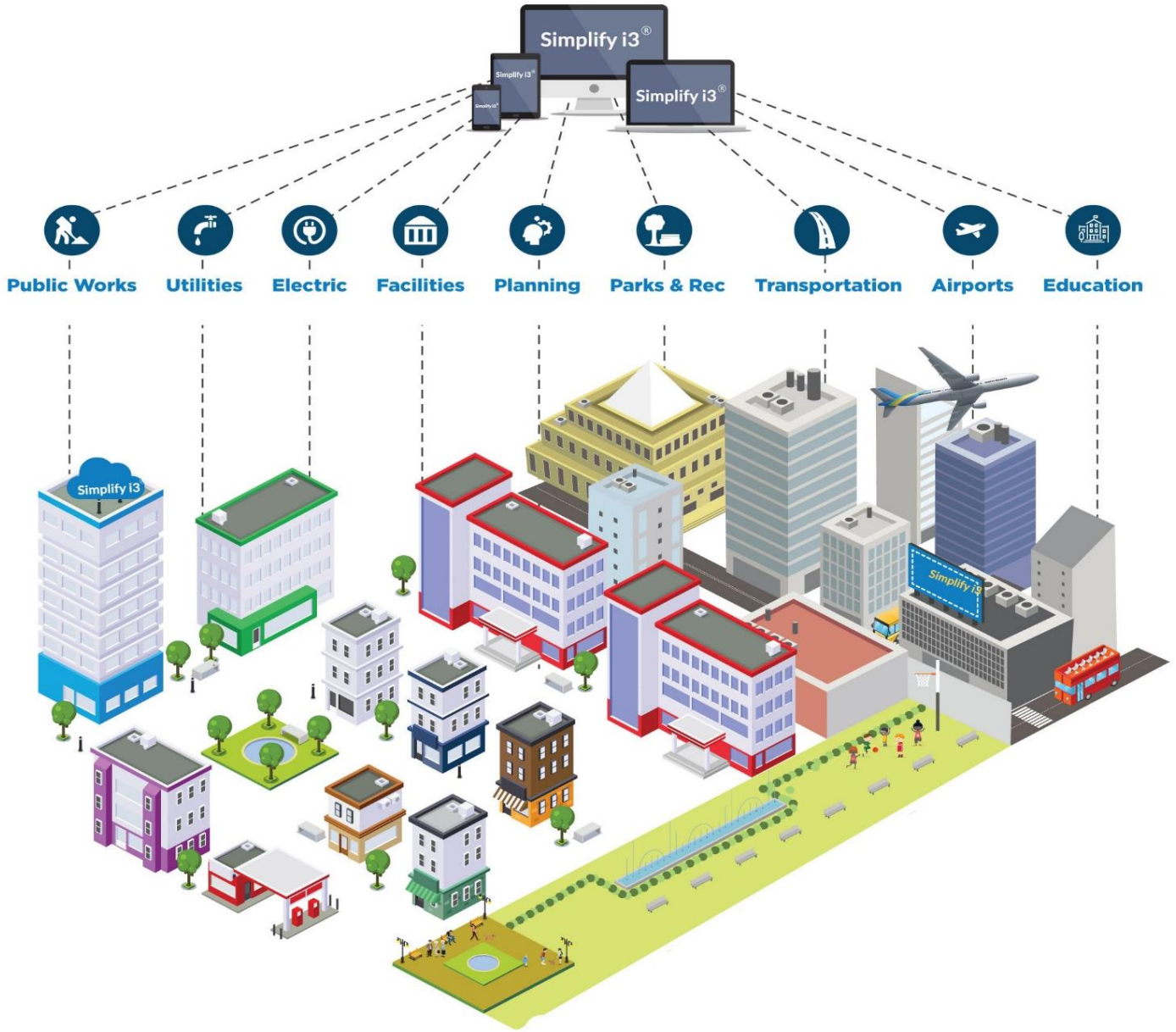
Integrated Infrastructure Intelligence®



NSF

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Integrated Infrastructure Intelligence® (i3)

NSF

SBIR·STTR
America's Seed Fund

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Simplify i3®

All Search for..

8 Hi Matthew

The City Of Sunshine Hills

- Dashboard
- Projects
- Assets
- Documents
- Maps
- Contacts
- Funds
- Setup

Sunshine Hills

Sunshine Hills Dashboard

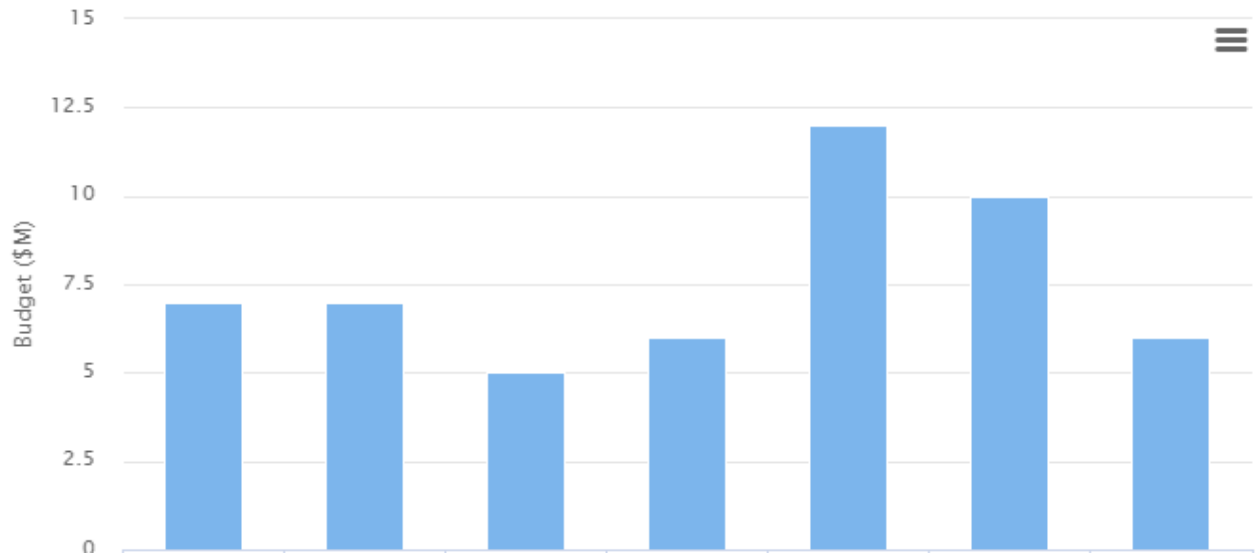
Budget Summary — $50M Total Budget

Expenditure — $19M Amount Spent

Progress — 36% Projects Completed

Projects Schedule — 5 on schedule, 7 behind schedule

Budget Summary



Active Programs

- Water Storage Improvement Program
- Water Plant Improvement
- Water Distribution System
- Wastewater Collection System Projects
- Sewage Treatment Programs
- Industrial Water Treatment Program
- General Engineering Services

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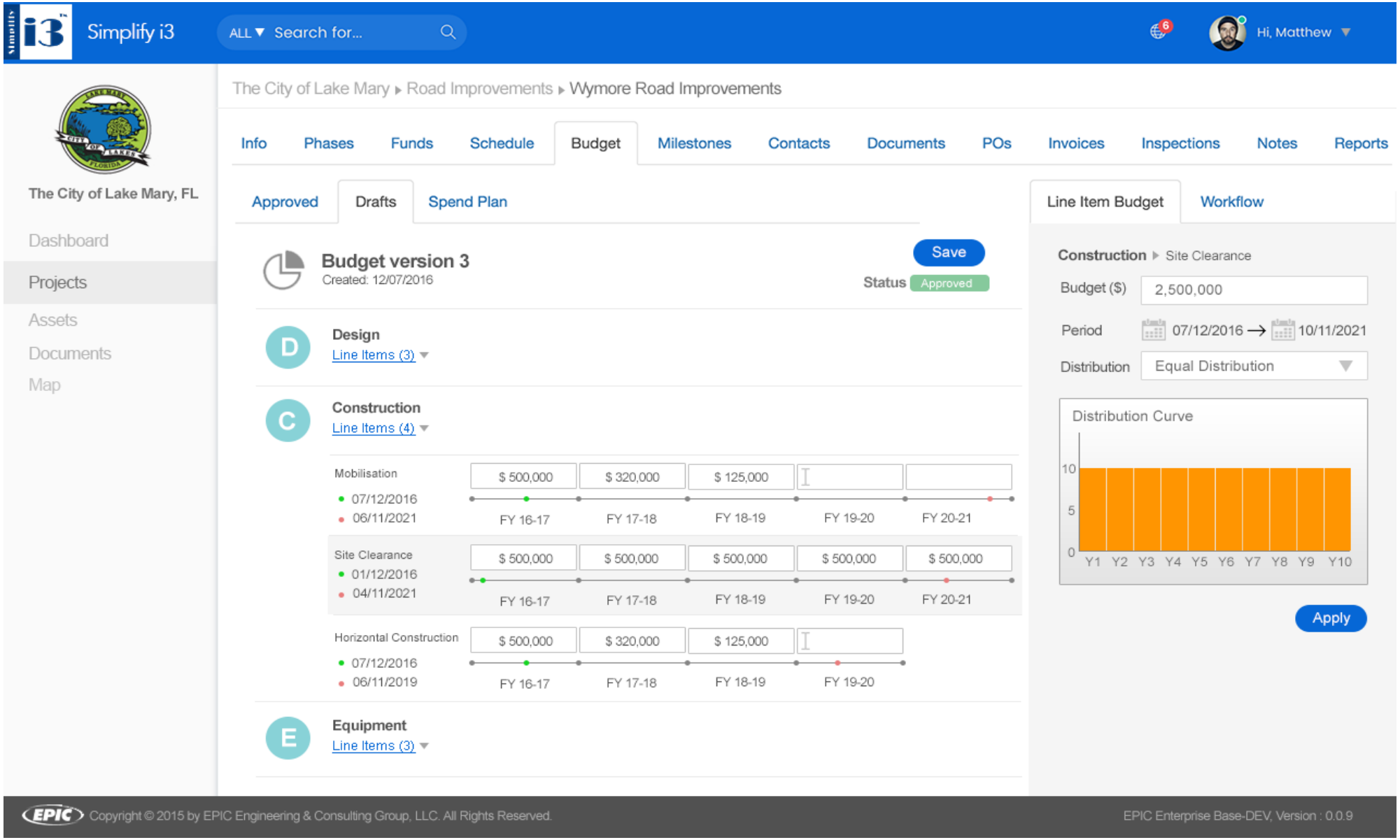
Budget Management



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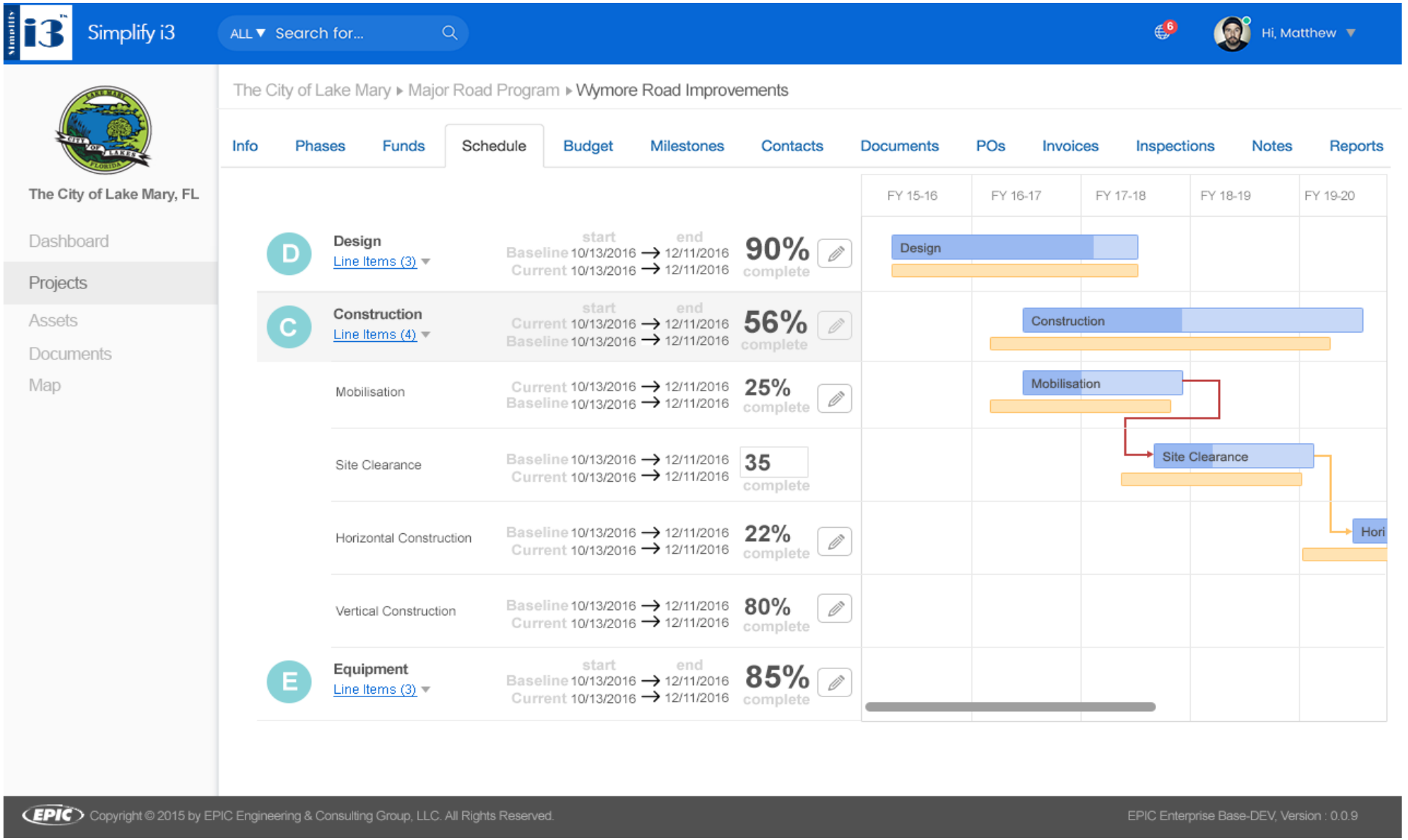
Simplify i3® Schedule View



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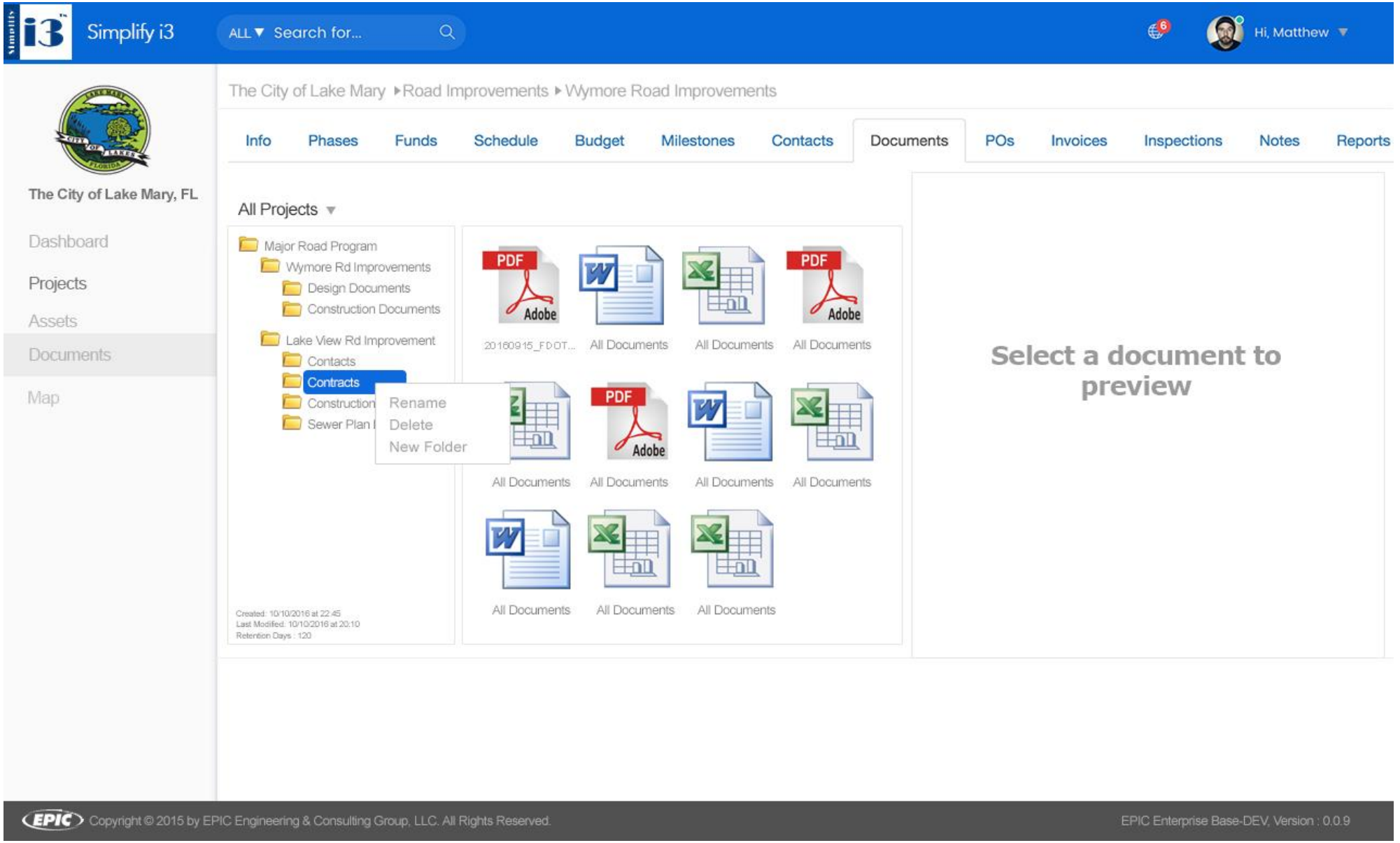
Document Management



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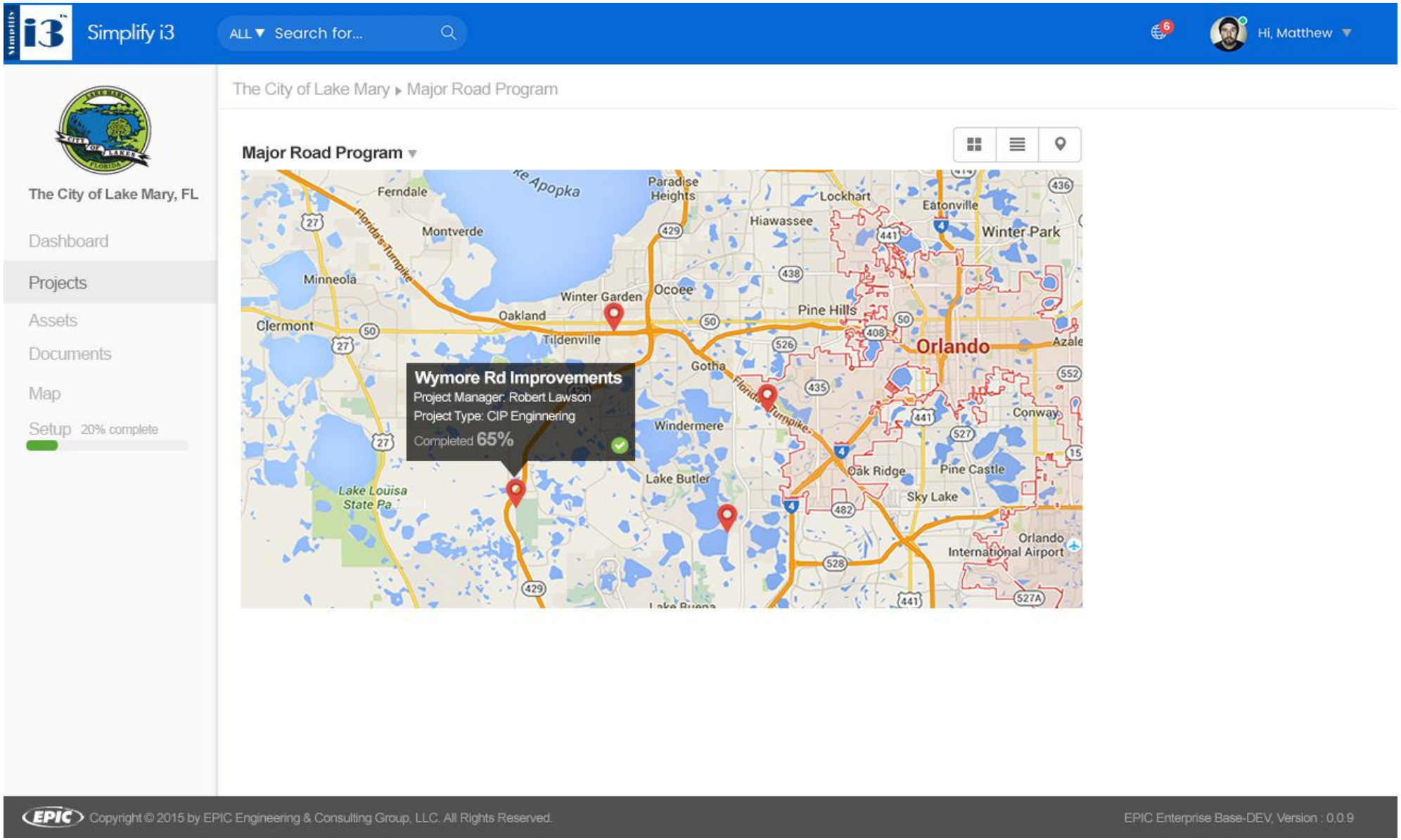
Simplify i3® Map View



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Q&A

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THANK YOU!

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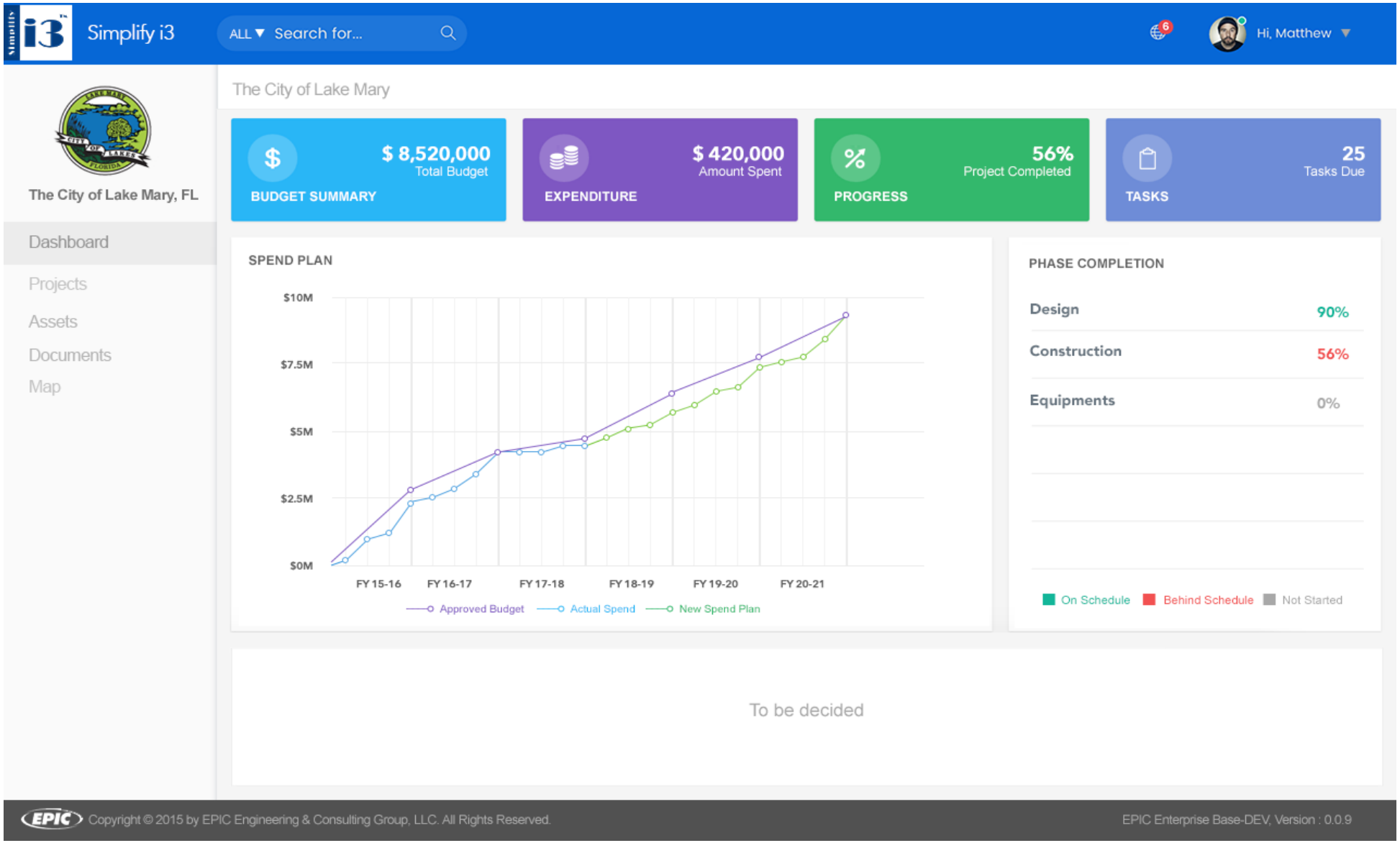
Project Status Dashboard



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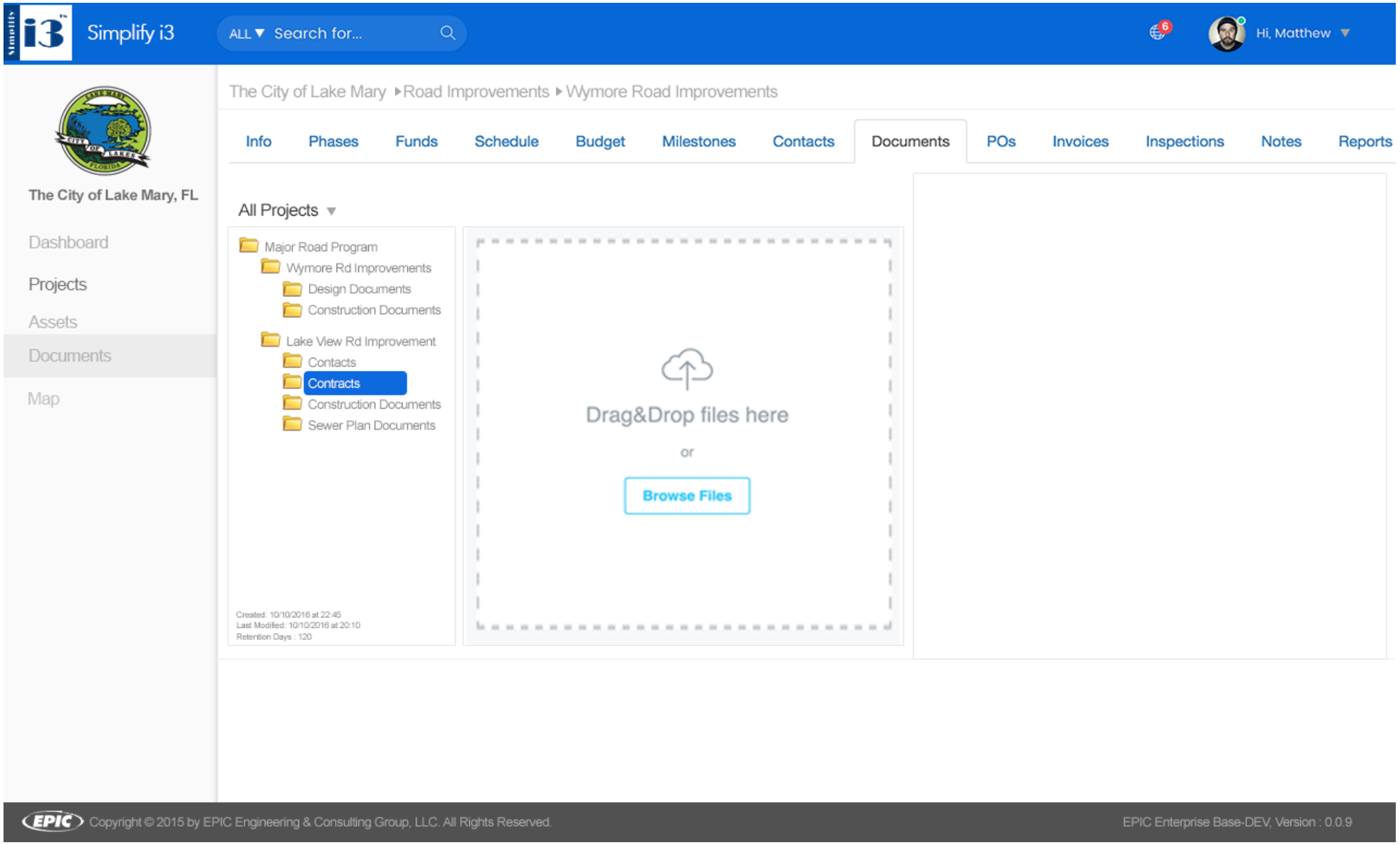
Document Management



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Points

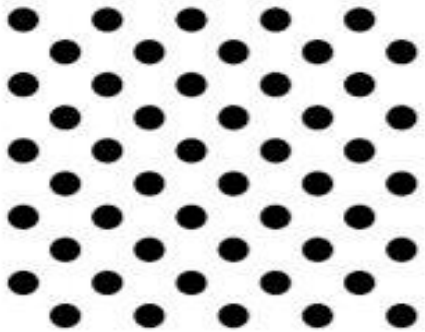
- Industry is moving to Big Data and Predictive Analytics
- Decision Making
  - Past
    - Establish goals and objectives
    - meet stakeholders
    - Measures of effectiveness
    - Communicate to stakeholders in meetings
    - Reporting (Manual)
    - Toll Collection
  - Present
    - Near-real time data analysis and metrics calculation
    - On-demand reporting
    - 24/7 communication through Dashboards
    - Sensor data capture and use
    - Electronic toll collection
  - Optimization
    - IoT
  - Integration (Data Fusion)
    - Data visualization and analytics tools
  - Save Money
  - Share data to all agencies seamlessly (Data Dissemination)

AI/Machine Learning

- Artificial Intelligence (AI) is the broad umbrella
  - Machine Learning
    - Combines computer science with statistical methods to make machines learn from big data
  - Statistical Learning
    - Is the underlying technique for machine learning. It was previously used with lesser data, hence not effective. With modern computing advancements and availability of big data, this evolved into ML.

Big Data Characteristics

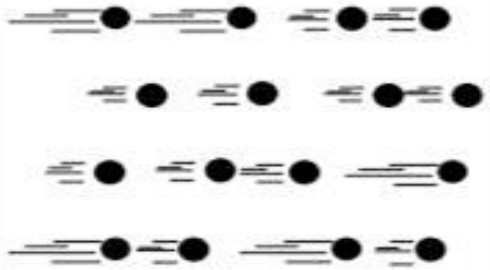
Volume



Data at Rest

Terabytes to exabytes of existing data to process

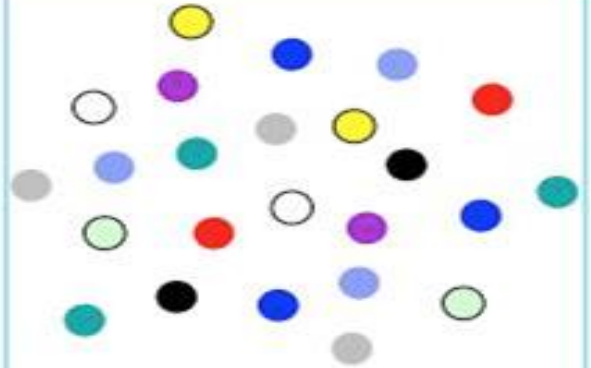
Velocity



Data in Motion

Streaming data, milliseconds to seconds to respond

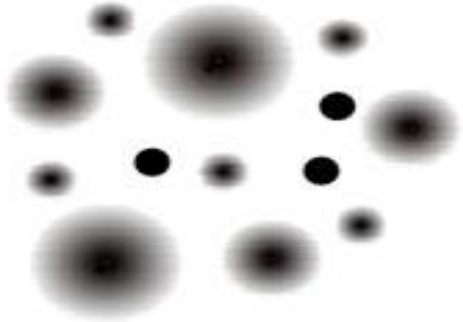
Variety



Data in Many Forms

Structured, unstructured, text, multimedia

Veracity*



Data in Doubt

Uncertainty due to data inconsistency & incompleteness, ambiguities, latency, deception, model approximations

Source: Google Image Search

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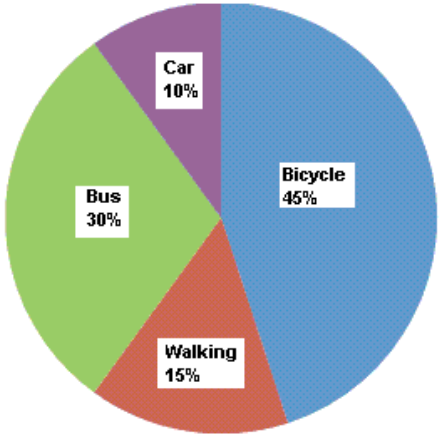
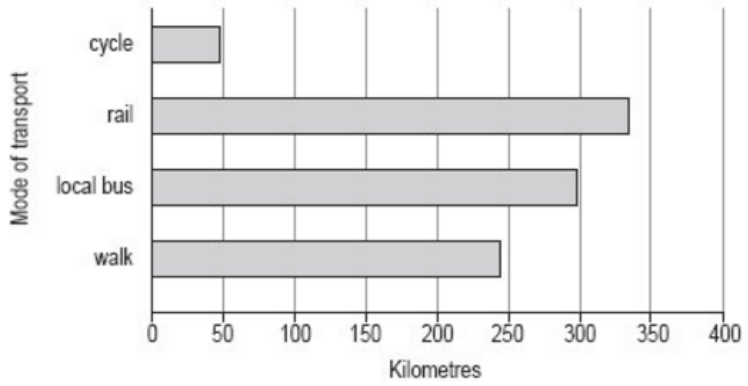
Data Analysis and Reporting

- Simple Statistical Analysis
- Present in Graphs, Bar Charts, Pie Charts, and Tables

Mode	Period	External		Internal		Total	
		High	Low	High	Low	High	Low
Passenger Vehicle	Peak Period	$0.769	$0.560	$1.053	$1.053	$1.822	$1.613
	Off-Peak Period	$0.358	$0.195	$0.756	$0.756	$1.113	$0.951
Transit Bus	Peak Period	$0.059	$0.040	$1.101	$1.101	$1.160	$1.141
	Off-Peak Period	$0.043	$0.026	$0.606	$0.606	$0.649	$0.632
SkyTrain	Peak Period	$0.211	$0.116	$0.356	$0.356	$0.567	$0.471
	Off-Peak Period	$0.211	$0.116	$0.249	$0.249	$0.460	$0.364
Cycling	Peak Period	-$0.119		$0.691		$0.572	
	Off-Peak Period	-$0.119		$0.534		$0.415	
Walking	Peak Period	-$0.157		$1.487		$1.330	
	Off-Peak Period	-$0.157		$0.877		$0.720	



Types of Transportation



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