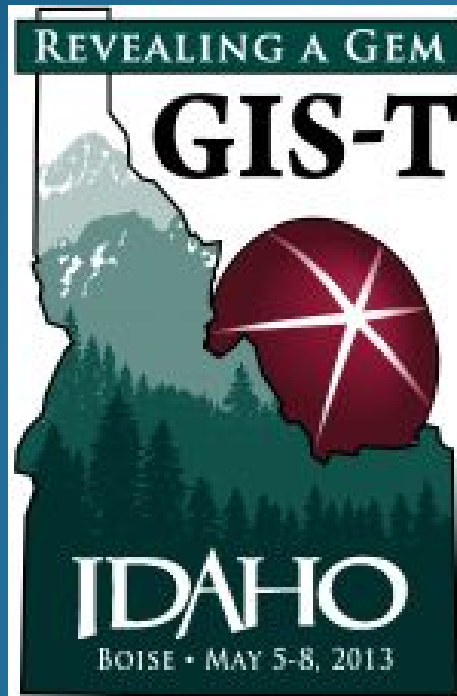


GIS/IT Integration – UDOT Experience



Bo Guo, PE, PhD

Gistic Research, Inc

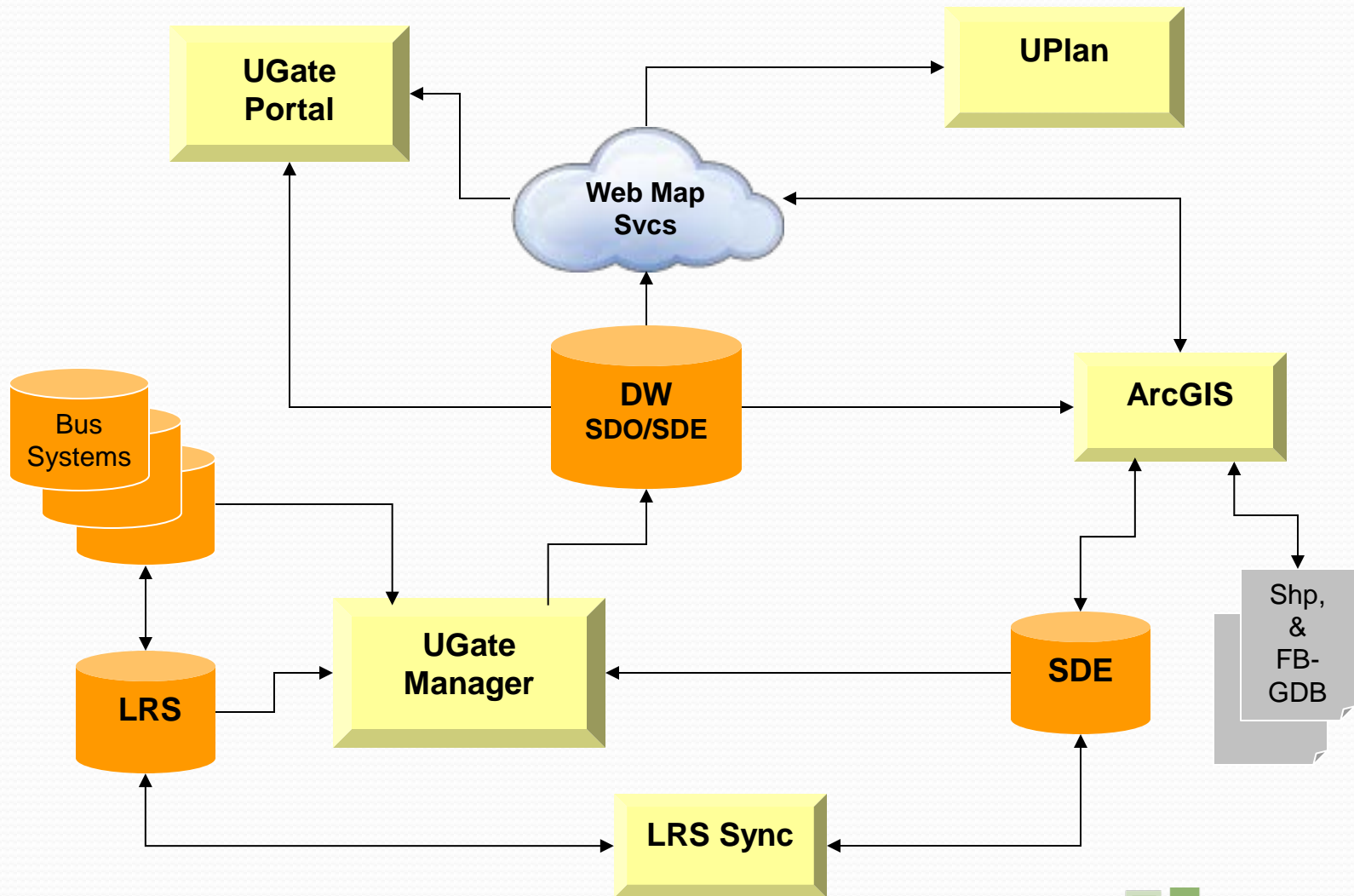
Frank Pisani

GIS Manager

Jake Payne

Technical Lead

The Journey



The UDOT LRS

- Prior to this effort, there were 8 LRMs with 26 variations used by various systems.
- LRS is used to define the state network and how assets reference to the network over time
- Some key features in the LRS Policy
 - Basic LRM is route mile point or accumulated miles
 - Two other supported LRMs
 - Route + coordinate
 - Route + reference post w/ offset
 - Temporal LRS
 - One-time load of route geometry (Esri->Oracle)

Common LRS/LRMs Benefits

- Position UDOT to move forward as technology changes
- Insulate UDOT systems from changes in location methods
- Create uniformity
- Allow data sharing between UDOT systems
- Eliminate data duplication and ambiguity
- Eliminate discrepancies and need for data reconciliation
- Provide audit/history of changes
- GIS integration!

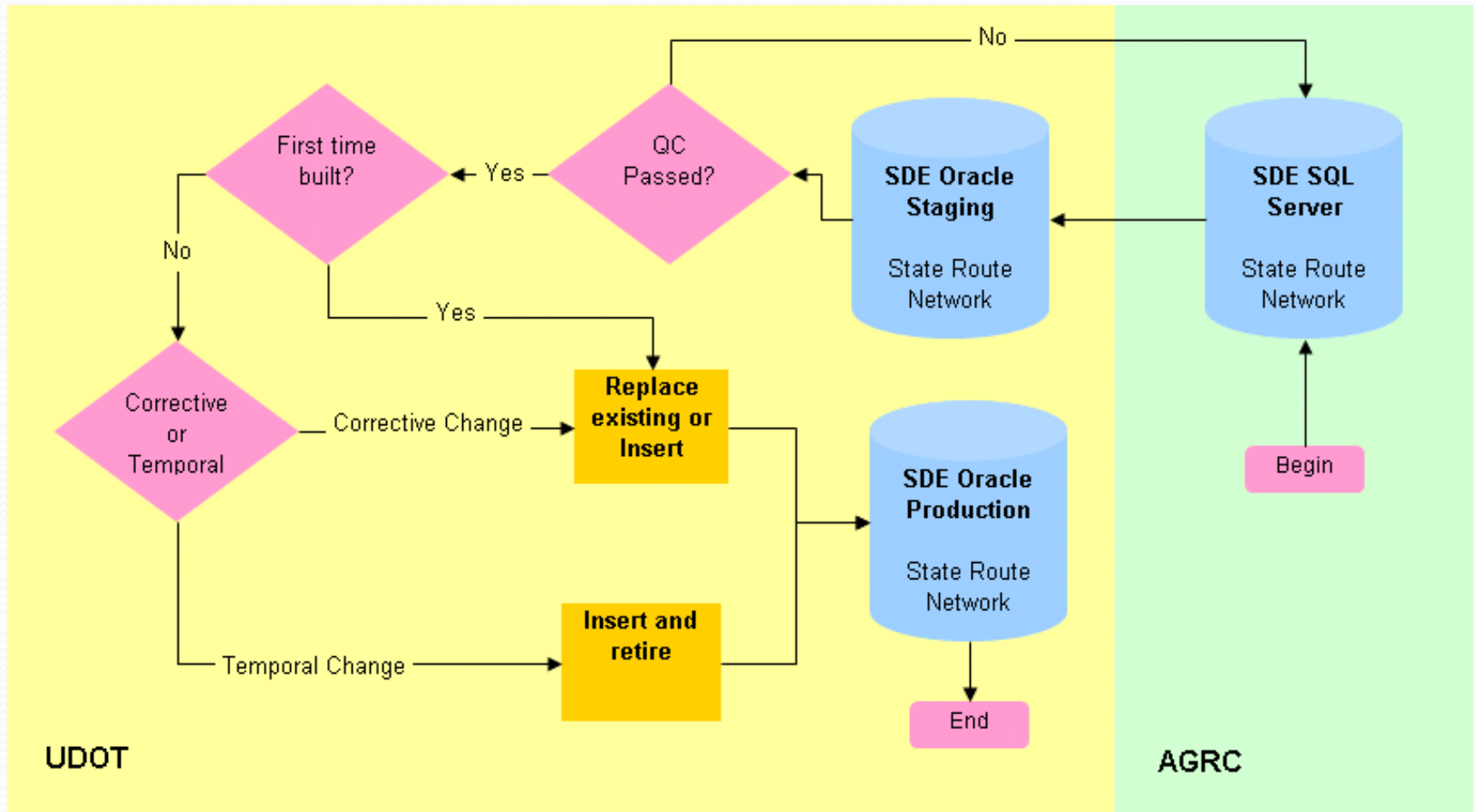
GIS Ready?

- Voila, we are able to see asset locations! But...
 - Do we have bridges in the Pacific Ocean?
 - Why are only 2/3s of my assets geo-locatable?
- Causes
 - Asset data has incorrect or incomplete LRM designations
 - Route geometry is incorrect or incomplete or not up-to-date
- Conclusions
 - We needed an LRS build and maintenance program to keep route geometry updated and cleansed
 - We needed a mapping plug-in that can be used in different asset systems for correcting LRM issues

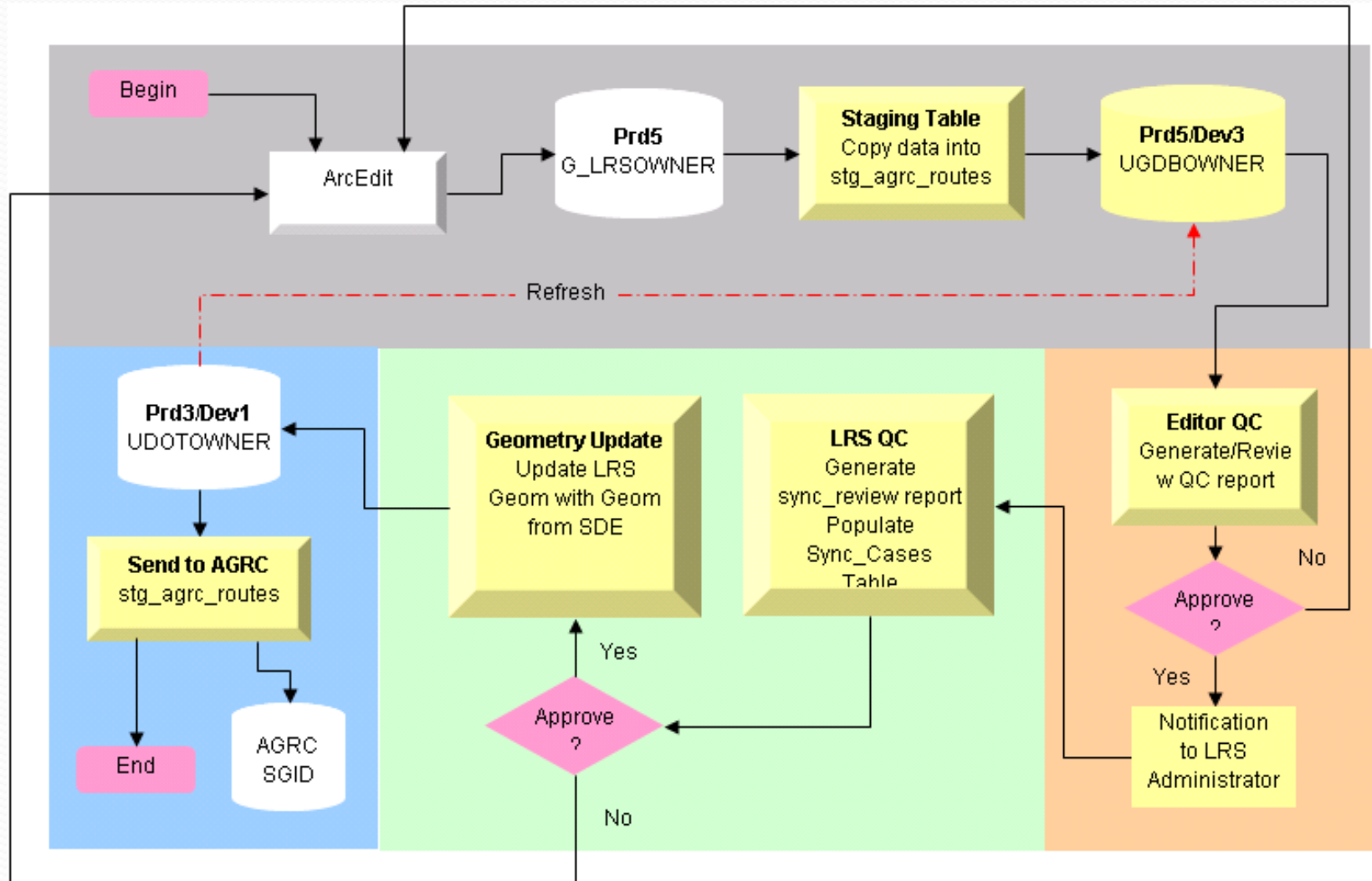
LRS Route Build & Maintenance

- Phase I - Initial LRS Synch (2008 – 2009)
 - AGRC builds routes on the State System
 - UDOT QCs
- Phase II - LRS Maintenance (2010 -)
 - In-house GIS group builds and QCs routes
 - Focus on State and Federal Aid System
- Software
 - ArcEdit for LRS route building and calibration
 - Oracle for route QC

Phase I - Initial LRS Sync Flow



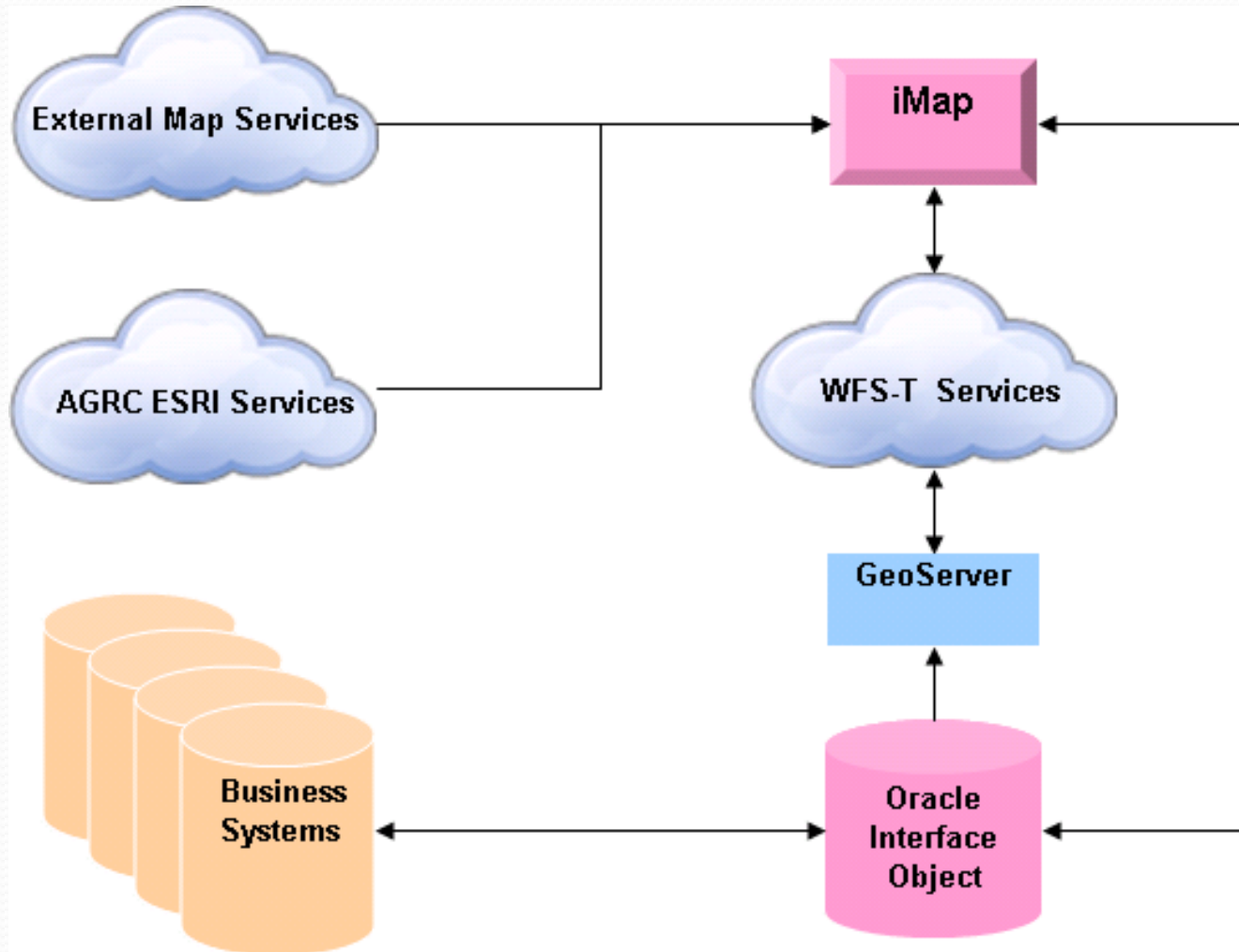
Phase II - LRS Maintenance Flow



LRS QC Error Codes

TYPE	CODE	CODE_DESC	FIX
COMP	DR	Duplicate routes	Y
	ID	Inconsistent route_name, direction, type and label descriptions	Y
	MR	Routes missed by GIS	Y
	NR	New routes built by GIS	Y
GEOM	DF	Three or more duplicate X-Y points on a route forming a fork	N
	DP	Duplicate X-Y points on a route part	Y
	IG	Invalid Oracle SDO geometry	Y
	ML	Measure length vs GIS length of routes or route parts	N
	ST	Routes with switchbacks	N
MEAS	AD	Ascending measurements on decreasing routes	Y
	DI	Descending measurements on increasing routes	Y
	GL	GIS measure length differs from LRS route length	Y
	MD	Inconsistent measure-segment directions	Y
	OM	Out-of-bound measures	Y
TOPO	DM	Duplicate measures on a route part	Y
	RG	Route gaps	N
	SS	Short or zero-length (GIS length) routes or route parts	N

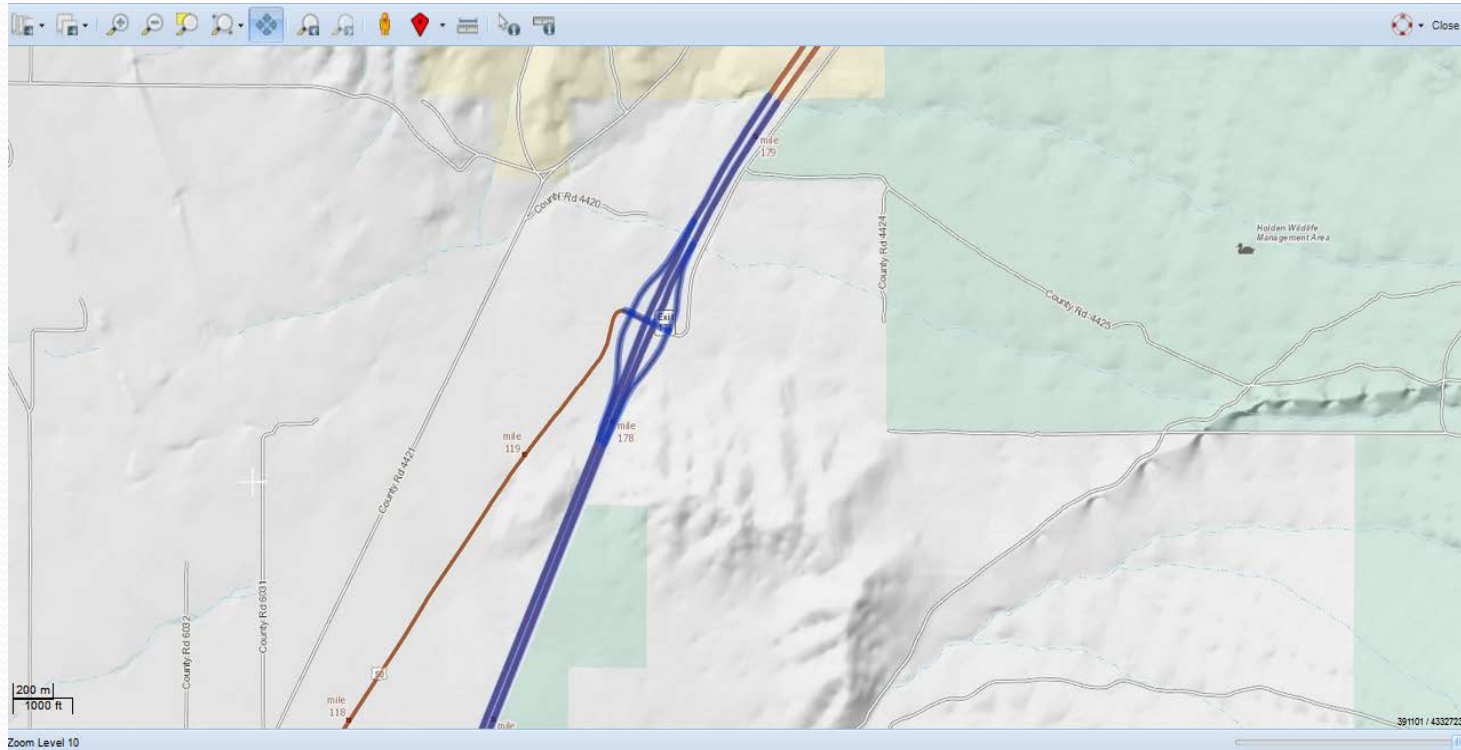
iMap - Map UI Plug-in



iMap Key Features

- LRS Support
 - Snapping – point event snaps to route
 - Following – linear event follows route
 - Defining event by route measure(s)
 - Dynamically measurement readout
- Plug-in designed
- Openlayers Javascript
- Support Esri REST services and WFS-T services
- Simple UI
- Light-weight

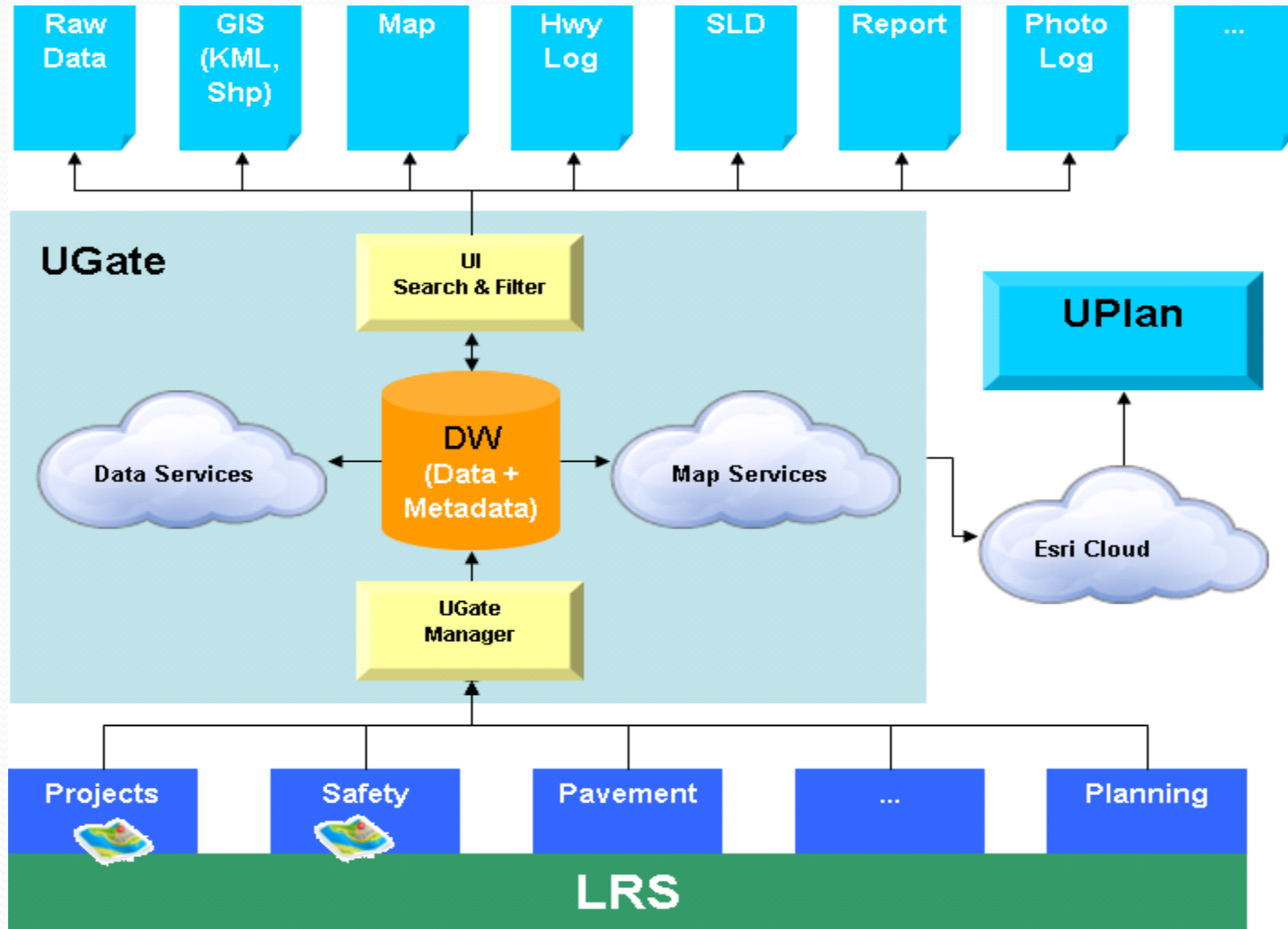
iMap Screen



IT Infrastructure

- Database
 - 13 or so Oracle 11g instances
 - Many SQL server instances that came with canned applications
- Operating systems
 - Linux for Oracle servers
 - Linux and Windows for other application servers
- CAD
 - Bentley Microstation with ProjectWise for document management
- GIS
 - Oracle, Esri, GeoServer, Intergraph
- Development platforms
 - PL-SQL, APEX, Oracle forms 10g, JavaScript
 - .Net used at Traffic Operations Center

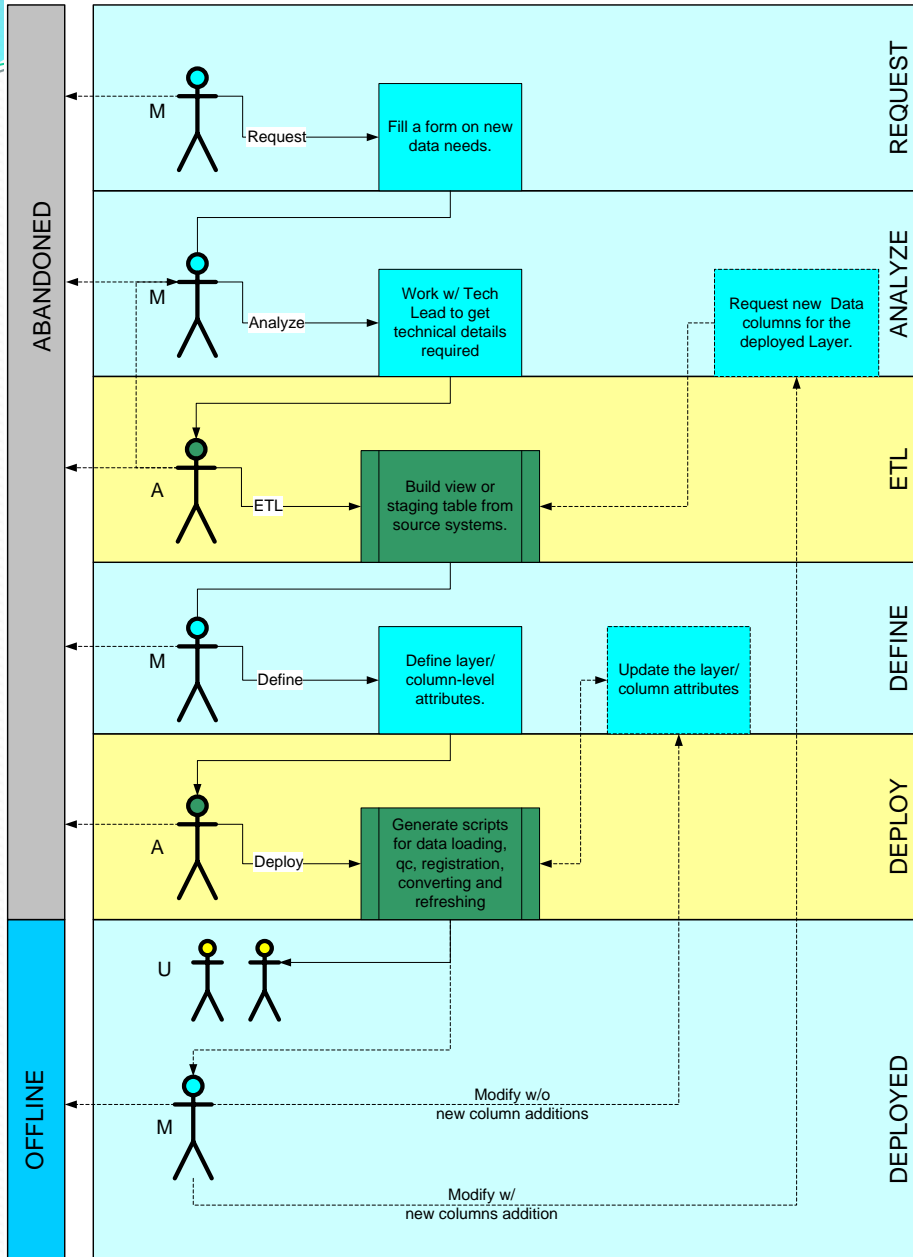
Integration Architecture



Data Warehouse

- Data warehouse is centerpiece of system
- UDOT's Financial DW
 - FY 05 through 07
 - Draws data from 12 different systems
- UGate DW was different
 - Large and diverse user base, both internal and external
 - Security levels
 - Spatial dimension and LRS

uGATE Manager Work Flow Summary



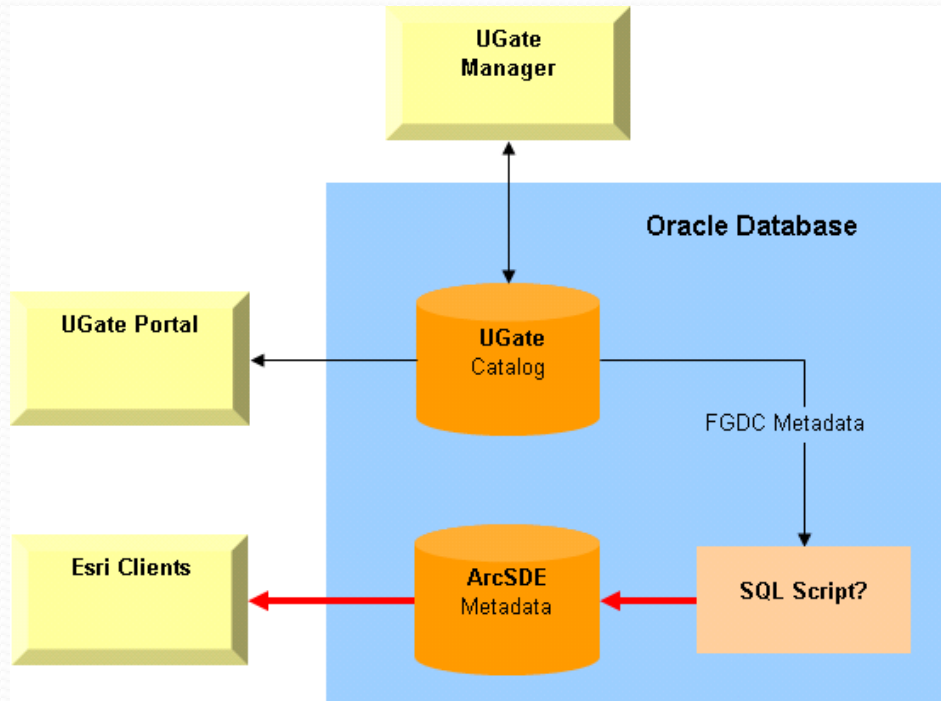
UGate Manager

- Users
 - System Manager
 - GIS Administrator
 - DBA
- Provides work flow management
- Empowers users

GIS Administration Utility

- Web application
- Liberates DBA and GIS Administrator from tedious and error-prone spatial layer registration and other tasks
- Enforces UDOT standards in SDE and SDO registration
 - Spatial reference
 - Bounding box
 - Tolerance
 - Build index
- Enforces UDOT standards in user/group management
- Features QC capabilities
 - Layer validation
 - Remove phantom layers
- Other
 - Displays SDE version hierarchies
 - Displays connection sessions

Metadata Synch Options

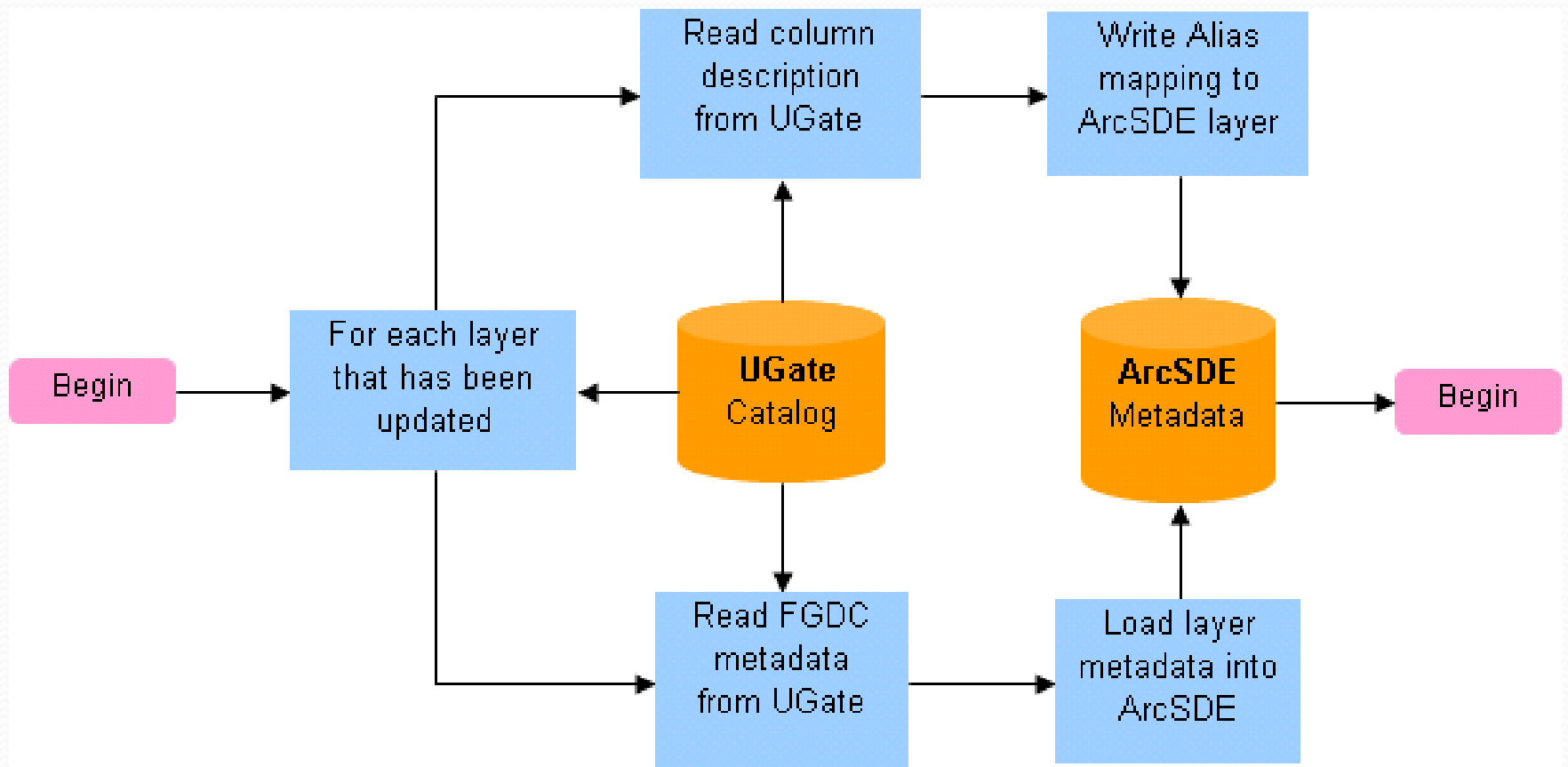


- Manual import
- Python automation in ArcGIS?

- ArcObjects programming in Python
- http://www.pierssen.com/arcgis/upload/misc/python_arcobjects.pdf

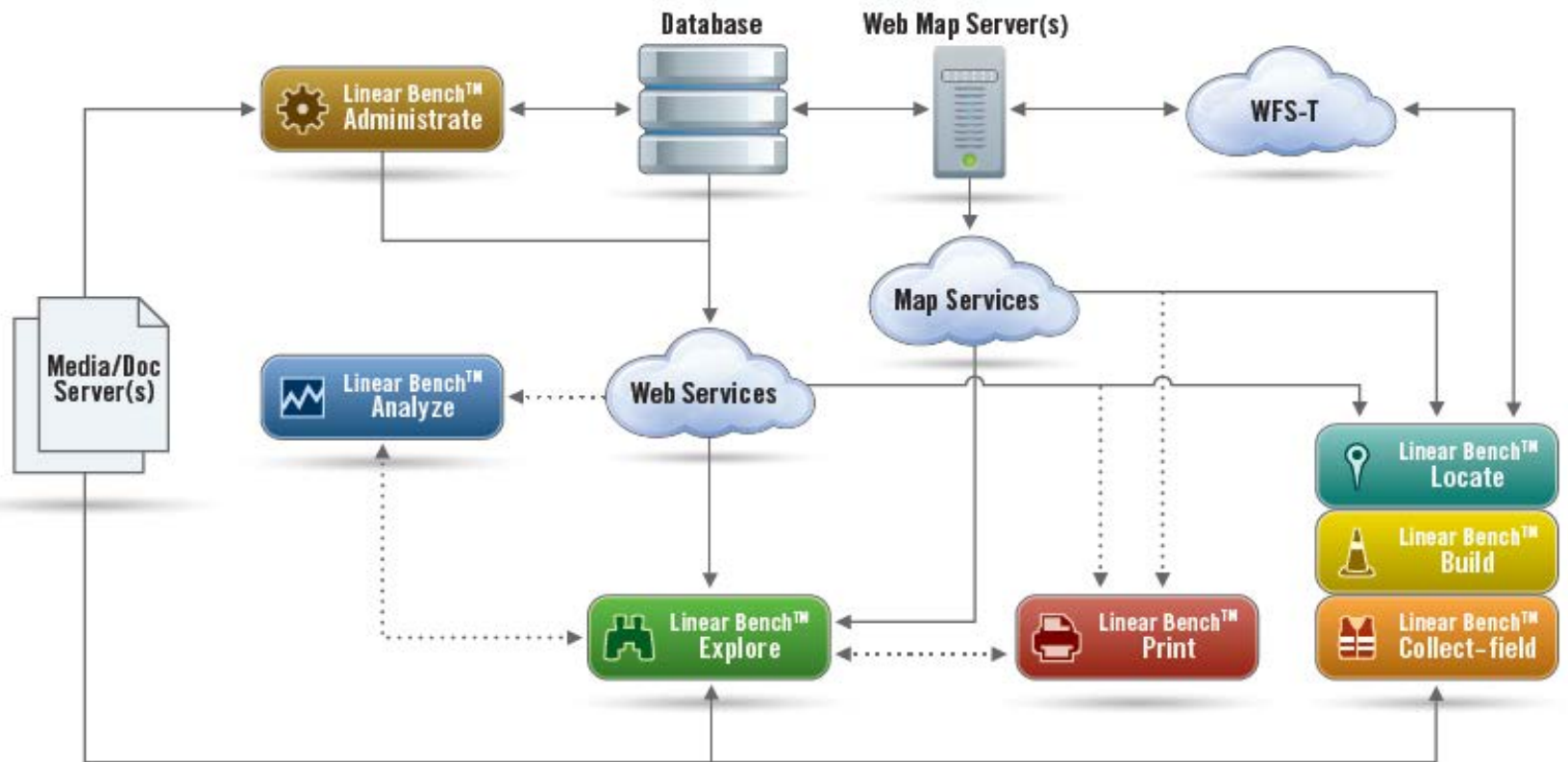
Metadata Synch Flow

General flow of Python script using ArcObjects



Adoption of LinearBench™ Technologies

UGate components include LinearBench™ Explore (LBE) and Print (LBP) modules for visualization, analysis and output of LRS data



..... Optional Flow

LinearBench™ Demo

- Multi-dimensional visualization
 - Map
 - Straight Line Diagram
 - Time Space Diagram^{new}
 - Photo log^{new}
 - Asset document/images^{new}
 - Traffic cams^{new}
- Output
 - PDF and Excel
- Analysis functions^{new}

UGate / UPlan Demo and Wrap up

Frank Pisani

GIS Manager

Design &
Construction
Projects

Maintenance &
Asset Management

The
Integrated
World

Planning &
Program Finance

Traffic & Safety

Data Collection - QC/QA – Metadata – Standards, etc.

Challenges

- ETL Process – Cumbersome, Time Consuming, Too Manual.
- Straight-Line Diagram – Cool Technology Looking for a Reason to Exist (Needs Data and Users)
- Delivering Value – Closing the Loop
- Roadway Data Collection Data – (30+ TB)
 - All State Roads, Ramps & Collectors (14,000 driven miles)
 - All Visible Assets – (signs, barrier, pavement markings, etc)
 - Pavement Condition Data
 - High Definition Images (20 per mile)
 - LiDAR

Roadblocks

- Legacy Systems & Technologies
- Disparate Technologies (Esri, Oracle, Intergraph, Bentley, Various Web and Map Services)
- Build vs. Buy
- Sufficient Funding
- Managed Growth
- How Accurate is Good Enough
- Data Storage – Requirements, Methods, Costs
- Converting Data to Information (BI, Maps, Analytics, etc.)