Multi-Level Linear Referencing System (MLLRS) Costs & Benefit Value Analysis Study

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Presentation Objectives

- Study Purpose
- Understanding the terminology used
- Assumptions made during the study
- The definition of a MLLRS
- Why implement a MLLRS
- The benefits and costs associated with a MLLRS
- Implementation considerations
Study Purpose

“The report was conducted to identify the costs and benefits of implementing and maintaining a statewide Multi-Level Linear Referencing System (MLLRS)”
What is a LRS?
Fundamental Definitions

• LRS - Linear Referencing System
  ■ A set of procedures and methods for specifying a location as a
distance, or offset, along a linear feature, from a point with
known location.
  ■ A LRS can relate a linear location (1D) to a spatial (2D) location
through a centerline representation of the roadway.

• LRM - Linear Referencing Method
  ■ Different methods of measuring locations (i.e. milepost, literal
descriptions, stations, address ranges, etc.).
  ■ A LRM is part of the LRS.
Linear GIS Data Models
Variable Segment Length

Road Info
- road_name
- pavement_type
- no_of_vehicles
- jurisdiction
- guard_rail
- structure

City A

Main Street

City B

500
2500
Asphalt
Concrete

City Info

Structure

Guard Rail

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Linear GIS Data Models
Variable Length Segments - GIMS
Linear GIS Data Models
Dynamic Segmentation Approach

• Data are maintained in individual tables, limiting data redundancy
• Attributes describe varying extents along a section of roadway
• Graphic representations of attribute data are generated “on the fly”

Pavement Type
Traffic Volumes
Lane Widths
Bridges
Linear GIS Data Models
Dynamic Segmentation Analysis

Linear Query Results
where: Speed => 45
AADT < 25000
Friction <= 30
Pavement = Asphalt
Data Collection
Accuracy Improvement
Terminology

• Baseline System – The minimum requirements of a fully functional MLLRS
• Optional Functional Elements – Additional elements added to the baseline to improve overall function
• Business/Operational Units – Categories within the DOT such as Safety, Risk, Maintenance, etc.
Assumptions

• Some type of LRS already exists
• A good existing primary road network is available
• Includes a spatial representation
• 25,000 miles of centerline per state
• Some hardware and software currently exists within the state’s system
What is a MLLRS

• Meets the NCHRP 20-27(2) data model
• Meets the needs of integrating increasing amounts of linearly referenced data
• Logically linked with other organizational electronic management systems
• Includes multiple linear referencing methods, multiple cartographic representations and multiple network representations
• Associates with a central object referred to as a “linear datum”
Data Integration
Conceptual Data Model (NCHRP 20-27)

LRS Components
(Datum & network)

- Coordinate Route
- Reference Post
- GIMS Segmental
- Milepoint
- Stationing
- Literal Description
- Address Range

- Centerline Representation 1
- Centerline Representation 2
- Centerline Representation 3
Data Integration
System Architecture for Integrating Data

LRS Maintainer

GIS Maintainer

Crash Records
Bridge
PMIS
GIMS

LRS
GIS

GeoData Library

General Decision Support
Web CTAMS
CTAMS
Specific Analysis Systems
PMIS

General Decision Support

Derived Data Values from Integrated Data

Derived Data Values from Integrated Data

Staging Process

Linear Business Data

GeoData Library
Core Functional Requirements

• Functional Requirements I: Spatial Referencing Methods
• Functional Requirements II: Temporal Referencing System/Temporal Datum
• Functional Requirements III: Transformation of Data Sets
• Functional Requirements IV: Multiple Cartographic/Spatial Topological Representations
• Functional Requirements V: Resolution
Core Functional Requirements

• Functional Requirements VI: Dynamics
• Functional Requirements VII: Historical Databases
• Functional Requirements VIII: Accuracy and Error Propagation
• Functional Requirements IX: Object-Level Metadata
• Functional Requirements X: Temporal Topology/Latency
Why Implement ML into LRS

- More readily available data and information from different sources
- Improvements in quality, timeliness, and efficiency for reporting
- Improved analysis leading to more data-driven decision making support
- Improved communication by being able to more readily share information, timely
Why Implement ML into LRS

• Desire to improve customer service
• Integrate with legacy systems and ultimately eliminate dependencies on obsolete technology,
• Establish standards to increase LRS consistency throughout the agency and industry-wide, and
• Lower the life cycle cost impacts of system ownership
Benefits of a MLLRS in a State Agency

• Quantitative Benefits
  ■ Identified as time and cost savings by reducing:
    • Staff hours
    • Operational hours
    • Hours within other departments
    • Improved stewardship of data
    • Business/Operational unit improvements
Cost Savings

• Baseline System
  ■ Up to $32,000 per FTE for reduction in staff, operational and other department staff hours

• Optional Functional Elements
  ■ Managing Change - Up to an additional $32,000 per FTE by increasing functionality
  ■ Modeling Connectivity – Up to an additional $32,000 per FTE
Cost Savings

• Business/Operational Unit Improvements
  ■ Sample Business/Operational Units Used
    • Safety improvements
    • Reduced level of risk for litigation
    • Reduced impacts to projects
    • Reduced maintenance
  ■ Baseline Savings
    • $1.1 million
  ■ Optional Functional Elements Savings
    • $2.5 million
Qualitative Benefits

- Ease of use and accessibility
- Flexibility and integration
- Quality of data
- Internal and external collaboration
- Data-driven decision support
Other Identified Benefits

• Facilitates the Breakdown of Departmental Silos
• Able to Take Advantage of External Resources
• Increased Opportunity to Integrate MLLRS into the Field Operations
Cost and Savings Assumptions

- The Costs Are Exclusive of What Is Available Within the Agency
- Labor Rates Are Represented by An Integrated Rate of Both Consultant and Civil Service Rates of $150.00 Per Hour
- The MLLRS Will Be Implemented From Scratch By Others
- Either Nothing is Existing or the System Will Not Integrate
- 25,000 Miles of Centerline Per State
Cost and Savings Assumptions

• There Already Exists a Good Primary Road Network
• All Important Open-to-Public Roads Are Included
• A Spatial Representation is Available
• The Existing Business System Targeted is Using Some LRM Method
• Some Staging Work Will Be Required Within a Business System
Costs to Implement a MLLRS

• Capital Costs
  ■ Baseline - $2 million
  ■ Optional Functional Elements
    • Manage Change - $31,650
    • Model Connectivity - $795,000
    • LRM Development - $40,000 each
Costs to Implement a MLLRS

• Maintenance Costs
  ■ Baseline - $252,000
  ■ Optional Functional Elements
    • Minor adjustments only
Cost/Benefit Analysis

• Based on a 5-year period
• 3% escalation rate, constant dollar approach
  ■ Baseline - $2.5 million in savings
  ■ Cost/Benefit Ratio – 2:1
  ■ Optional Functional Elements - $10 million in savings
  ■ Cost/Benefit Ratio – 21:1
MLLRS Implementation Considerations

- Organizational Support
- Establish model specifications and scope of work to be used to obtain outside services and/or complete the work with existing staff
- Identify functional requirements needed within the agency to meet the baseline performance attributes
- Establish a maintenance plan and approach, capitalizing on lessons learned
MLLRS Implementation Considerations

• Establish a training plan and approach
• Secure resources – manpower, funding, staffing, contingency for staff turnover, etc.
• Determine the schedule progress timeline and monitor it
• Set and manage internal expectations
• Develop an outreach plan internally with staff and management
Overcoming Challenges for Field-Based Asset Management

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Field Data Collection with Mobile Apps
Life Cycle Approach in Support of Asset Management
Questions