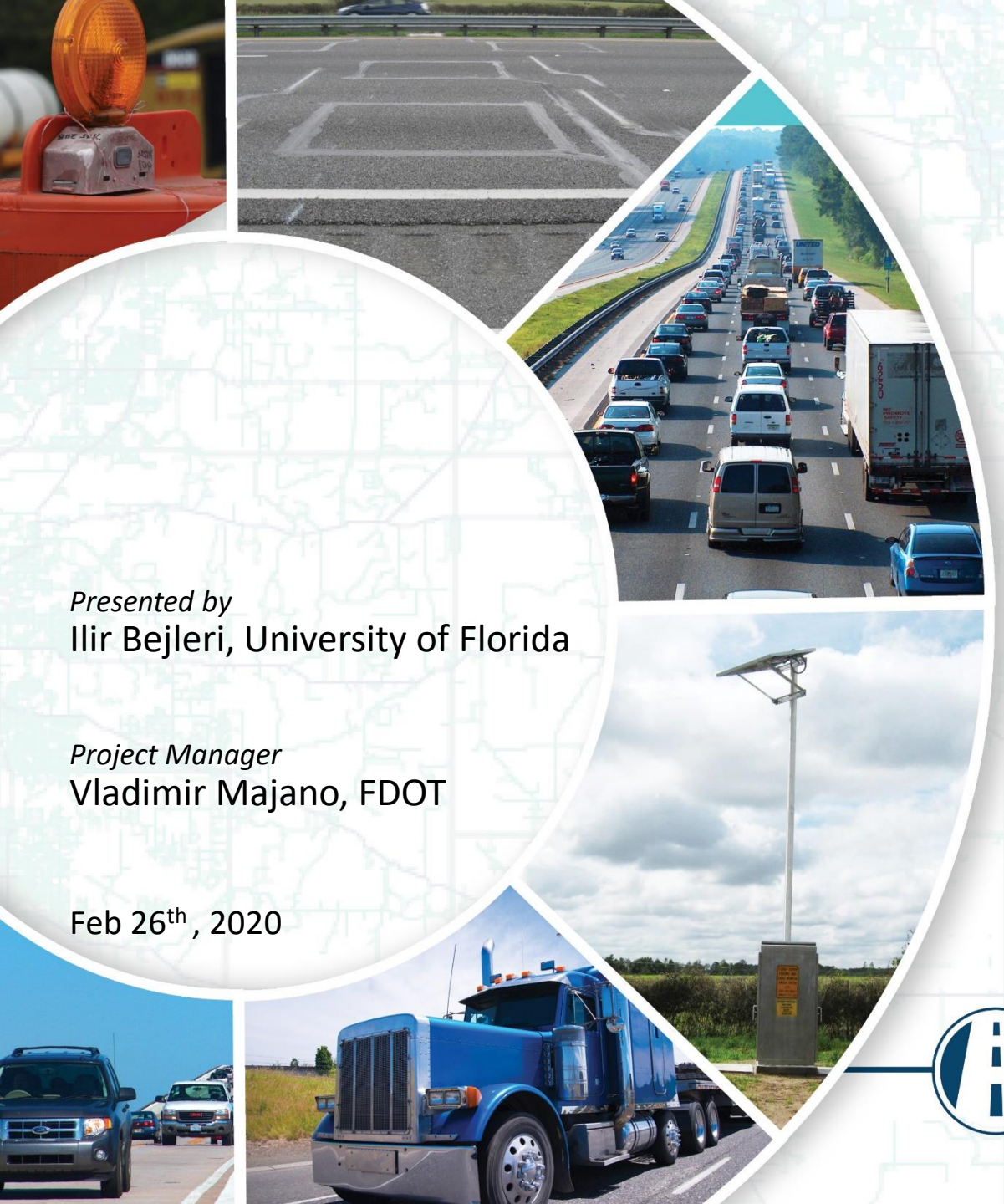

JOINT FLORIDA
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Data and Analytics Workshop

FTO FORECASTING & TRENDS OFFICE
FDOT TDA TRANSPORTATION DATA & ANALYTICS

Universal Roadway Network

Toward a More Efficient Network Structure for Travel Demand Modeling

Presented by
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Project Manager
Vladimir Majano, FDOT

Feb 26th, 2020

Network Problem for Modeling

State

State & Regional

State , Regional & Local

Network Problem for Modeling - continued

- Different models in overlapping geographic areas use different network representation of the same physical network
- We have data standards for modeling (FSUTMS), but we lack a standard/common network
- Difficult to share common input data elements
  - Facility type, area type, number of lanes, speed, traffic counts, etc.
- Difficult to exchange information among models of multi-scales and multi-resolutions
- Difficult to view and compare input data and future projections

FDOT

Considerations for Network Requirements

Network Structure

- One common node-link data structure that includes all roads
- Integrated easily with ArcGIS and compatible with modeling software
- Maintain required attributes for modeling

Data Source

- A reliable source such as FDOT RCI, ARBM, HERE...
- Criteria for choosing the source if multiple sources are available

Data Management

- Support different scales of models (state/regional/local)
- Shared among different agencies and stakeholders (safety, operations, transit, forecasting & trends, civil integrated management etc.)
- Clearly defined portion of data (links and attributes) that could be shared and managed

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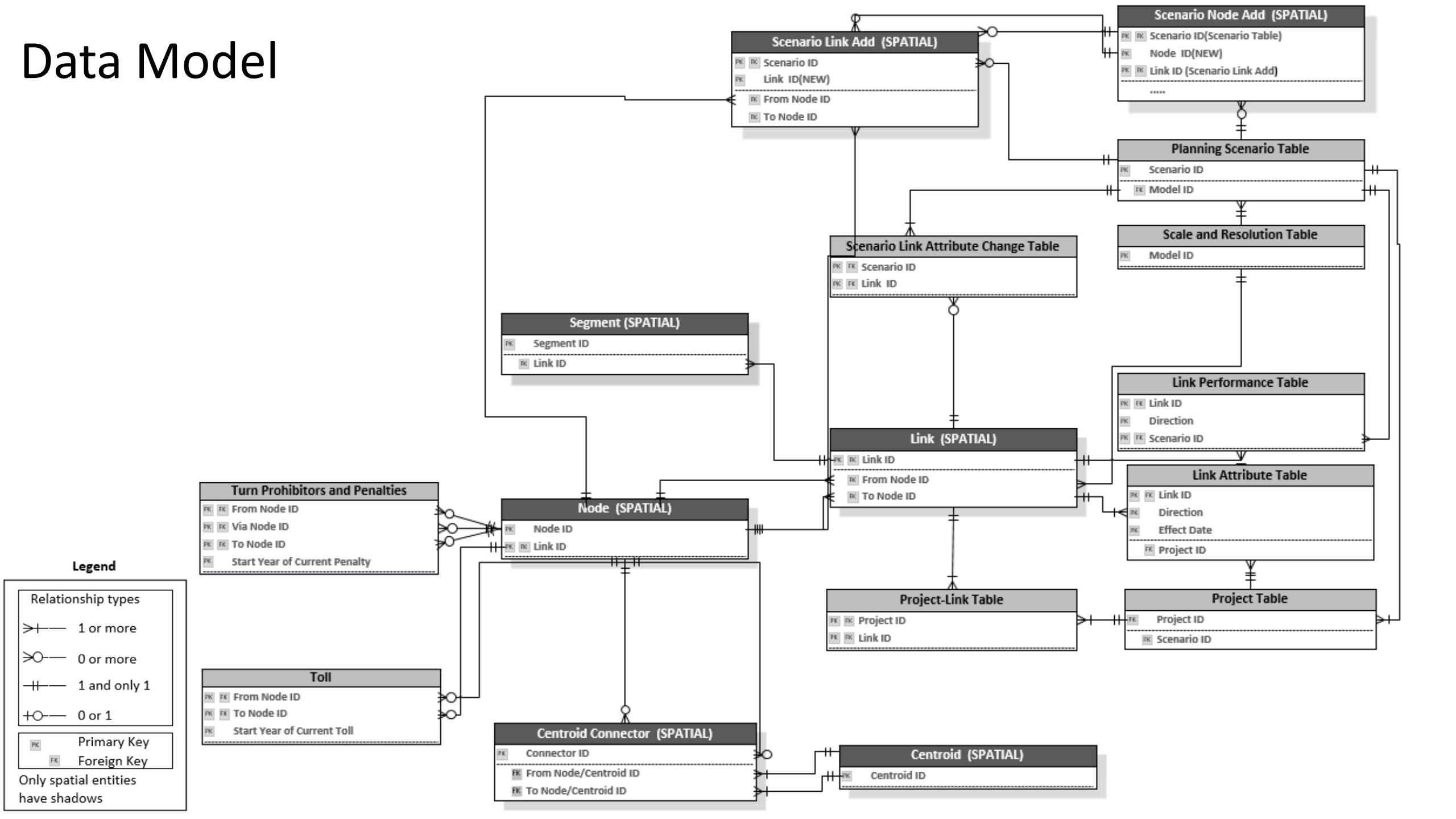
Proposed Data Model for Multi-scale and Multi-resolution Modeling

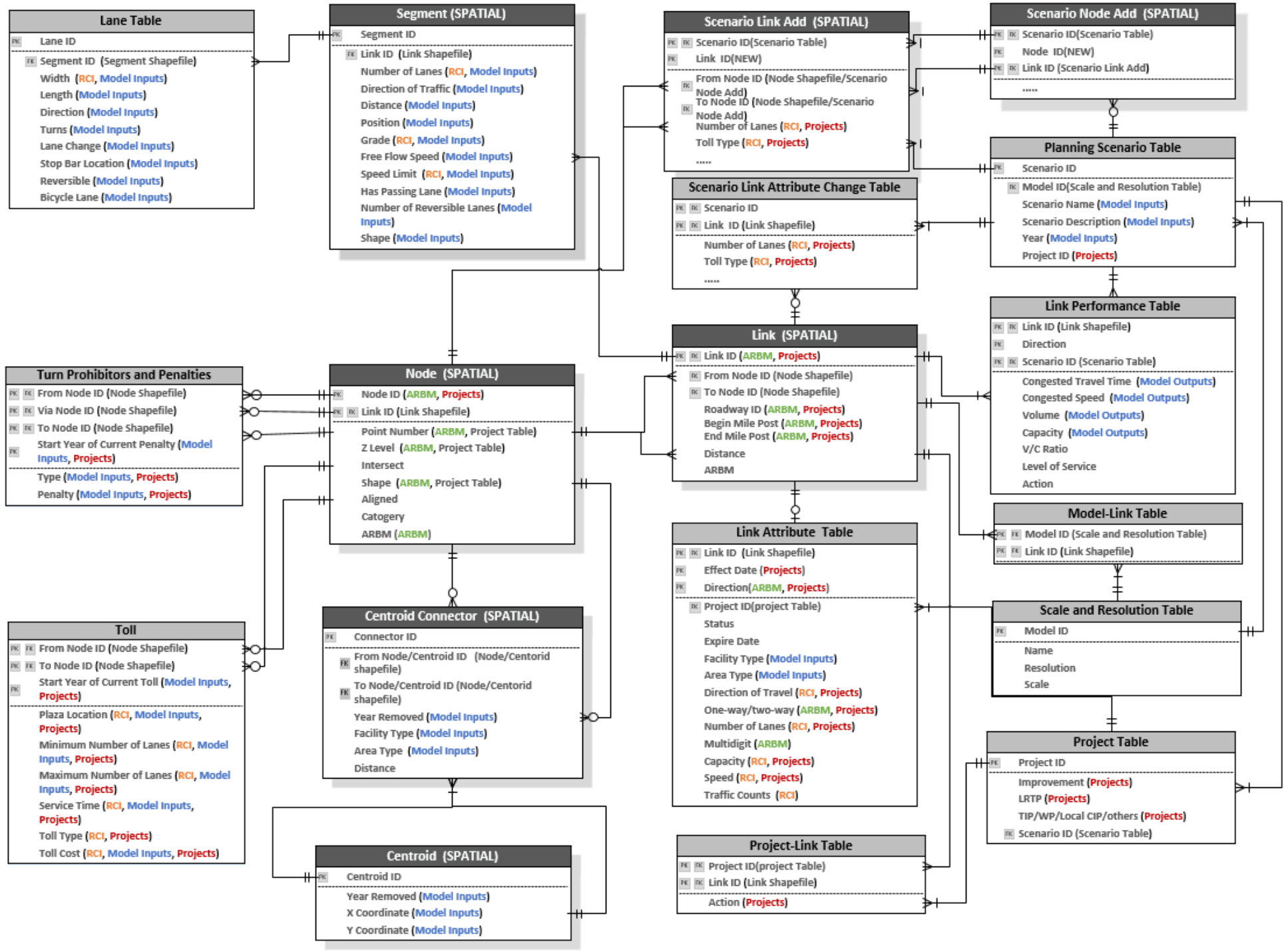
Data sources for the proposed data model

- **BASEMAP (DOT basemap/ARBM):** Link ID, Node ID, Multidigit, Milepost, Z level, …
- **RCI:** Direction of travel, Number of lanes, Speed, AADT, Toll plaza, Toll type, …
- **Projects:** Agency, Location, Work type, Planning status, Year of completion, Direction of travel, Number of lanes, Speed, …
- **Model inputs:** Facility type, Area type, Scenario Name, Turn type, Turn penalty, …

Data Model


Scenario Node Add (SPATIAL)
Scenario ID(Scenario Table)
Node ID(NEW)
Link ID (Scenario Link Add)
.....
Scenario Link Add (SPATIAL)
Scenario ID
Link ID(NEW)
From Node ID
To Node ID
Planning Scenario Table
Scenario ID
Model ID
Scale and Resolution Table
Model ID
Scenario Link Attribute Change Table
Scenario ID
Link ID
Segment (SPATIAL)
Segment ID
Link ID
Link Performance Table
Link ID
Direction
Scenario ID
Link (SPATIAL)
Link ID
From Node ID
To Node ID
Link Attribute Table
Link ID
Direction
Effect Date
Project ID
Turn Prohibitors and Penalties
From Node ID
Via Node ID
To Node ID
Start Year of Current Penalty
Node (SPATIAL)
Node ID
Link ID
Project-Link Table
Project ID
Link ID
Project Table
Project ID
Scenario ID
Toll
From Node ID
To Node ID
Start Year of Current Toll
Centroid Connector (SPATIAL)
Connector ID
From Node/Centroid ID
To Node/Centroid ID
Centroid (SPATIAL)
Centroid ID
Legend
Relationship types
1 or more
0 or more
1 and only 1
0 or 1
Primary Key
Foreign Key
Only spatial entities have shadows

Data Model



Data sources:

ARBM

RCI

Projects

Model inputs

Legend

Relationship types

1 or more

0 or more

1 and only 1

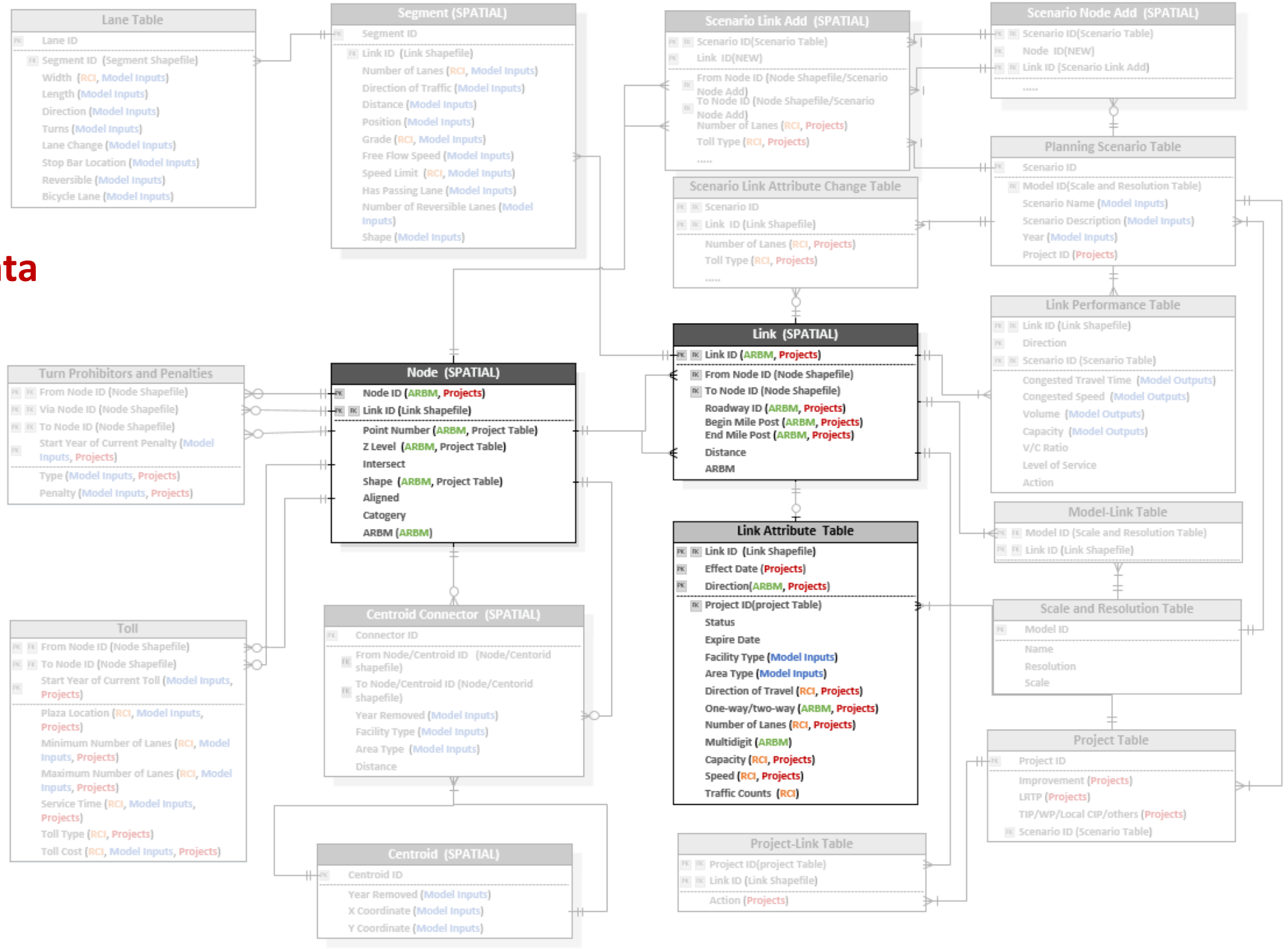
0 or 1

PK Primary Key

FK Foreign Key

Only spatial entities have shadows

First Priority Data



Data sources:

ARBM

RCI

Projects

Model inputs

Legend

Relationship types

1 or more

0 or more

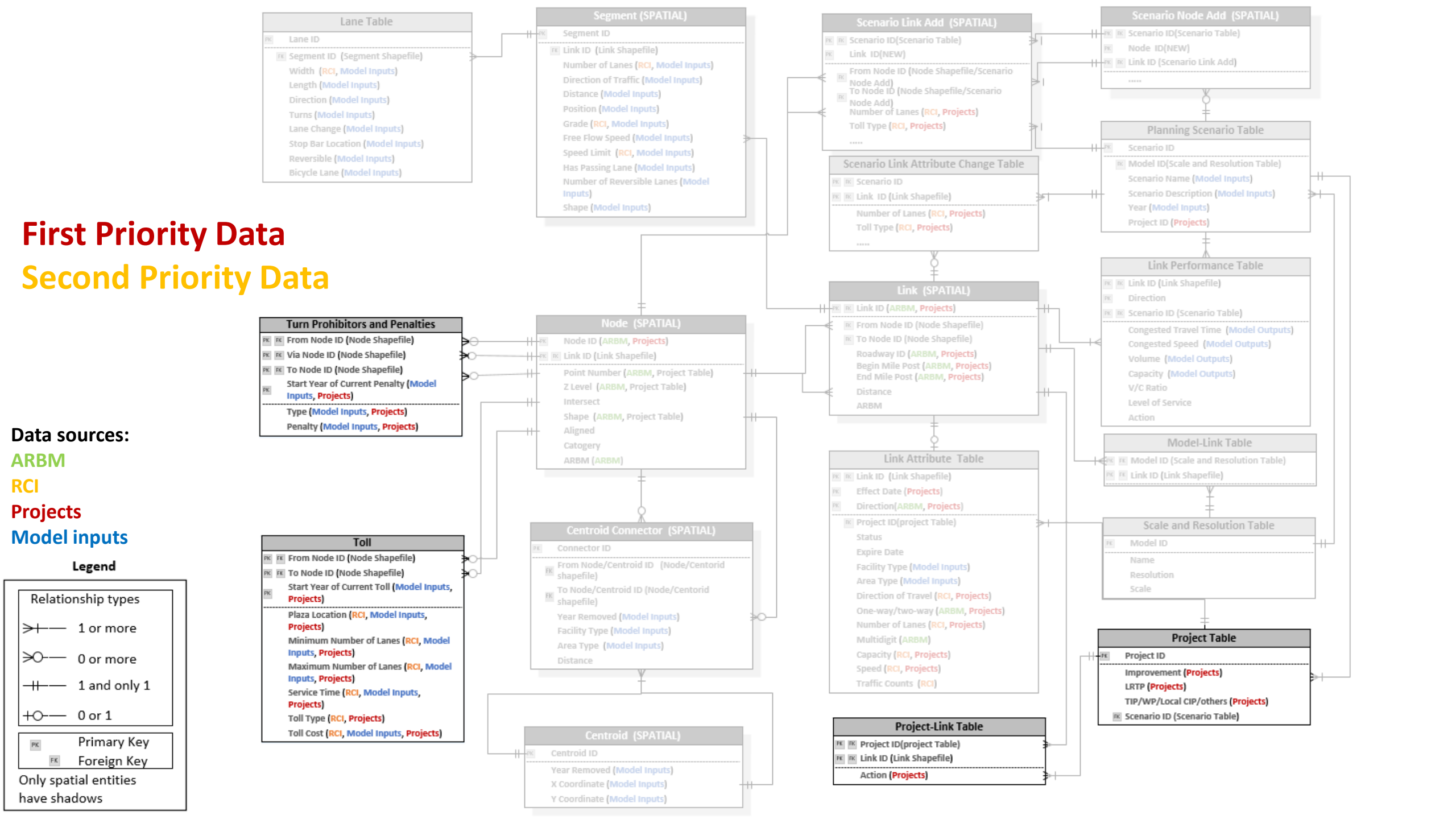
1 and only 1

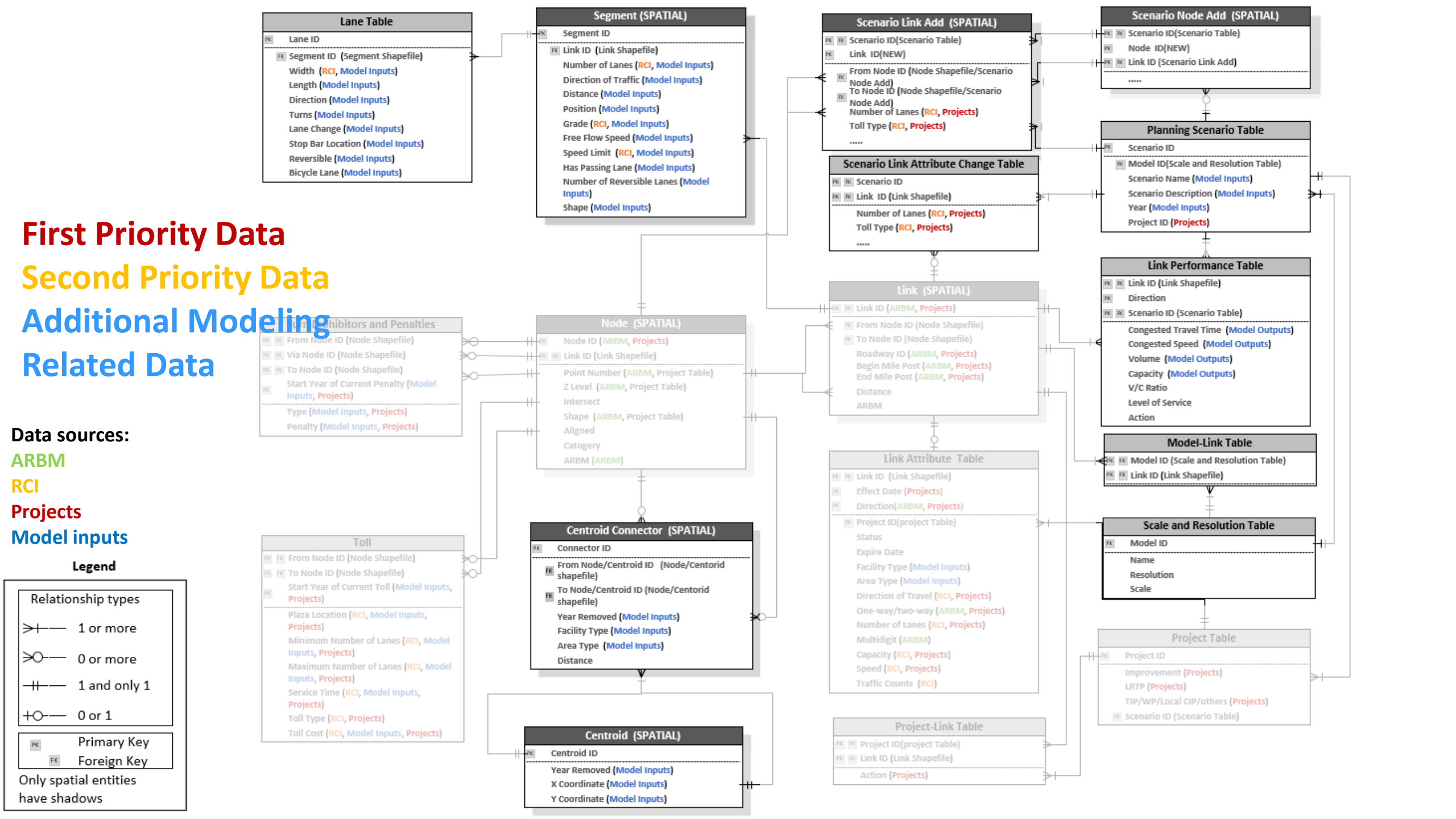
0 or 1

PK Primary Key

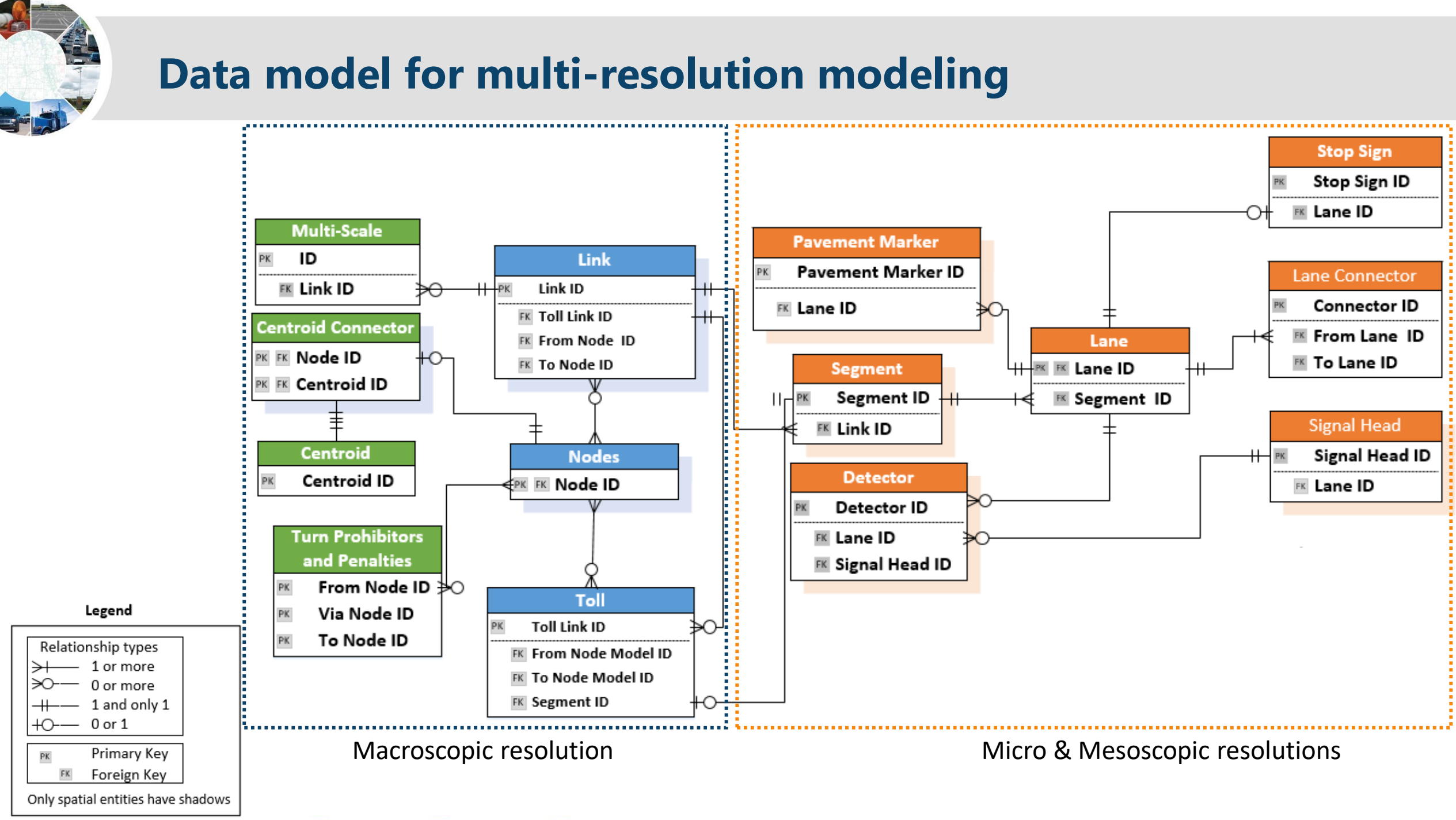
FK Foreign Key

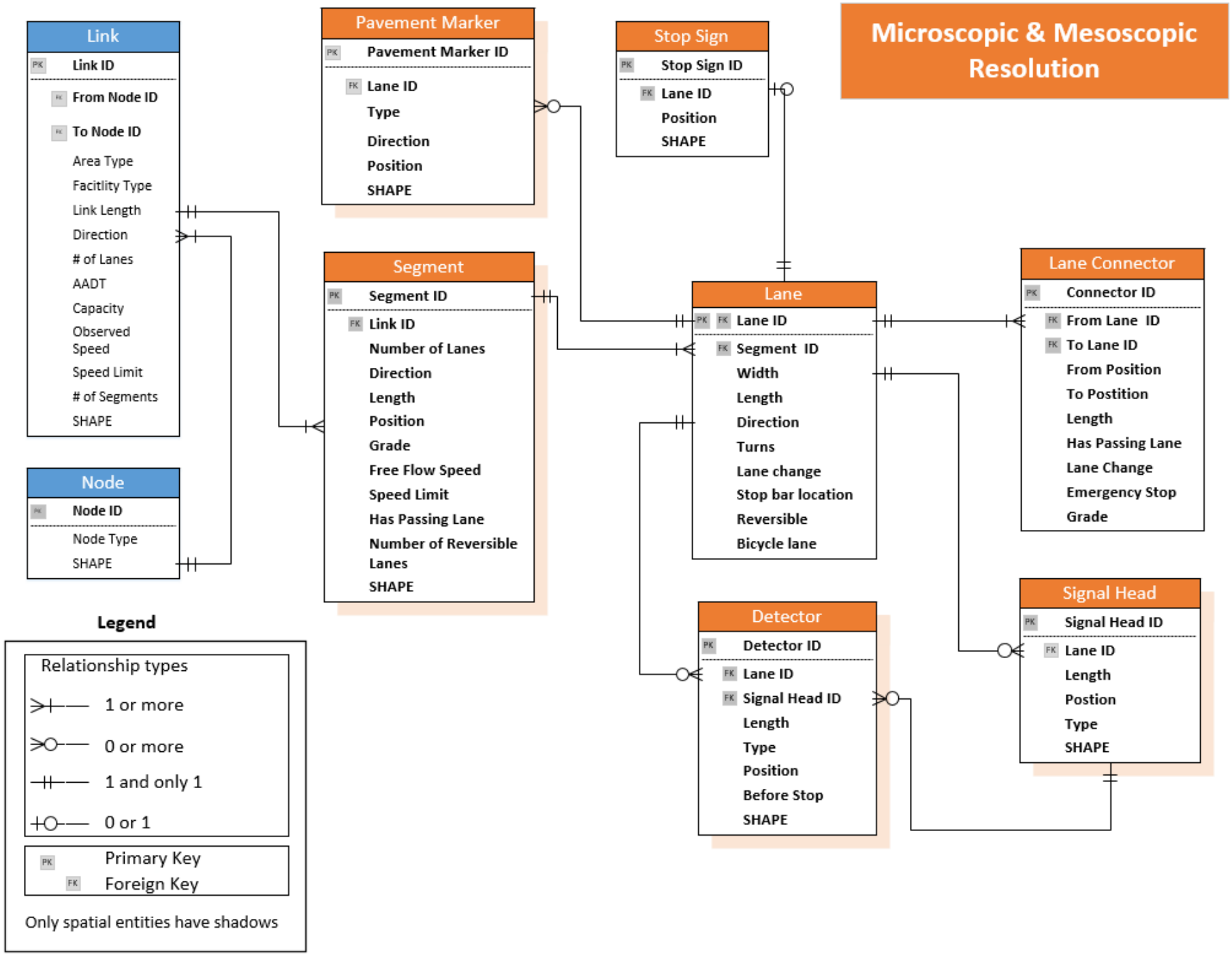
Only spatial entities have shadows


First Priority Data
Second Priority Data
Data sources:
ARBM
RCI
Projects
Model inputs
Legend
Relationship types
1 or more
0 or more
1 and only 1
0 or 1
Primary Key
Foreign Key
Only spatial entities have shadows
Lane Table
Lane ID
Segment ID (Segment Shapefile)
Width (RCI, Model Inputs)
Length (Model Inputs)
Direction (Model Inputs)
Turns (Model Inputs)
Lane Change (Model Inputs)
Stop Bar Location (Model Inputs)
Reversible (Model Inputs)
Bicycle Lane (Model Inputs)
Segment (SPATIAL)
Segment ID
Link ID (Link Shapefile)
Number of Lanes (RCI, Model Inputs)
Direction of Traffic (Model Inputs)
Distance (Model Inputs)
Position (Model Inputs)
Grade (RCI, Model Inputs)
Free Flow Speed (Model Inputs)
Speed Limit (RCI, Model Inputs)
Has Passing Lane (Model Inputs)
Number of Reversible Lanes (Model Inputs)
Shape (Model Inputs)
Scenario Link Add (SPATIAL)
Scenario ID(Scenario Table)
Link ID(NEW)
From Node ID (Node Shapefile/Scenario Node Add)
To Node ID (Node Shapefile/Scenario Node Add)
Number of Lanes (RCI, Projects)
Toll Type (RCI, Projects)
Scenario Node Add (SPATIAL)
Scenario ID(Scenario Table)
Node ID(NEW)
Link ID (Scenario Link Add)
Planning Scenario Table
Scenario ID
Model ID(Scale and Resolution Table)
Scenario Name (Model Inputs)
Scenario Description (Model Inputs)
Year (Model Inputs)
Project ID (Projects)
Scenario Link Attribute Change Table
Scenario ID
Link ID (Link Shapefile)
Number of Lanes (RCI, Projects)
Toll Type (RCI, Projects)
Link Performance Table
Link ID (Link Shapefile)
Direction
Scenario ID (Scenario Table)
Congested Travel Time (Model Outputs)
Congested Speed (Model Outputs)
Volume (Model Outputs)
Capacity (Model Outputs)
V/C Ratio
Level of Service
Action
Link (SPATIAL)
Link ID (ARBM, Projects)
From Node ID (Node Shapefile)
To Node ID (Node Shapefile)
Roadway ID (ARBM, Projects)
Begin Mile Post (ARBM, Projects)
End Mile Post (ARBM, Projects)
Distance
ARBM
Turn Prohibitors and Penalties
From Node ID (Node Shapefile)
Via Node ID (Node Shapefile)
To Node ID (Node Shapefile)
Start Year of Current Penalty (Model Inputs, Projects)
Type (Model Inputs, Projects)
Penalty (Model Inputs, Projects)
Node (SPATIAL)
Node ID (ARBM, Projects)
Link ID (Link Shapefile)
Point Number (ARBM, Project Table)
Z Level (ARBM, Project Table)
Intersect
Shape (ARBM, Project Table)
Aligned
Catogery
ARBM (ARBM)
Model-Link Table
Model ID (Scale and Resolution Table)
Link ID (Link Shapefile)
Link Attribute Table
Link ID (Link Shapefile)
Effect Date (Projects)
Direction(ARBM, Projects)
Project ID(project Table)
Status
Expire Date
Facility Type (Model Inputs)
Area Type (Model Inputs)
Direction of Travel (RCI, Projects)
One-way/two-way (ARBM, Projects)
Number of Lanes (RCI, Projects)
Multidigit (ARBM)
Capacity (RCI, Projects)
Speed (RCI, Projects)
Traffic Counts (RCI)
Scale and Resolution Table
Model ID
Name
Resolution
Scale
Toll
From Node ID (Node Shapefile)
To Node ID (Node Shapefile)
Start Year of Current Toll (Model Inputs, Projects)
Plaza Location (RCI, Model Inputs, Projects)
Minimum Number of Lanes (RCI, Model Inputs, Projects)
Maximum Number of Lanes (RCI, Model Inputs, Projects)
Service Time (RCI, Model Inputs, Projects)
Toll Type (RCI, Projects)
Toll Cost (RCI, Model Inputs, Projects)
Centroid Connector (SPATIAL)
Connector ID
From Node/Centroid ID (Node/Centorid shapefile)
To Node/Centroid ID (Node/Centorid shapefile)
Year Removed (Model Inputs)
Facility Type (Model Inputs)
Area Type (Model Inputs)
Distance
Centroid (SPATIAL)
Centroid ID
Year Removed (Model Inputs)
X Coordinate (Model Inputs)
Y Coordinate (Model Inputs)
Project-Link Table
Project ID(project Table)
Link ID (Link Shapefile)
Action (Projects)
Project Table
Project ID
Improvement (Projects)
LRTP (Projects)
TIP/WP/Local CIP/others (Projects)
Scenario ID (Scenario Table)


Lane Table
Lane ID
Segment ID (Segment Shapefile)
Width (RCI, Model Inputs)
Length (Model Inputs)
Direction (Model Inputs)
Turns (Model Inputs)
Lane Change (Model Inputs)
Stop Bar Location (Model Inputs)
Reversible (Model Inputs)
Bicycle Lane (Model Inputs)
Segment (SPATIAL)
Segment ID
Link ID (Link Shapefile)
Number of Lanes (RCI, Model Inputs)
Direction of Traffic (Model Inputs)
Distance (Model Inputs)
Position (Model Inputs)
Grade (RCI, Model Inputs)
Free Flow Speed (Model Inputs)
Speed Limit (RCI, Model Inputs)
Has Passing Lane (Model Inputs)
Number of Reversible Lanes (Model Inputs)
Shape (Model Inputs)
Scenario Link Add (SPATIAL)
Scenario ID(Scenario Table)
Link ID(NEW)
From Node ID (Node Shapefile/Scenario Node Add)
To Node ID (Node Shapefile/Scenario Node Add)
Number of Lanes (RCI, Projects)
Toll Type (RCI, Projects)
.....
Scenario Node Add (SPATIAL)
Scenario ID(Scenario Table)
Node ID(NEW)
Link ID (Scenario Link Add)
.....
Planning Scenario Table
Scenario ID
Model ID(Scale and Resolution Table)
Scenario Name (Model Inputs)
Scenario Description (Model Inputs)
Year (Model Inputs)
Project ID (Projects)
Scenario Link Attribute Change Table
Scenario ID
Link ID (Link Shapefile)
Number of Lanes (RCI, Projects)
Toll Type (RCI, Projects)
.....
Link Performance Table
Link ID (Link Shapefile)
Direction
Scenario ID (Scenario Table)
Congested Travel Time (Model Outputs)
Congested Speed (Model Outputs)
Volume (Model Outputs)
Capacity (Model Outputs)
V/C Ratio
Level of Service
Action
Link (SPATIAL)
Link ID (ARBM, Projects)
From Node ID (Node Shapefile)
To Node ID (Node Shapefile)
Roadway ID (ARBM, Projects)
Begin Mile Post (ARBM, Projects)
End Mile Post (ARBM, Projects)
Distance
ARBM
Node (SPATIAL)
Node ID (ARBM, Projects)
Link ID (Link Shapefile)
Point Number (ARBM, Project Table)
Z Level (ARBM, Project Table)
Intersect
Shape (ARBM, Project Table)
Aligned
Catogery
ARBM (ARBM)
Inhibitors and Penalties
From Node ID (Node Shapefile)
Via Node ID (Node Shapefile)
To Node ID (Node Shapefile)
Start Year of Current Penalty (Model Inputs, Projects)
Type (Model Inputs, Projects)
Penalty (Model Inputs, Projects)
Model-Link Table
Model ID (Scale and Resolution Table)
Link ID (Link Shapefile)
Link Attribute Table
Link ID (Link Shapefile)
Effect Date (Projects)
Direction(ARBM, Projects)
Project ID(project Table)
Status
Expire Date
Facility Type (Model Inputs)
Area Type (Model Inputs)
Direction of Travel (RCI, Projects)
One-way/two-way (ARBM, Projects)
Number of Lanes (RCI, Projects)
Multidigit (ARBM)
Capacity (RCI, Projects)
Speed (RCI, Projects)
Traffic Counts (RCI)
Scale and Resolution Table
Model ID
Name
Resolution
Scale
Centroid Connector (SPATIAL)
Connector ID
From Node/Centroid ID (Node/Centorid shapefile)
To Node/Centroid ID (Node/Centorid shapefile)
Year Removed (Model Inputs)
Facility Type (Model Inputs)
Area Type (Model Inputs)
Distance
Toll
From Node ID (Node Shapefile)
To Node ID (Node Shapefile)
Start Year of Current Toll (Model Inputs, Projects)
Plaza Location (RCI, Model Inputs, Projects)
Minimum Number of Lanes (RCI, Model Inputs, Projects)
Maximum Number of Lanes (RCI, Model Inputs, Projects)
Service Time (RCI, Model Inputs, Projects)
Toll Type (RCI, Projects)
Toll Cost (RCI, Model Inputs, Projects)
Project Table
Project ID
Improvement (Projects)
LRTP (Projects)
TIP/WP/Local CIP/others (Projects)
Scenario ID (Scenario Table)
Centroid (SPATIAL)
Centroid ID
Year Removed (Model Inputs)
X Coordinate (Model Inputs)
Y Coordinate (Model Inputs)
Project-Link Table
Project ID(project Table)
Link ID (Link Shapefile)
Action (Projects)
First Priority Data
Second Priority Data
Additional Modeling
Related Data
Data sources:
ARBM
RCI
Projects
Model inputs
Legend
Relationship types
1 or more
0 or more
1 and only 1
0 or 1
Primary Key
Foreign Key
Only spatial entities have shadows

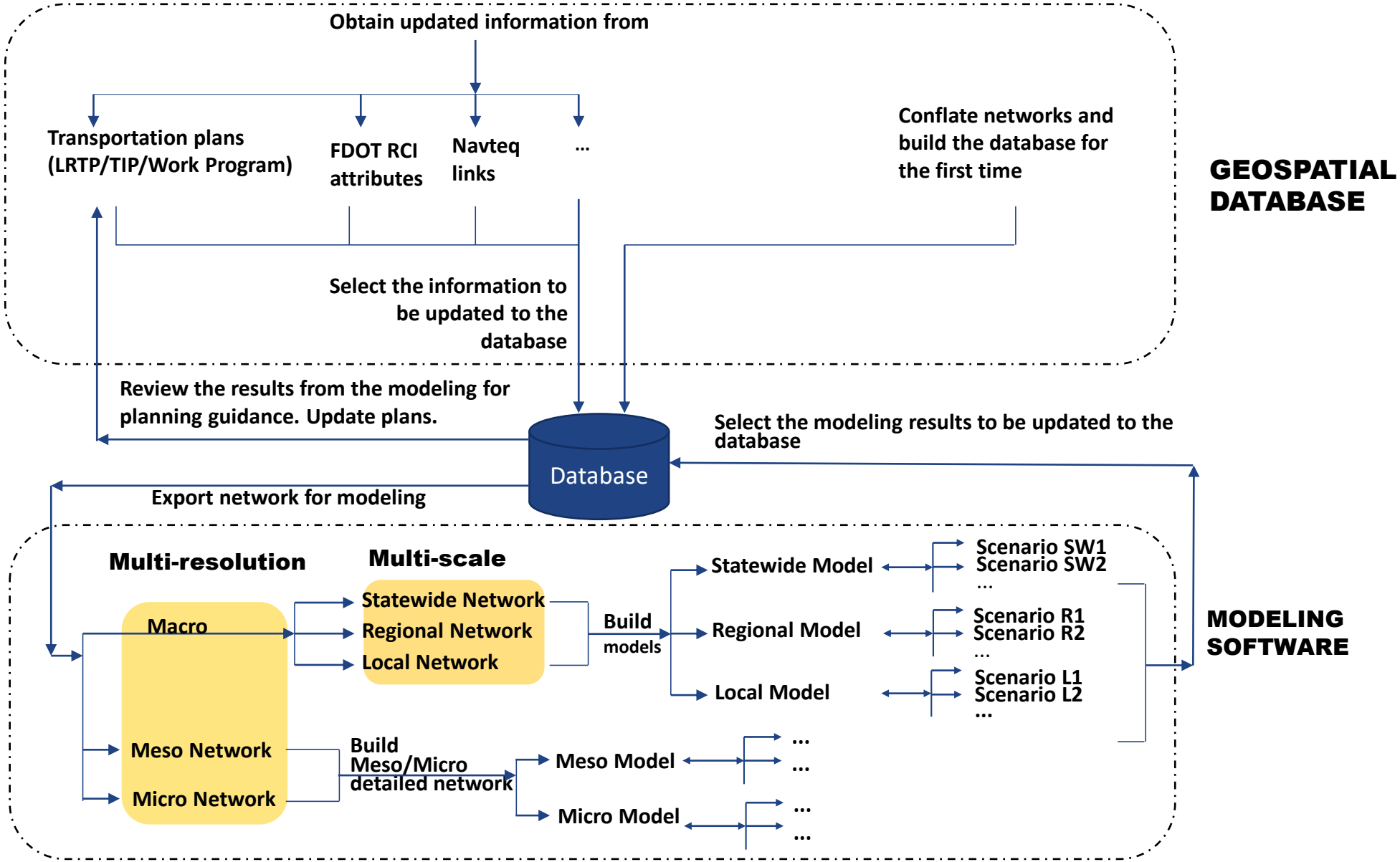
Data model for multi-resolution modeling



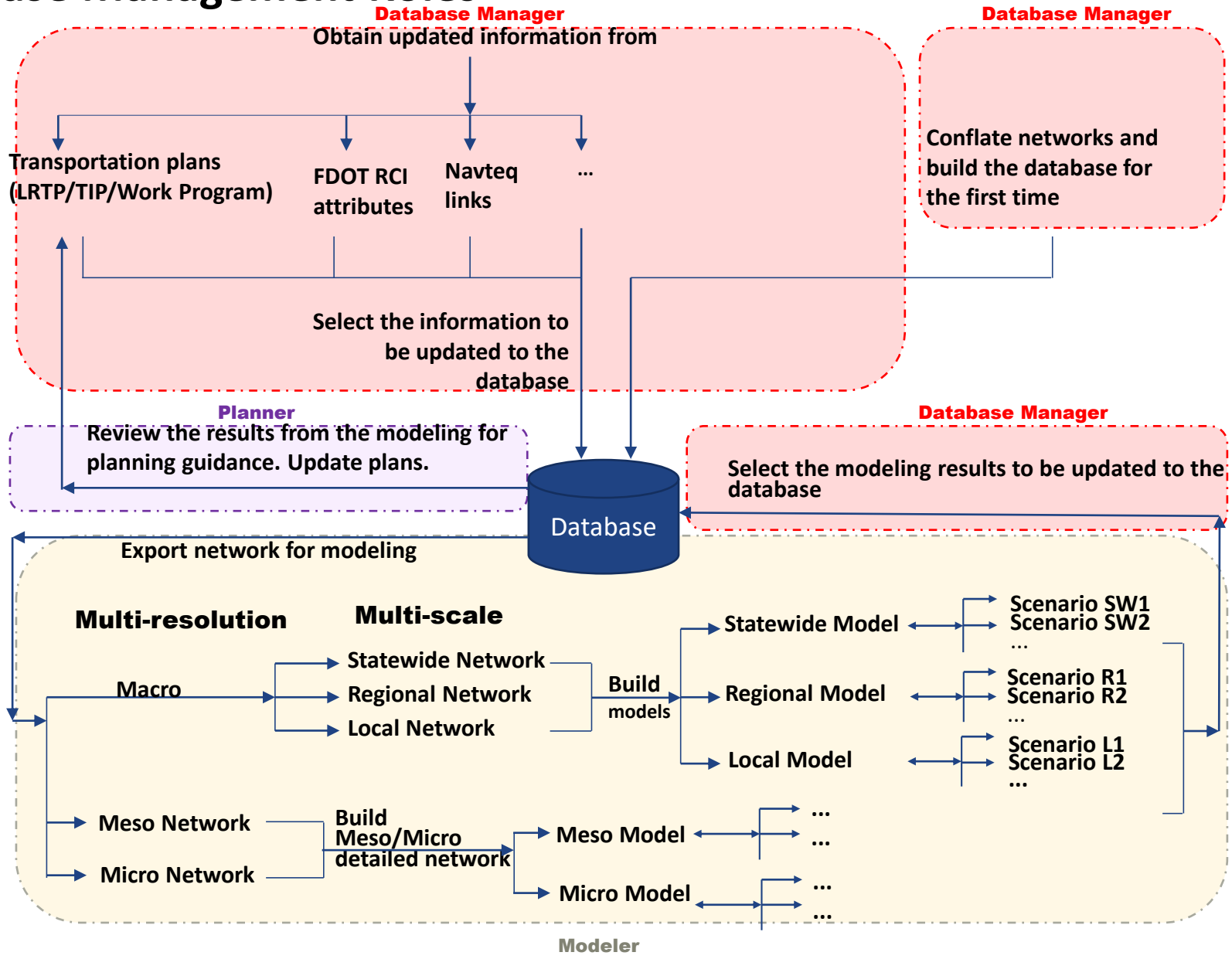

Microscopic & Mesoscopic Resolution
Link
Link ID
From Node ID
To Node ID
Area Type
Facitlity Type
Link Length
Direction
# of Lanes
AADT
Capacity
Observed Speed
Speed Limit
# of Segments
SHAPE
Node
Node ID
Node Type
SHAPE
Pavement Marker
Pavement Marker ID
Lane ID
Type
Direction
Position
SHAPE
Stop Sign
Stop Sign ID
Lane ID
Position
SHAPE
Segment
Segment ID
Link ID
Number of Lanes
Direction
Length
Position
Grade
Free Flow Speed
Speed Limit
Has Passing Lane
Number of Reversible Lanes
SHAPE
Lane
Lane ID
Segment ID
Width
Length
Direction
Turns
Lane change
Stop bar location
Reversible
Bicycle lane
Lane Connector
Connector ID
From Lane ID
To Lane ID
From Position
To Postition
Length
Has Passing Lane
Lane Change
Emergency Stop
Grade
Detector
Detector ID
Lane ID
Signal Head ID
Length
Type
Position
Before Stop
SHAPE
Signal Head
Signal Head ID
Lane ID
Length
Postion
Type
SHAPE
Legend
Relationship types
1 or more
0 or more
1 and only 1
0 or 1
Primary Key
Foreign Key
Only spatial entities have shadows

Data flow and management for the unified planning network

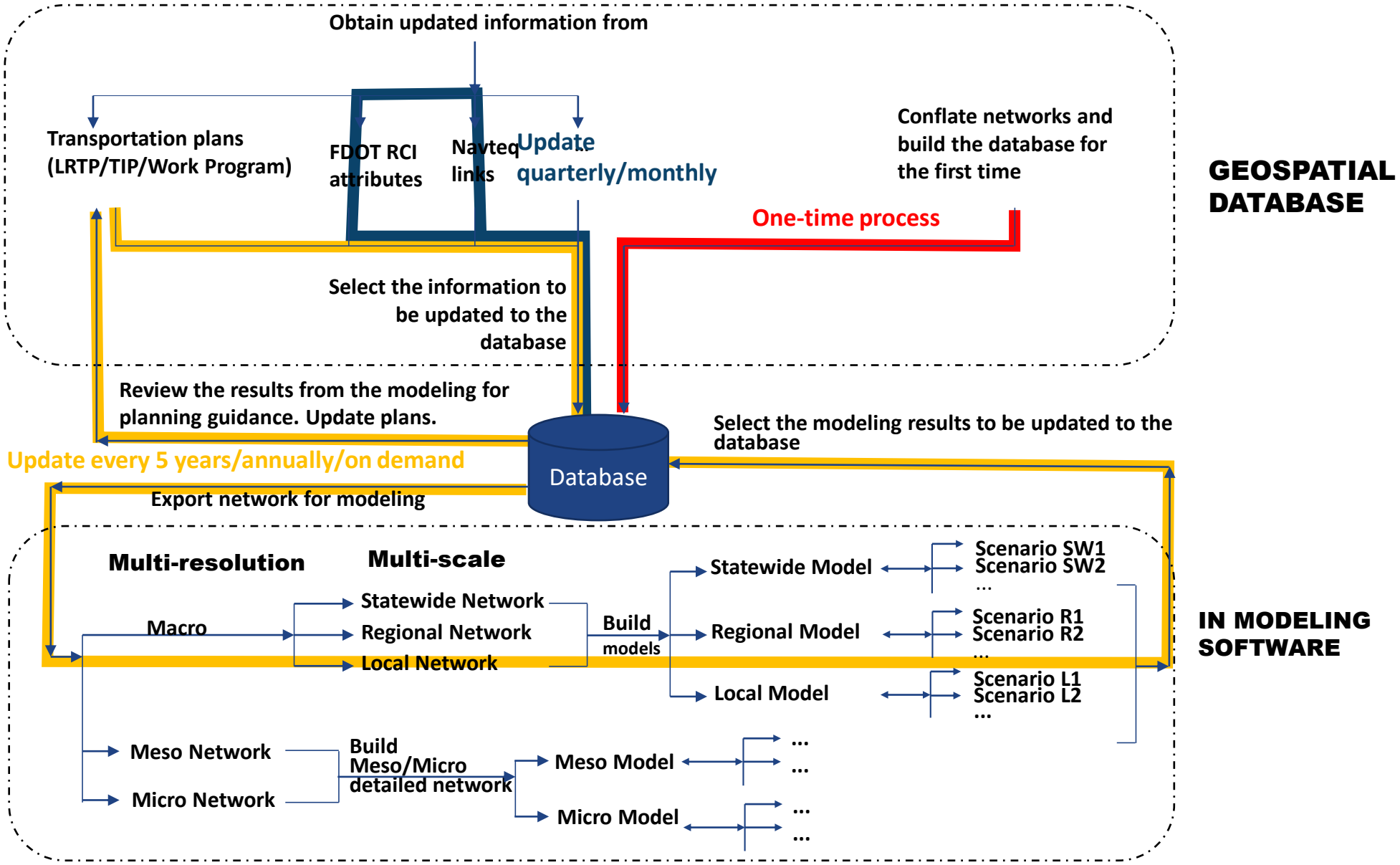
Network Database Data Flow



Network Database Management Roles



Network Database Update Cycle



Benefits for Modeling and Collaboration

- Integrate the data already being collected and maintained by FDOT
- Less need for data processing
- Easier to find potential errors on shared links
- Reduction of duplicate efforts

Benefits for Modeling and Collaboration - continued

- Various departments/agencies get access to shared information
- Facilitates coordination of agencies that rely on the same network - MPO, FDOT, Transit Agencies, Toll Operators
- While models can retain their independence, sharing can support ability to estimate/calibrate models to develop forecast

Considerations for Implementation

- FDOT offices encouraged to play contributing roles
  - As data providers
  - As hosts and managers of the database
- Leadership in developing and maintaining the unified network
  - TDA & FTO collaboration/coordination
- Modeling communities willing to collaborate and share
- Modeling software should support the unified true shape network

Considerations for Implementation - Network selection

- **All roads and true shape, e.g:**
  - All Roads Base Map (ARBM) contains all roads, it is true shape (based on HERE/Navteq)
  - FDOT has a maintenance contract with HERE
  - The State Safety Office has a process that integrates the LRS into HERE, RCI can be connected to the unified network
  - Turnpike model uses the HERE network
  - Methods have been developed and tested in the past to conflate the stick network to the HERE network

Suggested next steps towards implementation

- Coordinate with TDA
- Explore options and build a functional network prototype
- Start with Statewide and the Turnpike models
- Use the lessons for the regional and local models

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Thomas Hill Thomas.Hill@dot.state.ufl.edu

Questions / Comments ?