A Simple Application for Managing Multiple LRMs for Highway Asset Maintenance

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Objectives of Presentation

- Look at simple approach & application for highway asset management including:
- Outline business case
- Spatial processing from field to server
- Discuss Role of location referencing
- Review simplified approach for data collection requiring multiple LRS support

Background:

- Application for a private firm that provides highway maintenance services to DOTs
- Highly competitive industry with thin margins
- Customer requires Non-Disclosure for this reason
- Sought to automated WO management and asset tracking from field to central server
- Goal was to reduce cost using a low-cost approach and offer subscription services

Overview of Situation

- Inspector picks up Work Orders (WO) before visiting field
- Inspector works in the field replacing, rehabilitating, repairing assets and documenting
- While working inspector identifies new needs as service requests (SR) and Needs List (NL)
- Inspector returns to office with completed WOs and new SRs and loads into database.
- Needs list and new SRs also generated by calls from customer (DOT and public)

Traditional Problems

- Paper entry created backlog and errors
- Limited capability to describe SR locations (asset locations needing repair or replacement)
- Multiple Location Reference Methods affected operations and communications with customer
- Customers more frequently requiring access to inventory in digital format (GASB 34, etc)
- Limited ability to efficiently plan service route without spatial location & maps

Asset Location Requirements

- Work Orders may reflect a single location or type of activity over extended distance
- Also may require actions on many asset types
- Need GPS, LRS and maps for locating assets
- Inspector may need to locate assets for service using any available Location Referencing Method
- Inspector may need to create Service Requests defining assets to be serviced using any LRM
- Asset types include point, linear, and polygons

Other Requirements

- Needs to support cost centers with unique customer needs, assets, and requirements
- Linear Referencing System support must be expandable to accommodate new customer and cost center requirements
- Design must be context sensitive and responsive to user / cost center
- Universal spatial coverage not needed but simply buffer area around contracted ROW

Other Considerations

- There can be approximately 32 distinct asset types plus 3-10 spatial data layers per cost center
- 10-20 feet accuracy determined acceptable for field staff to locate assets
- Wireless reception not always available
- Utilize available spatial basemaps but verify accuracy

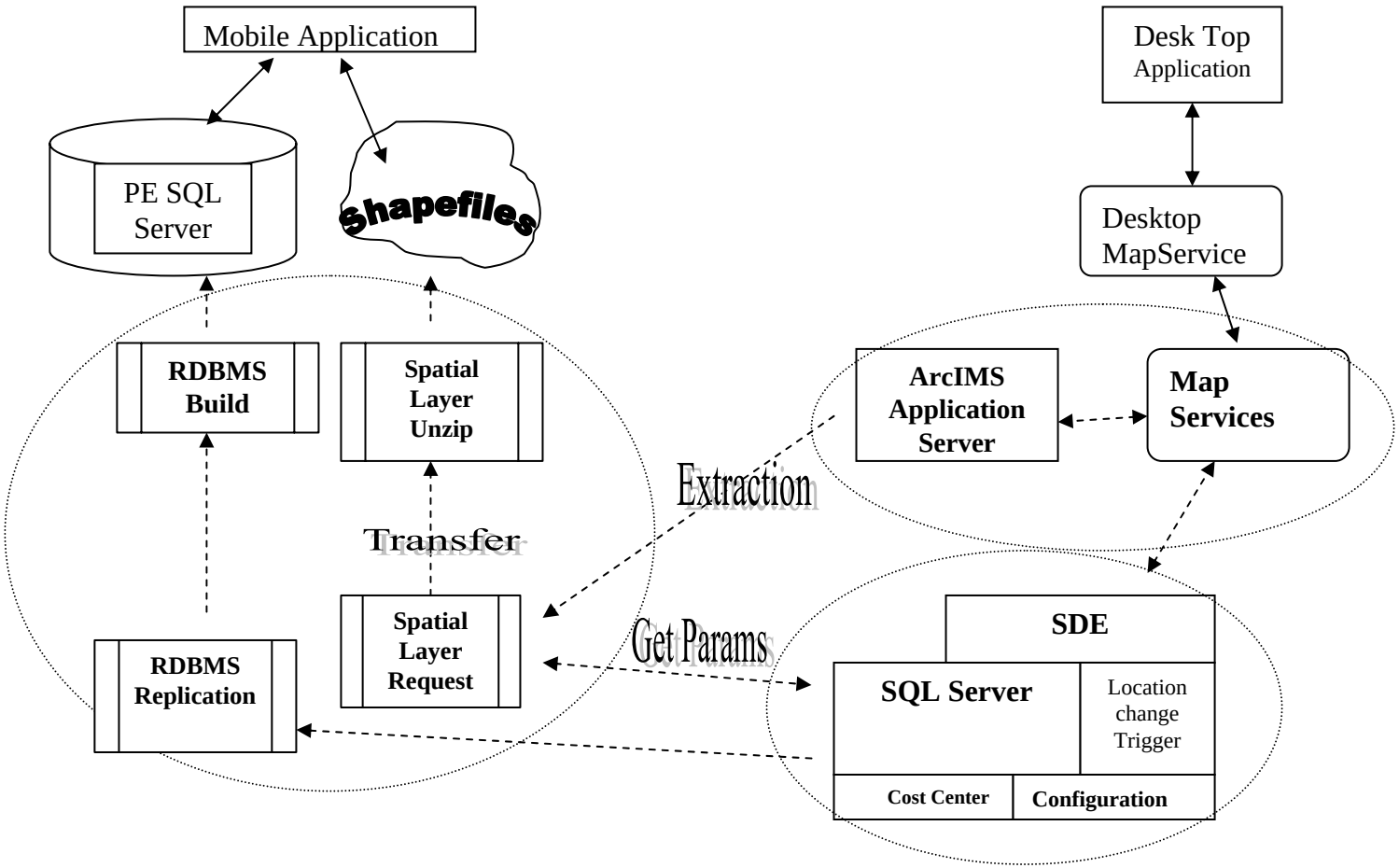
Core Requirements for Prototype

- Keep model simple yet flexible for multiple LRM support
- Minimize concurrent GIS license requirements
- Design initial model to support Geographic Coordinates, Route / Milepost, and Street Address location referencing methods
- Provide web based access spatial data downloads for mobile

Target Environment

- .NET framework
- ESRI SDE, ArcIMS
- MS SQL Server
- MS PE SQL Server on Mobile
- Laptops and IPAQs
- JAVA, ASP, Jscript, ArcObjects

High-Level Architecture



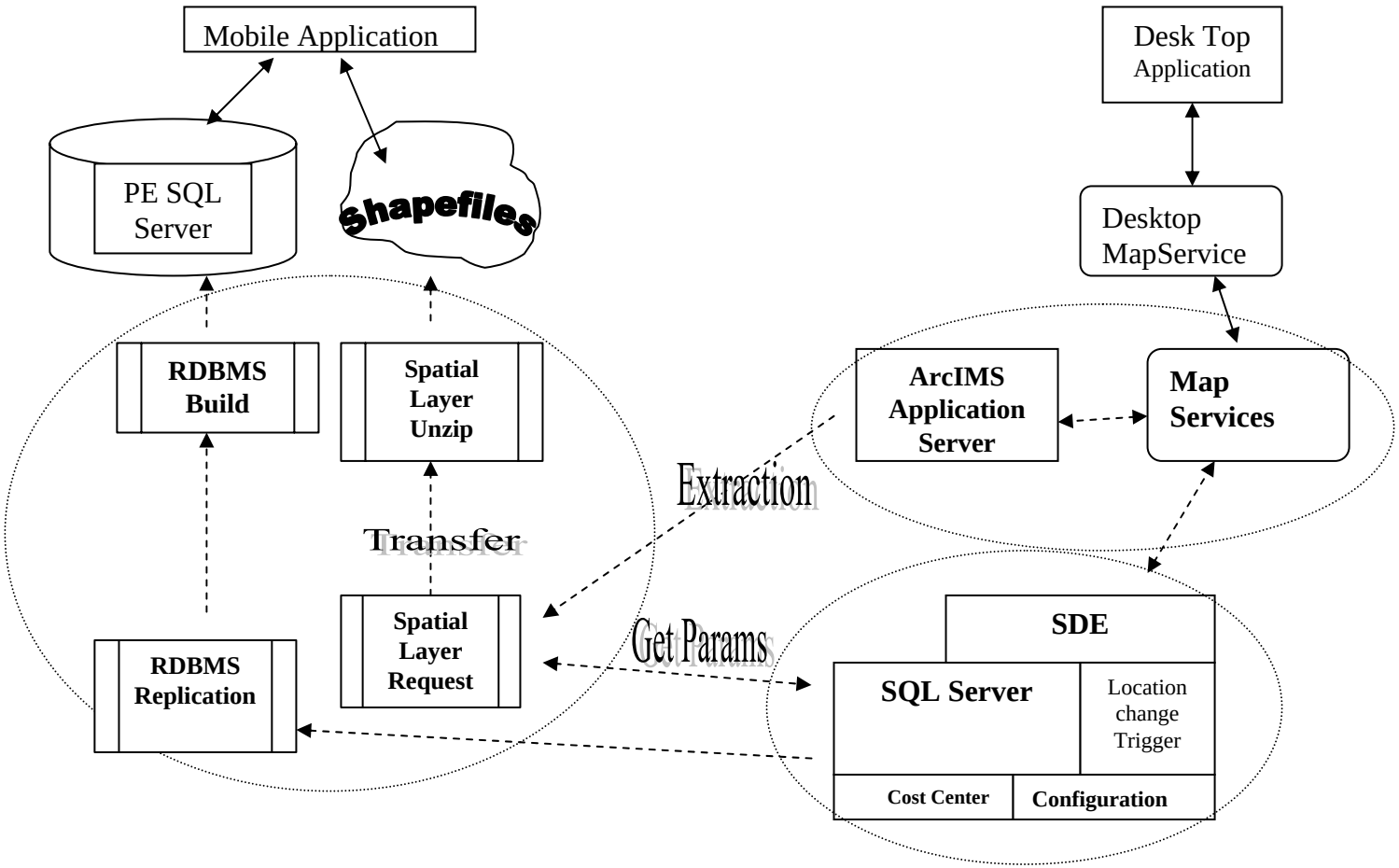
Selected Design Elements

- Spatial data pulled from central server through ArcXML requests
- Locations from the field come in as attributes to assets
- Originating LRM is master location
- Real-time synchronization between attributges & SDE for location changes on the backend during server updates

Downloading to Mobile: Spatial Processing Steps

- User connects laptop/IPAQ, logs in, and requests daily assignments
- Obtains user information & Cost Center/user preferences
- Formulate an ArcXML request for Map Service
- Extract the GIS data layers from SDE, into a zipped shapefile format. (GIS & spatial asset layers)
- Pass zipped data to mobile & expand into directories
- Replication of business data (WOs, assets, etc) to the mobile PE SQL Server occurs in parallel

Generalized Mobile Sync Process



Uploading from Mobile: Spatial Processing Steps

- Obtain user and Cost Center (CC) information.
- SQL Server's merge replication transfers the mobile asset attributes to the central database
- Location Change Trigger(s) write information about asset location changes to a staging table. Deletions captured also
- The Location Change Trigger fires by watching for changes to Cost Center LRMs
- An SDE update object is started to sync asset layers

Uploading from the Mobile: Coordinate References

- When the incoming location descriptor is a geographic coordinate:
  - Call the SDE API to translate x,y into the base TF LRS (computes offset and side)
  - Then call the LRS Translator to compute alternate LRS(s) for the cost center using the RDBMS
- Write each location descriptor to the central database for the asset.

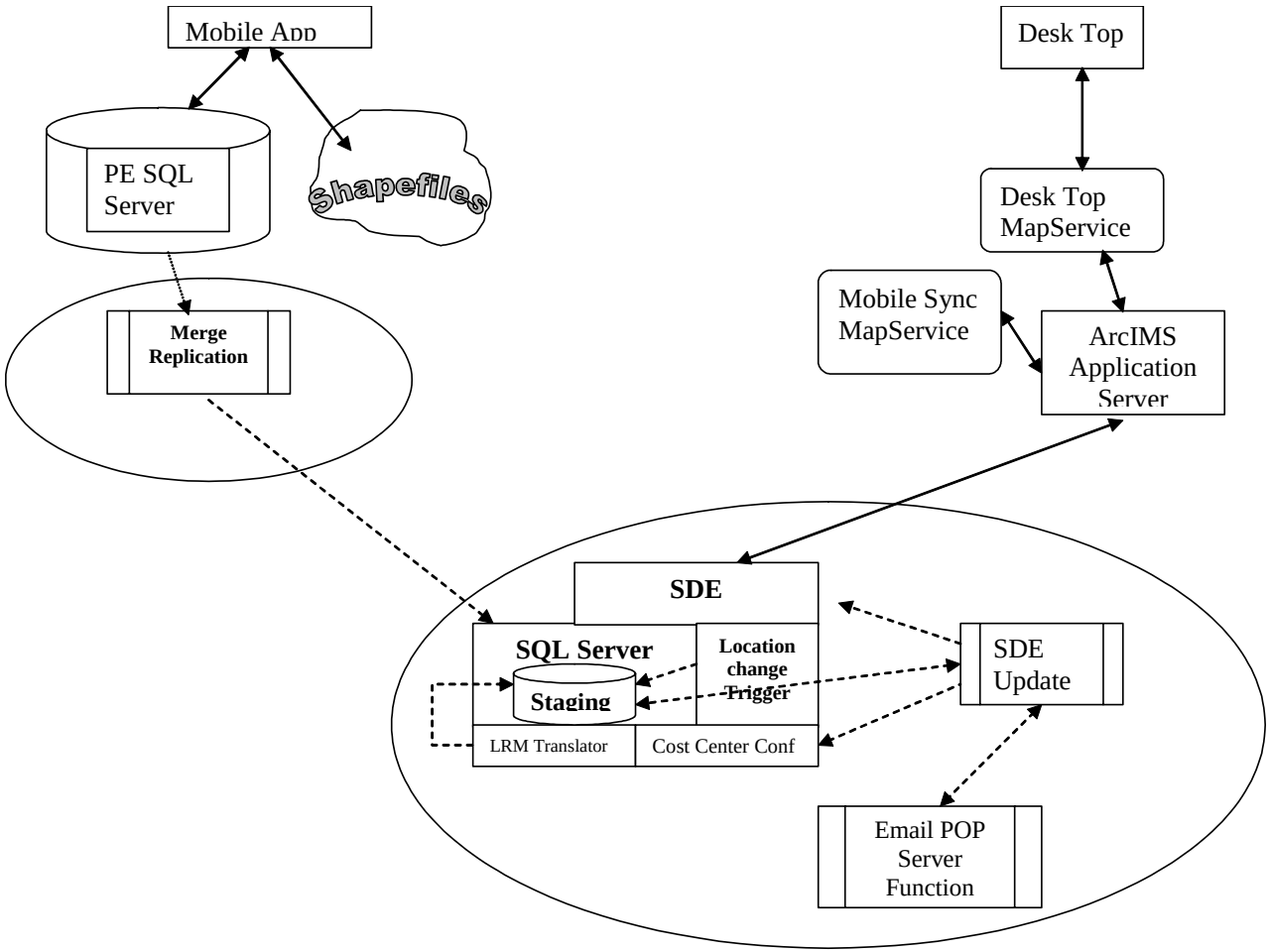
Uploading from the Mobile: LRS References

- When the incoming location descriptor is an address or LRS measure:
  - Call Linear Referencing Translator to attempt to match the incoming Location Referencing Method.
  - If error, call interactive DLL or write to error file/skip.
  - Translate the location descriptor into the base LRS.
  - Then translate the base referencing system's location descriptor into appropriate alternative LRS descriptors
- Call the SDE API to translate the base LRS descriptor's location into a geographic coordinate (inc. offset)
- Write each alternative location descriptor and geographic Coordinate to the relational database.

Spatial Data Synchronization

- After completion of processing for incoming asset location records for the user, update SDE feature classes:
  - For deletions: call SDE API to delete shape in appropriate layer
  - For new assets: call SDE API to create new shape in layer and replicate selected attributes
  - For asset location changes: update the shapes location

Mobile to Server Synchronization



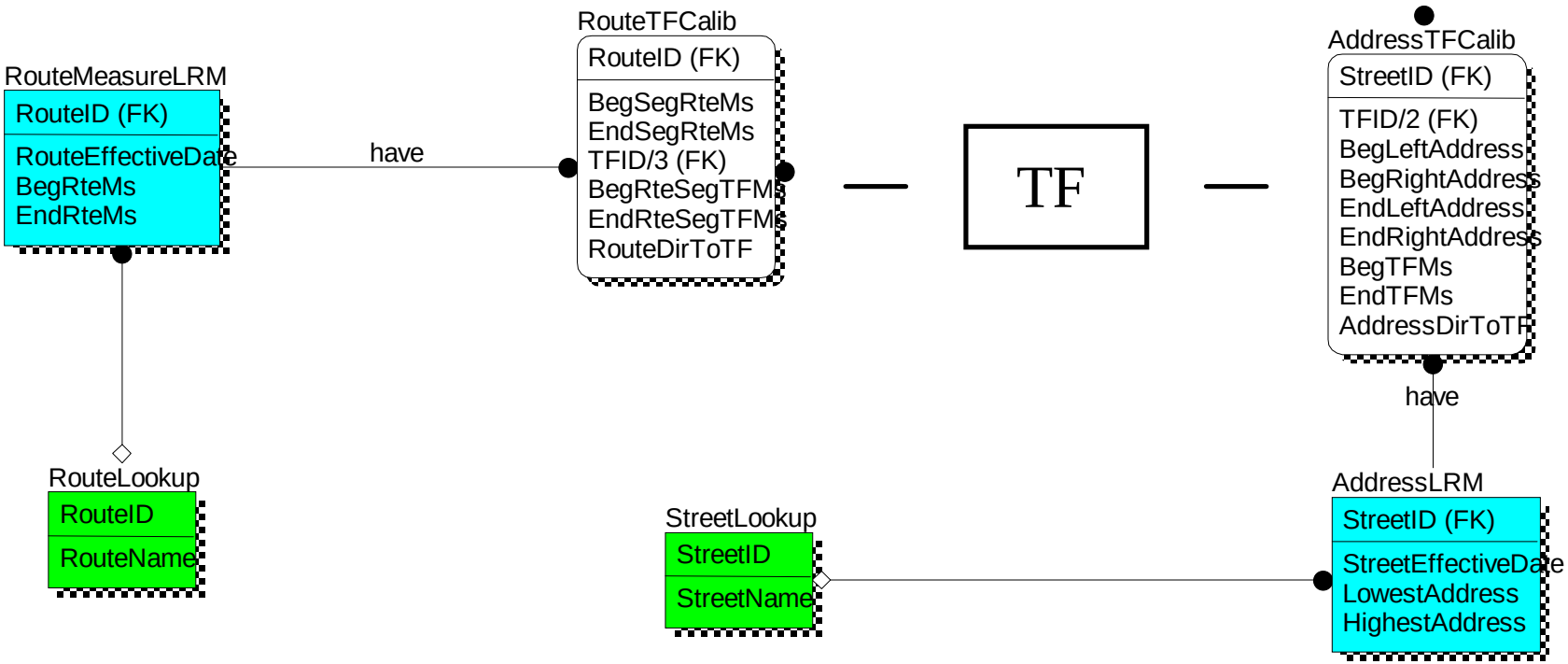
Selected Elements of the LRMS Design

- LRS translator operates within RDBMS to support large numbers of subscribers without large concurrent GIS licensing requirements
- Coordinate conversions require SDE API hit
- GIS route model based on modified Vonderhoe / Dueker models using transportation feature route system (TF)
- TF servers as basis in RDBMS for LRS translations and for SDE coordinate translations
- Designed to support addition of other LRMs

TF Base Route System

- Serves as the base route system, and a logical element within the RDBMS LRMS data model
- Represented as a physical layer (route system feature class) within SDE but somewhat abstract in nature.
- Ties together each LRS supported for the customer.
- Serves as a common reference frame for establishing disparate LRS relationships thus facilitating LRS translations within the relational database.
- Necessary for the translator since actual spatial coordinate relationships are not translated from GIS into SQL Server
- Facilitates reuse of code across disparate customer LRSs

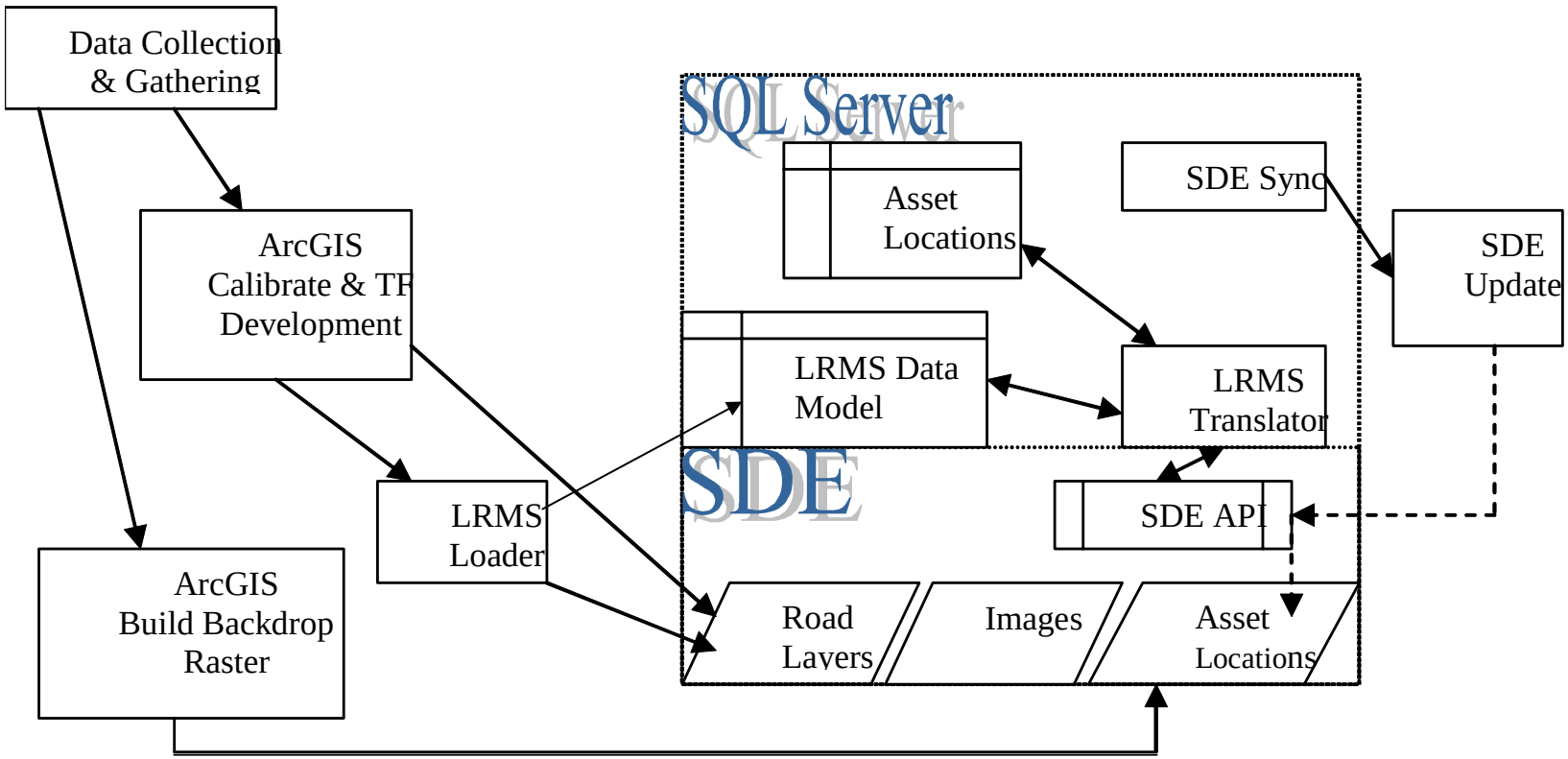
Simplified LRMS Data Model



Selected Maintenance Considerations

- LRSs maintained as feature data sets in the Geodatabase by ArcGIS
- Synchronized into the SQL Server LRMS data model after initial build
- If LRS/GIS updates are required, must resync RDBMS LRMS data model and affected assets
- LRMS data loader built on ArcObjects

LRMS Support Processes



Summary and Closing Comments

- Simple yet flexible approach RDMS based approach supports GPS and various LRMs
- Designed to support large numbers of subscribers avoiding large concurrent GIS license requirements
- Synchronization not a large issue as all data managed /warehoused for each Cost Center
- Geographic coordinate and all appropriate LRS computed & stored for all assets

Thank You

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