



Deploying Interoperable Multivendor GIS Solutions Using ArcGIS™ With Oracle® Spatial

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Deploying Interoperable Multivendor GIS Solutions Using ArcGIS With Oracle Spatial

Introduction One of the key reasons for using Oracle® Spatial is to facilitate interoperability with multiple geographic information system (GIS) products. Oracle Spatial can serve a data source that is accessible by applications from various software vendors. This technical paper presents a practical overview of using Oracle Spatial data, created by non-ESRI applications, with ArcGIS™. It discusses some considerations that you need to think about carefully when building your ArcSDE™/Oracle Spatial geodatabase.

Scope The evolution of Oracle Spatial has been rapid. Each version has improved upon its predecessor. Each version has significant differences, which complicate the discussion of its interrelationship with ArcGIS. To limit the complexity of this technical paper, the discussion will be largely limited to ArcSDE 8.2 QFE as it relates to Oracle Spatial for Oracle 8.1.7 and 9.x, though other versions are mentioned when appropriate.

Do I Need ArcSDE? ArcGIS includes a family of desktop client applications (ArcView®, ArcEditor™, and ArcInfo™), the ArcObjects™ development environment, and ArcSDE. The ArcSDE component is designed to provide a common interface, or gateway, to spatial data stored in a geodatabase for ArcGIS, ArcIMS®, and other ArcSDE client applications. (A geodatabase is a database that manages spatial data.) ArcSDE provides a common interface to geodatabases stored on a variety of relational database management systems (RDBMSs) including Oracle. All ArcSDE client applications use this common interface. (This includes other ArcSDE clients such as ArcIMS, ArcView 3.x, ArcInfo Workstation, and MapObjects®.) When these applications access geodatabases implemented on commercial RDBMSs, they do so via ArcSDE. ArcSDE supports sharing data among applications by isolating both ESRI's out-of-the-box client applications and development environments from the need to know how the data is stored in the underlying RDBMS. It ensures ESRI's client database investment by providing database portability (through ESRI's import and export tools) and spatial data integrity through strict spatial data validation rules.

ArcGIS with ArcSDE adds support for key functionality that ESRI's users require, which is not directly supported by Oracle Spatial, such as annotation, raster data storage, the advanced features of the ESR® geodatabase model, and a multiuser editing environment with a persistent multistate database model. All ArcGIS features and functionality supported on SDEBINARY feature classes are fully supported with feature classes stored in Oracle Spatial. Plus, ArcGIS users can take advantage of all of the key new features

planned for 2002 including detached editing, distributed databases, history, and parcel topology.

You can use ArcSDE to store spatial data in Oracle Spatial or other RDBMSs that provide SQL access to spatial types. This means that you may also access this data directly through SQL, even for nonmap-based applications. Conversely, because ArcSDE is able to read and write Oracle Spatial data, you can load data for use with ArcGIS using third party software, Oracle export files, or SQL. This flexibility is why some ESRI customers have chosen to use the combination of ArcGIS and Oracle Spatial.

Using Your Data With ArcGIS

ArcGIS Advanced Features

ArcGIS supports a host of advanced features, regardless of the type of RDBMS that is used to store the spatial data.

ArcGIS is a multiuser GIS with advanced data versioning that is capable of supporting multiple simultaneous users editing the spatial and nonspatial data. ArcGIS supports segregating, reconciling, and posting changes made to different versions of the data by different users. It also lets you define specialized feature behavior and relationships between features such as geographic networking. ArcGIS supports metadata storage, subtypes of rows within a single table or feature class based on attribute values, and domains used to set allowable values for attribute columns. It can be used to maintain topology between overlaid layers as they are edited. ArcGIS supports these and many other features.

You should keep in mind that many ArcGIS functions rely on ArcSDE and the ArcSDE system tables and not simply on the tables containing spatial data. The ArcSDE system tables hold some of the information needed by these advanced GIS capabilities. Third party applications do not understand the contents of the ArcSDE system tables or the proper way to access them. This can lead to problems should the spatial data be changed by third party applications.

Using ArcGIS to Edit Your Oracle Spatial Data

When working completely within ArcGIS, the software ensures that your data is not corrupted and that the interrelationships between tables are maintained. However, when editing data in a mixed processing environment of ArcGIS and third party editing systems, you need to be vigilant to protect the integrity of your data. With the current technology, it is not possible to edit data simultaneously with both ArcSDE client applications and non-ArcSDE applications. There are a number of practical reasons for this. For example, there is no common interface or process to visually reconcile conflicting changes made by different users when they are using different editing tools.

When you modify your data using only ArcGIS, you are free to use any ArcGIS functionality. If you choose to use these advanced features, you will find that third party applications will not recognize them. This is because information that supports these advanced features is stored in ArcSDE system tables and not in each feature class table.

For example, ArcGIS supports attributed relationship classes, which allows you to specify how two tables or feature classes are related and assign attributes to the relationships themselves. This advanced feature is implemented through information stored in the ArcSDE system tables. While the feature classes participating in the relationship will still appear as Oracle Spatial tables to third party applications, the special relationships and their attributes will not be visible. Adding or removing rows from the participating feature classes using a tool other than ArcGIS could corrupt the relationship class. If you choose to create or edit Oracle Spatial data with ArcGIS that will also be edited by third party applications, you should store these as simple feature classes. You should exclude advanced features such as ArcGIS subtypes and domains and participating in geometric networks from these feature classes.

ArcGIS uses versioned data to support multiuser editing. Once data is registered as versioned with ArcGIS, each edit session edits its own version of the data. ArcSDE maintains changes to the data in delta tables. (For more information about how ArcSDE maintains versioned data, please refer to the ESRI book *Building a Geodatabase*.) Because changes to a versioned table are not kept in the base table, these changes cannot be accessed through direct SQL queries on the base table. However, using the ArcSDE Native SQL Interface allows you to perform SQL queries and edits that properly access a specific version of a table. This interface is composed of a set of stored procedures that allow a SQL session to access a specific named version in the geodatabase through an ArcSDE multiversioned view. This interface is documented in *ArcSDE Developer Help*.

Editing Outside ArcGIS

Please bear in mind that ArcGIS is the sole implementer of ArcGIS advanced capabilities and maintains the special relationships and interaction of the features in the geodatabase. If editing is performed using a third party application that is not "geodatabase aware" (i.e., it does not understand the rules and interrelationships maintained by ArcGIS), these changes can corrupt the geodatabase. If you are editing data with a non-ArcSDE client application, you cannot edit features that participate in advanced ArcGIS features. If you do, you can corrupt your database.

Read-Only Connections From ArcSDE Client Applications

You could avoid corrupting the data supporting special relationships, versioned data, and other advanced ArcGIS features by avoiding the use of these features. You can prevent your users from introducing ArcGIS-specific items into your data by providing read-only access to the data from ArcGIS. In this scenario, you maintain your data with a third party application and only read the data with ArcGIS. A wide array of features is provided by ArcGIS that can be used even when limited to read-only access to your spatial data.

It is easy to grant read-only access to your data using one of the following approaches:

- Use ArcSDE direct connect without an ArcSDE server license. If no server license is available, then the ArcSDE client applications using direct connect can only read from the server.
- If you are using the ArcSDE application server, you can set up a read-only ArcSDE service. You can create a read-only service for some users and another read-write

service for other users, each handling connections to the same geodatabase. Please see the ESRI book *Managing ArcSDE Services* for details about configuring a read-only service.

- You can limit access to specific tables using RDBMS privileges. You can use Oracle tools, SQL, ArcCatalog™, or ArcSDE administration commands to manage privileges on these tables.

You can still autoregister Oracle Spatial tables with ArcSDE, even when you have read-only access to the ArcSDE geodatabase. ArcSDE will autoregister all unregistered Oracle Spatial tables each time any user requests a list of layers from ArcSDE. For more information about registering Oracle Spatial tables with ArcSDE, please see the ESRI technical paper *Configuring ArcSDE to Use Oracle Spatial Third-Party Data*.

Oracle Spatial Features Not Supported by ArcGIS

If you use a third party application to load and edit Oracle Spatial data, ArcSDE is not involved in those operations and, therefore, has no control over the quality or type of data stored. To be sure that it can process such data correctly, ArcSDE validates Oracle Spatial data as it accesses it. Not all Oracle Spatial data loaded or edited outside an ArcSDE client application will pass the validation tests. Here is a description of some situations in which it will not.

Unsupported Feature Types

ArcSDE does not support multiple geometry columns in a single Oracle Spatial table or any other type of geodatabase table. In addition, ArcSDE does not support the following Oracle Spatial geometry types:

- Features containing ETYPE 0 application-specific geometric element types. (See the discussion of these element types in the next section.)
- Heterogeneous collections, a feature containing combinations of point, line, and polygon geometry types. Homogeneous collections, containing only one type of geometry, are supported. ArcSDE uses them to implement multipart features
- Optimized rectangles, where only two corners are specified. ArcSDE supports rectangles (or any other polygon shapes) in which all of the vertices are specified as a closed polygon. Features containing optimized rectangles introduce ambiguities when they must be geographically projected.
- Optimized circles, where any three points define the circle. ArcSDE supports circular arcs. The first and last vertices are assumed to be endpoints of the arc. If a circle is required, two arcs can be combined to form a circle.

ETYPE 0 Elements

Geometric elements are the pieces of the geometry that make up the whole of the geometry. For example, line string geometry might be composed of straight-line segments and circular arcs. The Oracle Spatial schema identifies each geometric element with an element type number. Some other common element types are compound line strings (element type 4), outer and inner polygons (1003 and 2003), line strings (2), and

points (1). These elements are combined to form a single geometry, and several geometries can be combined into a multipart geometry.

Oracle Spatial allows applications to define and use new geometric element types and store these within the SDO_GEOMETRY data type. These elements have an element type designation of zero. The contents or meaning of these ETYPE 0 elements is defined by the applications that create or use these elements. Unfortunately, it is unlikely that an application from one vendor will know the meaning of the ETYPE 0 elements created by another vendor's application. The use of these element types can be a major impediment to interoperability because the meaning of ETYPE 0 elements is not standardized. ESRI software does not define, create, display, or edit any ETYPE 0 geometric elements. If any row with spatial data is edited by ArcGIS, the ETYPE 0 geometric elements will be removed from the geometry in the row. If the geometry itself is edited, any ETYPE 0 elements will be removed at that time. If only attributes of the feature are edited, the ETYPE 0 elements will be removed when the geodatabase is compressed.

Determining whether a table contains geometries that have ETYPE 0 elements can be complicated. The element type is stored as one part of a triplet of values in an array of these triplet values in the SDO_ELEM_INFO array, part of the SDO_GEOMETRY data type. Please refer to the *Oracle Spatial Users Guide and Reference* for more information about element types.

Invalid Geometries

ArcSDE has very strict spatial geometry validation. ArcSDE strives to maintain only valid features in the geodatabase by applying a set of rules to each feature that it processes. ArcSDE guarantees that any data loaded by ArcSDE clients will have valid geometry. If they edit using ArcSDE clients, then users cannot insert invalid features or update features to make them invalid. However, ArcSDE cannot perform validation on Oracle Spatial data that was created by another application and registered with ArcSDE—at least not until ArcSDE reads the data. At that time, if the features do not conform to ArcSDE geometry validation rules, they are not passed on to ArcSDE client applications.

Oracle Spatial does not validate a feature's geometry as it is inserted into Oracle Spatial tables. Instead, Oracle Spatial provides a means of validating geometry afterwards. Please see the VALIDATE_GEOMETRY and VALIDATE_LAYER references in the *Oracle Spatial Users Guide and Reference* for more information on Oracle Spatial's geometry validation tools and rules. These validation rules are different from the rules applied by ArcSDE and cannot be relied on to determine whether a geometry is valid for use with ArcSDE. The upstart of this is that when you register an Oracle Spatial table with ArcSDE, it may already contain invalid geometries from the point of view of ArcSDE (or even from the point of view of Oracle Spatial). Also, it is possible for users to insert invalid geometries into an Oracle Spatial table using SQL statements at any time if they have sufficient privileges on the table.

Oracle Spatial Data Prior to Version 8.1.6

ArcSDE does not support reading and writing Oracle Spatial Object Types for versions prior to Oracle 8.1.6. Earlier versions had some differences in the interpretation of some fields in the spatial schema. Oracle provides tools for migrating Oracle Spatial data to

later versions. At the time of this writing, Oracle was providing a tool for loading Oracle Spatial tables directly from shapefiles. This loader is called SHP2SDO. It produces data in the Oracle Spatial 8.1.5 format. If you choose to use this tool to load your data, and you want to use your data with ArcSDE, you will need to migrate your data to a later version after loading it. SHP2SDO is not supported by ESRI, and it is not recommended that you use it.

Conclusion

Oracle Spatial can be used to provide the common geographic storage medium of a geodatabase that serves data to software from various vendors. A common storage medium, however, is only part of the desired goal of providing interoperability between GIS software. While data can be accessed from multiple applications, these applications need to precisely agree on the meaning of the data and how it can be edited appropriately. When any application extends its capabilities by adding rules and relationships, interoperability can break down. You can achieve some level of interoperability by simplifying the data, avoiding application-specific functionality, or simplifying the data access model, allowing only one application to modify the data.



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ESRI
380 New York Street
Redlands, California
92373-8100, USA
Telephone: 909-793-2853
Fax: 909-793-5953

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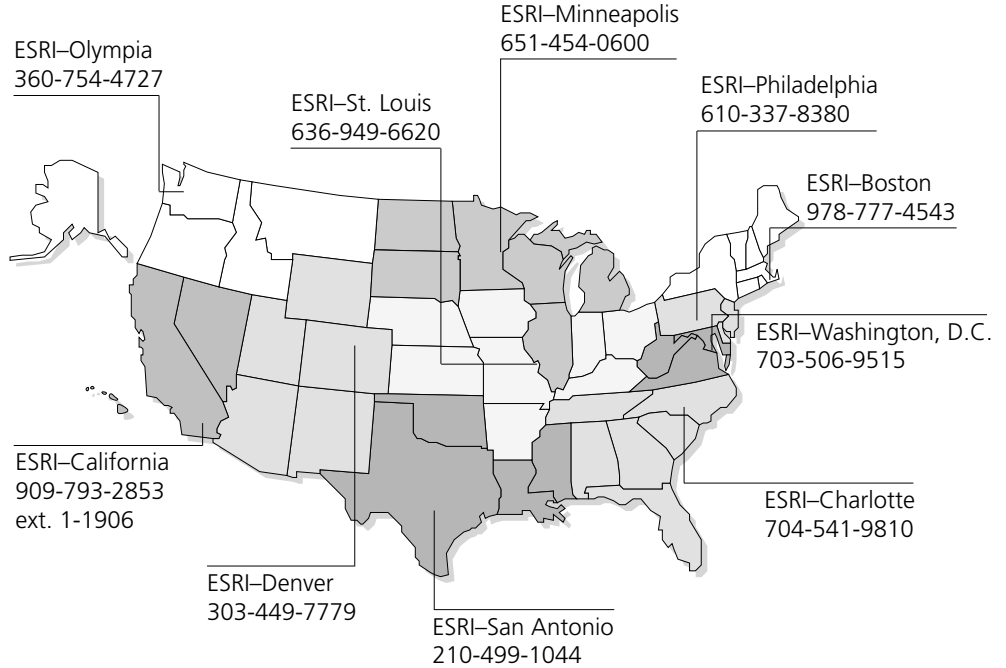
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