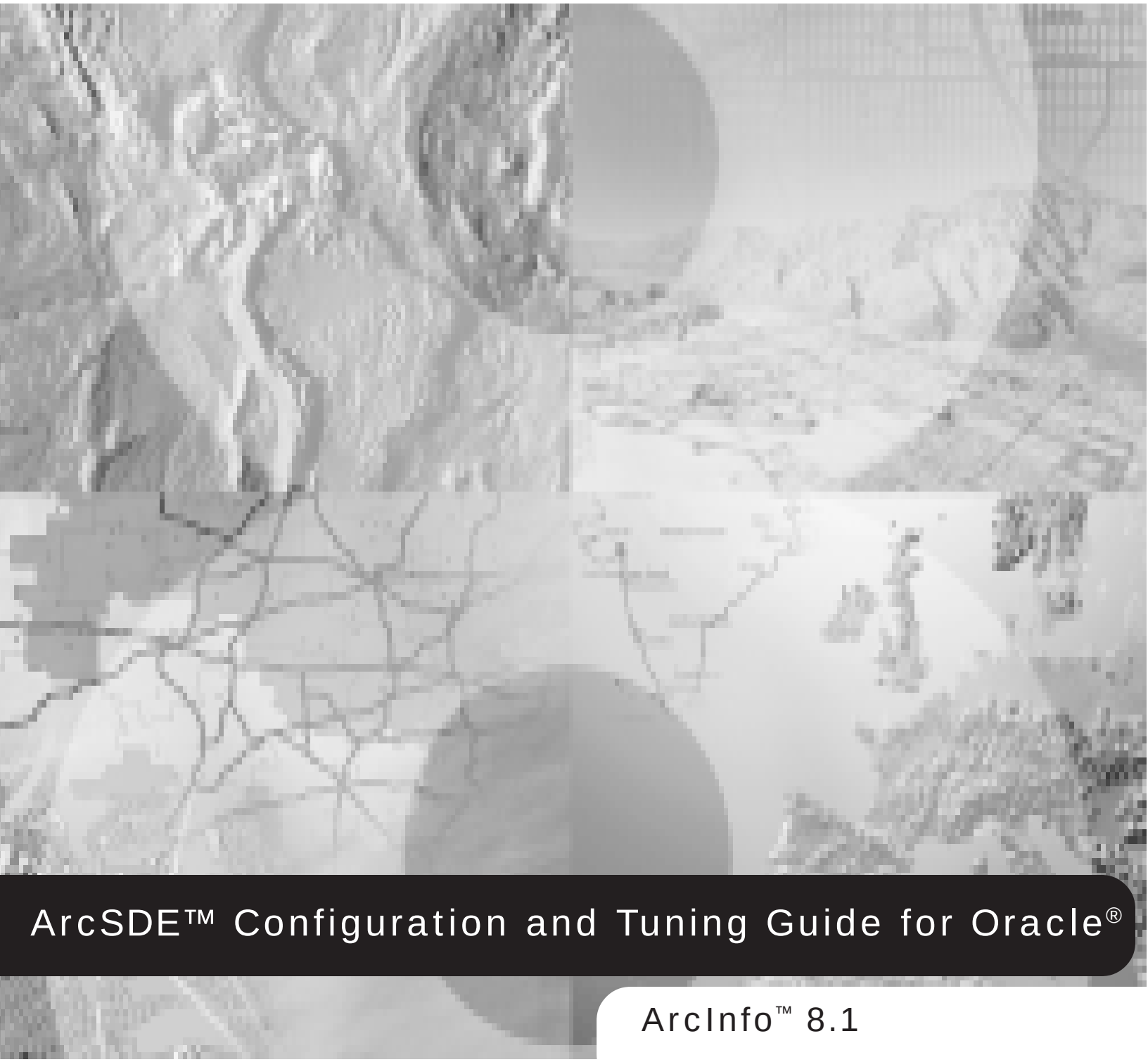

ArcSDE™ Configuration and Tuning Guide for Oracle®

ArcInfo™ 8.1

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CHAPTER 1

Getting started

Creating and populating a geodatabase is arguably a simple process, especially if you use ESRI® ArcCatalog™ or ArcToolbox™ to load the data. So, why is there a configuration and tuning guide? Well, while database creation and data loading can be relatively simple, the resulting performance may not be acceptable. It requires some effort to build a database that performs optimally. Also, as an Oracle® user, you have some choices for storing the geometry of your spatial data. This book provides instruction for configuring the physical storage parameters of your data in the database management system (DBMS) as well as providing information about the available options you have to store the geometry. This book also provides some important guidelines for configuring and tuning the Oracle instance itself.

Tuning and configuring the Oracle instance

Building an efficient geodatabase involves properly tuning and configuring the Oracle instance and proper arrangement and management of the database's tables and indexes. Chapter 2, 'Essential Oracle configuring and tuning', teaches you how to do just that.

Chapter 2 lists the necessary steps to create a geodatabase. You will learn how to properly

- Create an Oracle database.
- Create the tablespaces that will store your tables and indexes.
- Tune the Oracle instance that will mount and open the database.

- Manage the optimization statistics of the tables and indexes after they have been created and populated.

Arranging your data

Every table and index created in a database has a storage configuration. How you store your tables and indexes affects your database's performance.

DBTUNE storage parameters

How is the storage configuration of the tables and indexes controlled? ArcSDE™ reads storage parameters from the DBTUNE table to define physical data storage parameters of ArcSDE tables and indexes. The storage parameters are grouped into configuration keywords. You assign configuration keywords to your data objects (tables and indexes) when you create them from an ArcSDE client program.

Prior to ArcSDE 8.1, configuration keywords were stored in a dbtune.sde file maintained under the ArcSDE etc directory. The dbtune.sde file is still used by ArcSDE 8.1 as the initial source of storage parameters. When the ArcSDE 8.1 sdesetupora8* command executes, the configuration parameters are read from the dbtune.sde file and written into the DBTUNE table.

It should also be noted that ArcSDE 8.1 has simplified the storage parameters. Rather than matching each Oracle storage parameter with an ArcSDE storage parameter, the ArcSDE storage parameters have evolved into configuration strings and represent the entire storage configuration for a table or index. Pre-ArcSDE 8.1 storage parameters are automatically converted to the new simpler ArcSDE 8.1 storage parameters. The ArcSDE storage parameter holds all the Oracle storage parameters of an Oracle CREATE TABLE or CREATE INDEX statement.

The sdedbtune command has been introduced at ArcSDE 8.1 to provide the ArcSDE administrator with an easy way to maintain the DBTUNE table. The sdedbtune command exports and imports the records of the DBTUNE table to a file in the ArcSDE etc directory.

The ArcSDE 8.1 installation creates the DBTUNE table. If the dbtune.sde file is absent or empty, sdesetupora8* creates the DBTUNE table and populates it with default configuration keywords representing the minimum ArcSDE configuration.

In almost all cases, you will populate the table with specific storage parameters for your database. Chapter 3, 'Configuring DBTUNE storage parameters', describes in detail the DBTUNE table and all possible storage parameters and default configuration keywords.

Spatial data storage choices

The DBTUNE storage parameter GEOMETRY_STORAGE allows you to select from four possible spatial column storage formats.

The four possible storage formats are:

- ArcSDE compressed binary with LONG RAW. The ArcSDE geometry is stored in a "LONG RAW" column in a separate feature table. A business table's spatial column is a foreign key reference to the records of the feature table. This is the default spatial storage format for ArcSDE.

- ArcSDE compressed binary with binary large object (BLOB). The schema of this storage format is the same as the previous one except for the fact that the geometry is stored in the BLOB data type.

- Oracle Spatial geometry type. In this object-relational model, Oracle8*i* extends the database model to include an SDO_GEOMETRY type in the Oracle. Under this storage format, the spatial column is an SDO_GEOMETRY data type, and no foreign key reference to another table storing a geometry column is required.

- Oracle Spatial normalized schema (relational model). In the normalized geometry schema, the coordinate values for a shape are stored as DBMS numeric data types in a separate geometry table. Access from a business table to a geometry is through a foreign key—the Geometry ID, or GID. This data storage format can result in multiple rows of data for a single feature, depending on how many x,y points define the feature (for example, the coast of Norway might occupy many rows). This implementation conforms to the normalized geometry model defined by the OpenGIS® Simple Features Specification for SQL.

These spatial storage choices are discussed more fully in this book.

Appendix C, 'ArcSDE compressed binary', describes the ArcSDE compressed binary for both LONG RAW and BLOB.

Appendix D, 'Oracle Spatial Geometry Type', and Appendix E, 'Oracle normalized geometry schema', describe the Oracle Spatial storage formats supported by ArcSDE.

Creating spatial data in an Oracle database

ArcCatalog and ArcToolbox are graphical user interfaces (GUIs) specifically designed to simplify the creation and management of a spatial database. These applications provided the easiest method for creating spatial data in an Oracle database. With these tools you can convert existing ESRI coverages and shapefile format into ArcSDE feature classes. You can

also import an existing ArcSDE export file containing the data of a business table, feature class, or raster column.

Multiversioned ArcSDE data can be edited directly with either the ArcCatalog or ArcMap™ GUI.

An alternative approach to creating spatial data in an Oracle database is to use the administration tools provided with ArcSDE.

Chapter 4, 'Creating tables, feature classes, and raster columns', describes the methods used to create and maintain spatial data in an Oracle database.

Connecting to Oracle

The ArcSDE for Oracle8*i*™ provides two different ways to connect to the Oracle 8*i* instance. ArcSDE clients can either connect to the ArcSDE service, or they may now connect directly to the Oracle8*i* instance.

Under the traditional ArcSDE three-tiered architecture, the ArcSDE client connects to the ArcSDE service, and the ArcSDE service spawns a dedicated *gsrvr* process that connects to the Oracle instance. The *gsrvr* process brokers the spatial data between the ArcSDE client and the Oracle instance. The ArcSDE service and the *gsrvr* processes typically reside on the Oracle host machine, while ArcSDE clients are typically on remote machines.

Under the new two-tiered architecture, ArcSDE clients can connect directly to an Oracle8*i* instance. Essentially the functionality of the *gsrvr* process has been moved into the ArcSDE client. Typically, the ArcSDE clients run on remote desktop machines, while the Oracle8*i* instance runs on a server class machine.

Note: The direct connection method cannot be used with an Oracle8 instance; it will only work with an Oracle8*i* instance.

It is possible to use a combination of these two architectures to connect to an Oracle8*i* instance. With a mixed configuration, some of the ArcSDE clients may be connected directly to the Oracle8*i* instance, while others connect through an ArcSDE service.

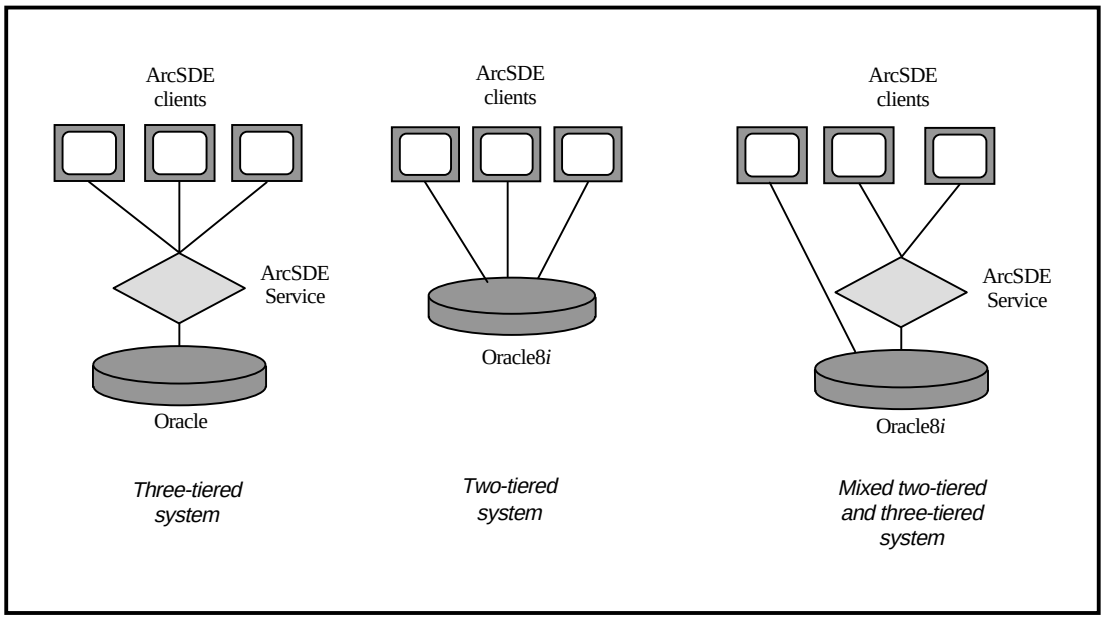


*Figure 1.1 With the traditional three-tiered architecture, the ArcSDE client applications connect to the ArcSDE service, which in turn connects to the Oracle8*i *instance. Within the two-tiered architecture, the ArcSDE client applications connect directly to the Oracle8*i *instance. Under a mixed architecture, some of the ArcSDE client applications connect to the ArcSDE service, while others connect directly to the Oracle8*i *instance.*

National language support

If you intend to support a database that does not use the Oracle default 7-bit United States ASCII English (US7ASCII) character set, you will have to take a few extra steps in creating the Oracle database. You will also need to set the national language system environment of the client applications.

Chapter 6, 'National language support', describes how to configure the Oracle database and set up the application environment.

Backup and recovery

Developing and testing a backup strategy is every bit as important as the effort put into creating it. A good backup strategy protects the database in the event of a media failure.

Chapter 7, ‘Backup and recovery’, lists the ArcSDE files that must be included as part of the regular Oracle backup. In addition, suggested Oracle reference materials are listed for further reading.

CHAPTER 2

Essential Oracle configuring and tuning

The performance of an ArcSDE service depends to some extent on how well you configure and tune Oracle. This chapter provides basic guidelines for tuning an Oracle database for use with an ArcSDE application server. It assumes that you have a basic understanding of the Oracle data structures, such as tablespaces, tables, and indexes, and that you are proficient with Structured Query Language (SQL). We encourage you to refer to Oracle's extensive documentation, in particular *Oracle8 Server Administrator's Guide*, *Oracle8 Concepts Guide*, and *Oracle8 Server Tuning*.

How much time should you spend tuning?

The appreciable difference between a well-tuned database and one that is not depends on how it is used. A database created and used by a single user does not require as much tuning as a database that is in constant use by many users. The reason is quite simple—the more people using a database, the greater the contention for its resources.

By definition, tuning is the process of sharing resources among users by configuring the components of a database to minimize contention and remove bottlenecks. The more people you have accessing your databases, the more effort is required to provide access to a finite resource.

A well-tuned Oracle database makes optimum use of available CPU and memory while minimizing disk input/output (I/O) contention. Database administrators approach this task knowing that each additional hour spent will often return a lesser gain in performance.

Eventually, they reach a point of diminishing returns, where it is impractical to continue tuning; instead, they continue to monitor the server and address performance issues as they arise.

Reducing disk I/O contention

Disk I/O contention provides the most challenging performance bottleneck. Other than purchasing faster disk drives and additional network cards, the solution to this problem lies in minimizing disk I/O and balancing it throughout the file system—reducing the possibility of one process waiting for another to complete its I/O request. This is often referred to as "waiting on I/O".

Creating a database using the Oracle installer

Before installing Oracle and creating the database, decide where to position the software and the files of the Oracle database. The Oracle installer program will request this information.

If you have already installed Oracle and created your database files, you should still read the sections that follow. Although it involves more effort, you can move the Oracle database files after they have been created.

Defining the database's components and their size

The physical components of an ArcSDE service and the underlying Oracle database, as they exist on any given file system, include the ArcSDE and Oracle software and all of the physical files (datafiles, redo log files, and control files) of the Oracle database. Each of the components is described below.

Software

The software includes both Oracle and ArcSDE. The ArcSDE software occupies approximately 32 MB of space. Depending on the components installed, Oracle software can occupy approximately 1 GB of disk space.

Control files

The control files maintain an inventory of an Oracle database's overall physical architecture. If they are all lost or destroyed, you must recover the database from your last full backup. During the creation of the database, create at least three control files on different disk drives. If a disk containing a control file fails, the database can remain up as long as Oracle can access at least one control file, the SYSTEM tablespace's datafile(s), and any two online redo log files. At Oracle8 the control files are about 2 MB initially. At Oracle8*i* control files are more dynamic

and initially require about 4 MB of disk space and can grow to more than 10 MB depending on the activity of your database.

The initialization parameter CONTROL_FILE_RECORD_KEEP_TIME controls the size of the control files. By default, this parameter is set to 7—instructing Oracle to overwrite its reusable section every seven days. For more information on initialization parameters, refer to 'Setting the Oracle initialization parameters'.

Online redo log files

The online redo log files record the changes made to the database. Oracle requires a database to have at least two online redo log files present. Our analysis has found that for ArcGIS™ Desktop applications the Oracle server performs reliably when the Oracle database has at least three online redo log files present.

An Oracle database receiving regular edits (inserts, updates, or deletes) has highly active online redo log files. Writes to the current online redo log file occur according to the following schedule:

- The log buffer becomes one third full.
- Any session issues a commit.
- Every three seconds if the data block buffer contains nonlogged dirty blocks.

It is important to physically separate the online redo log files from other datafiles that also experience high rates of I/O. Whenever possible, create the log files on their own disk drives or with other relatively static files.

Each time a log file fills up, a log file switch occurs and Oracle begins writing to the next log file. A checkpoint must occur after each log file switch. Much happens within the database during a checkpoint, so you will want to lower the frequency of this event. You can and should force checkpoints to occur only after a log switch by setting the initialization parameters LOG_CHECKPOINT_INTERVAL and LOG_CHECKPOINT_TIMEOUT to 0.

The size and number of online redo log files in your database depend on the type of database. This section will describe three basic kinds of databases:

a. A database that is being created.

b. An OnLine Transaction Processing (OLTP) database. A multiversioned ArcSDE database that is constantly edited while it is being queried is an example of an OLTP database.

c. A read-only database, meaning a database that, once loaded, receives changes at posted intervals. An ArcIMS® database is an example of a read-only database.

Establishing a new spatial database

With the vast amount of spatial data available as coverage and shapefile format, many spatial databases are mass populated immediately following their initial creation. For this type of database, create two very large online redo log files and, if possible, place them on a disk drive separate from all other datafiles. In this situation, it is not unreasonable to create log files in excess of 1 GB.

After you have finished loading the data, connect to Oracle as the database administrator (DBA) and issue a checkpoint with 'ALTER SYSTEM CHECKPOINT'. Then create new, smaller log files. The size and number of the log files depend on what kind of database it will become, either OLTP or read-only (see below).

When loading a database you should turn off archiving. You obtain a performance gain by eliminating the periodic copy to the archive log destination following a log switch. It is just as easy to recover the database from your load scripts and source data as it is to read the changes stored in the archive logs. Remember to turn archiving on after the database has been loaded if it is going to be an OLTP database.

OLTP database

For these types of databases, the redo log files should be large enough to delay the checkpoint as much as possible.

If you are archiving the redo logs, create three to 10 redo log files that are 50 MB each and, if possible, place them on disk drives that experience very low I/O. The archive log file destination should also be placed on a separate and protected disk drive.

If you are not going to archive your log files, create three redo log files that are 250 MB each and place them on separate disk drives. In this case if you experience a disk failure on a disk storing one of your Oracle data files, you may not be able to recover the changes made since the last backup. It is recommended that you turn archiving on following the initial creation of the database.

Read-only databases

Some ArcSDE databases become relatively static following their creation. Such databases receive posted intervals of changes over their lifetime. For this type of database, create three 50 MB online redo log files. Since they're used infrequently, positioning is not as critical as for the other two types of database just described.

Monitoring the log files

For all three types of databases, connect as the SYSTEM user and issue the following query to determine if your online redo log files are large enough and if the checkpoint frequency is occurring at a desirable interval:

```
SELECT TO_CHAR(FIRST_TIME,'dd-mon-yy hh24:mi:ss') FROM V$LOGHIST;
```

This is an example of the output:

```
TO_CHAR(FIRST_TIME)
-----------------
04-nov-99 13:15:14
04-nov-99 13:21:04
04-nov-99 13:27:04
04-nov-99 13:32:36
```

The example output shows the log switches are occurring at intervals greater than five minutes, the interval at which Oracle issues the checkpoints. If the interval was less than five minutes, the DBA should consider increasing the size of the online redo log files.

Modifying the online redo log files

To change the size of the log files, you must actually create new log files of the correct size, make one of the new ones active, and drop the old log files. Remember, Oracle requires that you always have at least two log files active.

Note: ESRI recommends that you always create at least three online redo log file groups.

Follow this procedure using the SQL statements listed below.

1. Add the log files with their new size.

```
ALTER DATABASE ADD LOGFILE '<path to log file>' SIZE <size>;
```

2. Determine which of the existing log files is current.

```
SELECT GROUP#,STATUS FROM V$LOG;

GROUP#    STATUS
--------- ----------------
        1 INACTIVE
        2 CURRENT
        3 INACTIVE
```

3. Issue the correct number of manual log switches required to make a new log file current.

```
ALTER SYSTEM SWITCH LOGFILE;
```

4. Remove the old log files, identifying them by their group numbers. You can get a log file's group number by querying the V$LOG table (see step 2).

```
ALTER DATABASE DROP LOGFILE GROUP <group number>;
```

Tablespace datafiles

The tablespace represents Oracle's logical storage container. Each tablespace has assigned to it one or more physical datafiles.

System tablespace

The system tablespace stores Oracle's data dictionary. Each time Oracle parses a SQL statement, it checks metadata concerning data objects referenced by the statement from the data dictionary. Among other things, Oracle ensures the data objects actually exist and the user has the proper privileges.

Place the SYSTEM tablespace on a disk of moderate activity. The default size of the SYSTEM tablespace for Oracle8™ is 40 MB. At Oracle8*i* the SYSTEM tablespace has increased in size to 175 MB.

Rollback tablespaces

The rollback tablespaces store rollback segments, which maintain the undo image needed to roll back aborted transactions. Rollback segments also provide read consistency for queries started prior to a transaction.

Determine the storage parameters of the rollback tablespace and the rollback segments by the type of transactions using them. ArcSDE has three basic categories of transactions.

Loading transactions—The initial loading of data into an ArcSDE database generally entails converting an existing storage format such as an ArcSDE coverage, shapefile, sde export file, or file format provided by a data vendor into an ArcSDE feature class.

To maximize throughput of the load process, ArcSDE provides a commit interval, allowing you to batch inserts. The commit interval also serves to regulate transaction size. The commit interval defaults to 5,000 features and is set with the ArcSDE giomgr.defs AUTOCOMMIT parameter. Refer to *Managing ArcSDE services* for more information on the AUTOCOMMIT parameter. When loading data this interval uses approximately 2 MB of rollback segment space. Therefore, we recommend setting the extent size of the rollback segment to 2 MB when you are loading data into your database. Create a 50 MB rollback tablespace and assign two rollback segments to that tablespace.

If more than two processes are used to load data, create an additional rollback tablespace on a separate disk drive and create two rollback segments on it. The addition of the rollback tablespace reduces contention for the rollback segment header.

```
create tablespace rbs '<path to datafile>' size 50M extent management local
uniform size 2M;
```

```
create rollback segment ro1 tablespace rbs storage (minextents 10);

create rollback segment ro2 tablespace rbs storage (minextents 10);
```

Version edit transactions—The data maintenance transactions of the ArcGIS system tend to be smaller than loading transactions. We recommend that the extent size of the rollback segments assigned to these transactions be approximately 256 KB.

Create a 50 MB rollback tablespace and assign four rollback segments to that tablespace. Each rollback segment can optimally support the concurrent transactions of six users, so this configuration will support 24 concurrent users.

```
create tablespace rbs1 '<path to datafile>' size 50M extent management local
uniform size 256K;

create rollback segment r01 tablespace rbs1 storage (minextents 20);

create rollback segment r02 tablespace rbs1 storage (minextents 20);

create rollback segment r03 tablespace rbs1 storage (minextents 20);

create rollback segment r04 tablespace rbs1 storage (minextents 20);
```

You may need to create additional rollback segment tablespaces depending on the number of concurrent transactions you expect the database to support. Each transaction is assigned to a rollback segment. A rollback segment may be assigned more than one transaction at a time. Oracle evenly distributes transactions among the available rollback segments.

After the database has been started and is in use for a period of time, query the V$ROLLSTAT table to determine if the transaction waits are greater than 4 percent of the transaction gets.

```
SQL> select ((sum(waits) / sum(gets)) * 100 )
```

If the result of this query is larger than 4 percent, you should create additional rollback tablespaces on another disk drive and add more rollback segments to them.

Version compress transactions—Periodically, the ArcSDE administrator is required to compress the states of a multiversioned database to reduce the number of records held by the delta tables. To guarantee the consistency of the database, the transactions of the compress operation are very large, requiring an equally large transaction. Therefore, if you are maintaining a multiversioned database you should create a separate rollback tablespace that is at least 300 MB in size and assign one rollback segment to it. Set the name of this rollback segment in the COMPRESS_ROLLBACK_SEGMENT storage parameter of the DEFAULTS dbtune configuration keyword. If this parameter is not set, the next available online rollback segment will be used. If the rollback segment is not large enough, the compress operation will fail since the transaction will be forced to roll back.

The extent size of the version compress rollback segment should be set to 100 MB.

```
create tablespace big_o_rb_tspace '<path to datafile>' size 301M extent
management local uniform size 100M;
```

```
create rollback segment big_o_rbspace tablespace big_o_rb_tspace storage
(minextents 3);
```

The rollback segment optimal parameter

ESRI recommends that you **not** set the rollback segment optimal storage parameter. The optimal parameter causes a rollback segment to shrink whenever it exceeds the optimal threshold. Constantly shrinking the rollback segments will significantly degrade performance. As a rule, if you find that your transactions are rolled back because your rollback segments fill up, you should reduce the size of your transactions or increase the size of the rollback tablespaces rather than set the optimal parameter. Large transactions delay recovery, increase overhead for queries that must access them for read consistency, and increase overhead for other transactions that must allocate additional extents. ArcSDE allows you to limit the size of your transactions by setting the giomgr.defs AUTOCOMMIT parameter.

Temporary tablespace

Oracle applications need temporary tablespace whenever they perform a sort that exceeds the memory allocated to the sort area. The sort area is memory allocated to the user's Program Global Area (PGA) and is controlled by the init.ora parameter SORT_AREA_SIZE. Sorts occur when indexes are created (Oracle:CREATE INDEX statement), statistics are generated (ANALYZE statement), and queries require on-the-fly sorting (SELECT statements that include table joins, ORDER BY clauses, and GROUP BY clauses).

When establishing a new database, the temporary tablespace will need to be large enough to create the indexes. Oracle requires twice as much temporary space to create the indexes as it does to store it. Therefore, determine the size of your largest index.

If you are using the ArcSDE compressed binary format to store your spatial data, the S<n>_IX1 index on the spatial index table is likely to be your largest index. Refer to Appendix A, 'Estimating the size of your tables and indexes', for information on determining the size of your indexes.

If you are storing your spatial data as an Oracle Spatial data type, refer to Appendix A, 'Tuning Tips and Sample SQL Scripts', of the *Oracle Spatial User's Guide and Reference* for more information on sizing temporary tablespace for the construction of the Oracle Spatial data type indexes.

After the data has been loaded and the indexes created, temporary tablespace is used for data sorts. Temporary tablespace is used when sorts exceed the PGA's sort area, which is allocated according to the init.ora SORT_AREA_SIZE parameter.

We have found that with spatial data stored as ArcSDE compressed binary, setting the SORT_AREA_SIZE to a minimum of 512 KB prevents Oracle from writing to the user's

temporary tablespace. Setting the SORT_AREA_SIZE this large will most likely result in very infrequent I/O to the temporary tablespace. The temporary tablespace can be mixed with other data files of higher I/O since there is a very low risk of disk I/O contention.

By default, the Oracle installation process creates the temporary tablespace stored in a datafile with logging turned on. Since this tablespace holds temporary data, for which there is no requirement to maintain an archive, drop the tablespace and re-create it with a tempfile that has logging turned off.

Always create the temporary tablespace with the syntax

```
CREATE TEMPORARY TABLESPACE <name> TEMPFILE '<path to temporary datafile>'
SIZE 300M EXTENT MANAGEMENT LOCAL UNIFORM SIZE 2M;
```

rather than the Oracle default syntax

```
CREATE TABLESPACE <name> DATAFILE '<path to temporary datafile>' SIZE 300M
TEMPORARY DEFAULT STORAGE (INITIAL 128K NEXT 128K MINEXTENTS 1 MAXEXTENTS 121
PCTINCREASE 0);
```

If you use the latter syntax, the temporary segments are logged and must be recovered in the event of a media failure. The former (and preferred syntax) is also created with locally managed extents, which Oracle allocates more efficiently.

Always use an extent size that is four times larger than your SORT_AREA_SIZE. Doing so reduces the allocation of temporary extents.

ArcSDE system tablespaces

The ArcSDE system tablespaces store the ArcSDE and geodatabase system tables and indexes created by the ArcSDE sdesetupora8* command. The number and placement of the tablespaces depend on what you intend to use the ArcSDE database for.

The placement of these tables and their indexes is controlled by the storage parameters of the dbtune DATA_DICTIONARY configuration keyword. The DATA_DICTIONARY keyword is used exclusively for the creation of the ArcSDE and geodatabase system tables.

Multiversioned databases that support ArcGIS OLTP applications have a very active state-tree. The state-tree maintains the states or the change history of all editing operations that have occurred on tables and feature classes registered as multiversioned. Four ArcSDE system tables—STATES, STATE_LINEAGES, MVTABLES_MODIFIED, and VERSIONS—maintain the transaction information of the versioned database's state-tree. In this type of environment these four tables and their indexes have their own DATA_DICTIONARY configuration keyword storage parameters.

In an active multiversioned database, the STATES_LINEAGE table can easily grow to between one and two million records occupying between 26 and 52 MB of tablespace. The

STATES table is much smaller, storing between 5,000 to 10,000 records occupying between 2 to 4 MB of tablespace. The MVTABLES_MODIFIED table typically has between 50,000 and 100,000 records occupying between 1 to 2 MB of tablespace. The VERSIONS table is usually quite small with less than 100 rows occupying about 64 KB.

For most applications you can probably create a tablespace for the ArcSDE system tables and one for their indexes on different disk drives and set the DATA_DICTIONARY parameters accordingly. For highly active editing ArcGIS applications, the STATES, STATES_LINEAGE, and MVTABLES_MODIFIED tables and their indexes need to be created in separate tablespaces and positioned across the file system to minimize disk I/O contention.

If you are not using a multiversioned database, the aforementioned tables are dormant, in which case the tables can be stored with the other ArcSDE system tables and indexes.

The remainder of the ArcSDE and geodatabase system tables store information relating to schema changes. They are relatively small and have a low frequency of I/O. They should be grouped together in two separate tablespaces—one for tables and one for indexes—and positioned with other tablespaces of high activity.

To summarize, if you are creating an active multiversioned database, create a 70 MB tablespace to store ArcSDE tables. On a separate disk drive create a 30 MB tablespace for the tables indexes.

If you are not going to use a multiversioned database, reduce the extent sizes of the STATE_LINEAGES, STATES, and MVTABLES_MODIFIED tables and their indexes to 40 KB. Create two 5 MB tablespaces on separate disk drives—one for the tables and one for the indexes.

For more information about the DATA_DICTIONARY configuration keyword, see Chapter 3, ‘Configuring DBTUNE storage parameters’.

Business table and index tablespaces

The Oracle installation creates the USER tablespace as the default user tablespace. There is no requirement by Oracle that you use the USER tablespace, and you may drop it if you wish. If you are building a sizable, permanent spatial database, create tablespaces with names reflecting the data they will store.

The B_STORAGE DBTUNE storage parameter holds business table storage parameters.

The 15 MB INDX tablespace created by the Oracle installation process can be used to store indexes. However, for large spatial databases you will need to create index tablespaces whose

name and size reflect the indexes they store. You may drop the Oracle-generated INDX tablespace if you do not intend to use it.

The B_INDEX_USER DBTUNE storage parameter holds the storage parameters of the business table indexes that you create.

Arranging the database components

Minimizing disk I/O contention is achieved by balancing disk I/O across the file system—positioning frequently accessed "hot" files with infrequently accessed "cold" files. Estimate the size of all the database components and determine their relative rates of access. Position the components given the amount of disk space available and the size and number of disk drives. Diagramming the disk drives and labeling them with the components help keep track of the location of each component. Have the diagram handy when you create the Oracle database.

Establish a maximum datafile size

Choose the maximum size of a datafile. It is a good policy to set a maximum size limit for your datafiles because doing so facilitates interchanging them. After the database has been in use for some time and a "normal" pattern of usage has been established, heavily accessed datafiles sharing the same disk drive need to be separated. They can only be interchanged with medium or low accessed datafiles of a similar size (unless you have a lot of free space on your disk drives).

A common maximum size was 512 MB but, with the advent of more advanced backup technology, larger sizes are being adopted. Some operating systems have a maximum file size of 2 GB, so check your operating system documentation for further details.

Separate tables from their indexes

Each time Oracle accesses the index to locate a row, it must then access the table to fetch the referenced row. The disk head must travel between the index and the table if they are stored on the same disk.

Whenever possible, never store indexes and tables in the same tablespace. Always separate the datafiles of a table from the datafiles of its indexes.

Doing so eliminates disk head travel that occurs when the data blocks of the table and its indexes are on the same disk drive.

Determine the size of the tables and indexes

To determine the sizes of tables and indexes stored in an ArcSDE database, refer to the formulas listed in Appendix A, 'Estimating the size of your tables and indexes'.

Establish the threshold data object size

As a rule, small data objects, be they tables or indexes, are stored together in the same tablespace, while larger data objects are stored by themselves in their own tablespace. Decide how large a data object must be before it requires its own tablespace. Generally, the threshold data object size corresponds in part to the maximum datafile size. Data objects capable of filling the maximum size datafile should be stored in their own tablespace. Data objects that approach this limit should also be considered. Since each new tablespace requires its own datafile, you should strive to keep the number of tablespaces to a minimum to reduce the number of datafile headers that must be updated during a database checkpoint.

Separate the tables and indexes into those that require their own tablespaces and those that will be grouped together. Never store tables and their indexes together in the same tablespace.

Store small tables and indexes by access

Base the decision of which small tables to store together in the same tablespace on expected access. Store tables of high access in one tablespace and tables of low access in another. Doing so allows you to position the datafiles of the high access tablespaces with low access datafiles. This same rule applies to indexes. They, too, should be divided by access.

Create tablespaces containing a single table or index according to the size of the table or index they contain. A tablespace may be large enough that it requires several datafiles. Therefore, if the maximum datafile size allowed is 2 GB and a tablespace must store a table or index that will grow to 7 GB, the tablespace is created with a 2 GB datafile. Then the tablespace is altered three times to add two 2 GB datafiles and one 1 GB datafile.

Example:

```
create tablespace roads datafile '/gis1/oradata/roads1.dbf' size 2048M extent
management local uniform size 1024M;

alter tablespace roads add datafile '/gis2/oradata/roads2.dbf' size 2048M;

alter tablespace roads add datafile '/gis3/oradata/roads3.dbf' size 2048M;

alter tablespace roads add datafile '/gis4/oradata/roads4.dbf' size 1024M;
```

Sum the sizes of the objects that you will store together to determine the size of their tablespaces. If you expect the table or index to grow in the future, be sure to allow for that as well.

Number of extents

Keep the number of tablespace extents for tables and indexes less than 1,000 to minimize overhead associated with each additional extent. In fact, creating a table or index with MAXEXTENTS set to UNLIMITED can render a database unusable if the table or index acquires more extents than the database can manage (~10,000). As a general rule of thumb, you should try to keep the number of extents to a minimum; however, you do not need to fanatically maintain a single extent for each object.

Positioning the files

Once you have estimated the size of the datafiles, determine where to position them on the file system. This section provides a list of guidelines that you may not be able to follow in its entirety, given the number and size of your disk drives. The guidelines have been listed in order of importance—from the most to the least.

Store the online redo log files on their own disk drive. In a database that is frequently edited, the online redo log files are the most active in terms of I/O. If you cannot position them on their own disk drive, store them with other files that experience relatively low rates of I/O.

After the indexes have been constructed, ArcSDE does not use temporary tablespace if SORT_AREA_SIZE has been set to the recommended 512 KB. Therefore, the temporary tablespace can be positioned with other datafiles of high activity, provided your other applications do not use it.

Keep the rollback segment datafiles separate from the redo log files. The rollback segments are frequently accessed when a database is edited. Try to separate these datafiles from other highly active data. Doing so improves the rate at which Oracle is able to process transactions.

Position the system tablespace datafile with other data files that experience high I/O activity. The access to these data dictionary tables is moderately low because their data is cached in the shared pool and the buffer cache.

Position your business table and index datafiles according to their expected I/O. If you expect a particular datafile to experience a high degree of I/O, try to position it alone on its own disk drive or with other datafiles of low to moderate activity.

The spatial index table of the ArcSDE compressed binary storage format is written to whenever new features are added to a feature, but the table is never read. The spatial index table's S<n>_IX1 index is a coverage index; therefore, Oracle reads the values from the index and never accesses the table. Since the table is never read from, the I/O is very low, so the positioning of this table is not very important.

Repositioning datafiles

After the database has been in use for a while, you can examine the reads and writes to the datafiles with the following query:

```
select vd.name, vs.phyrds, vs.phywrts
from v$datafile vd, v$filestat vs
where vs.file# = vd.file#;
```

If you find that some disk drives are receiving a higher percentage of the I/O than others, you can balance the I/O by repositioning the datafiles. The datafiles are repositioned by shutting down the Oracle instance, performing a full backup, and moving the files using operating system commands to copy them from one disk to another. The instance is started, and the database is mounted but not opened.

```
SQL> startup mount
```

Before the database can be opened, you must update the control files with the new locations of the datafiles using the *alter database* statement.

```
SQL> alter database rename datafile 'old name' to 'new name';
```

Once all of the new locations have been entered, you may open the database.

```
SQL> alter database open;
```

Creating the database

The database should be created after the location of the database files has been determined. At the very least you should assign the locations for the rollback segment, temporary and system tablespace data files, as well as control files and online redo log files.

Once you have mapped out the way you want the files to be arranged on disk, create the database. First install the Oracle and ArcSDE software.

Refer to the Oracle installation guide for instructions on installing the Oracle software and the ArcSDE installation guide for instructions on installing the ArcSDE software.

The Oracle installation provides you with the opportunity to create the Oracle database following the installation of the software. If you elect to do so, select the custom database option so that you can position the Oracle files on the disks according to your layout.

At Oracle8, the installation process automatically generates and executes scripts that can be modified and executed again later if you wish to change some part of the Oracle database such as the temporary tablespace. However, at Oracle8*i* the scripts are not generated automatically. Instead, you are given the choice of generating the scripts and creating the database later or creating the database immediately, in which case the scripts are never created. If you want the scripts available as a record of how the database was created, then you will have to generate the scripts and run them following the completion of the installation process.

The control files, online redo log files, and Oracle database tablespaces (system, rollback, and temporary) are created during the Oracle installation process. The USER and INDX tablespaces created by the Oracle installation process may drop the USER and INDX tablespaces if you don't want to use them.

Setting the data block size

During the installation process you will be prompted to enter the data block size. Data blocks are the Oracle atomic unit of data transfer. After a database has been created, you cannot change the size of the data blocks. So it is important that it be set correctly at this time.

The minimum recommended data block size for ArcSDE applications is 8 KB; however, 16 KB have been found to deliver a higher overall level of performance for databases storing mostly linear or area features.

If you are not going to let the Oracle installer create the database, you can set the data block size with the DB_BLOCK_SIZE initialization parameter. Set the DB_BLOCK_SIZE to at least 8 KB.

```
DB_BLOCK_SIZE = 8192
```

For more information on the init.ora file, refer to 'Setting the Oracle initialization parameters'.

Creating the business and index tablespaces

Once you have completed the installation of Oracle, create the tablespaces that store your tables and indexes. You may want to write a SQL script and execute it as the SYSTEM user within SQL*Plus®. Alternatively, you could use the graphical user interface of the Oracle Enterprise Manager's Storage Manager to perform this task.

Creating the Oracle sde user space

During the installation of ArcSDE, you will create the Oracle sde user and the sde user's default tablespace (usually called sde) to store the ArcSDE and geodatabase system tables.

Update the storage parameters of the DATA_DICTIONARY configuration keyword in the dbtune.sde file located in the SDEHOME etc directory on UNIX® systems. On Windows NT® systems the install shield will prompt you for the location of this file (see the *ArcSDE for Oracle Installation Guide* for more information).

Set the extent sizes and name of the tablespaces the ArcSDE and geodatabase system tables will be stored in. The ArcSDE and geodatabase system tables are created by the ArcSDE sdesetupora8 or sdesetupora8i administration command.

ArcSDE for Oracle8 maintains its lock information in memory, while ArcSDE for Oracle8*i* stores locks in the system tables LAYER_LOCKS , OBJECT_LOCKS, STATES_LOCKS, and TABLES_LOCKS.

ArcSDE for Oracle8*i* uses the stored procedures of the DBMS_PIPE and DBMS_LOCKS Oracle built-in packages. Stored procedures of the DBMS_PIPE package store and transmit ArcSDE rowids. Stored procedures of the DBMS_LOCK package add a row to the PROCESS_INFORMATION table for each connected session. Your Oracle DBA must connect to the Oracle instance as the SYS user and grant execute on these packages to PUBLIC.

```
SQL> connect sys/<password>
SQL> grant execute on dbms_pipe to public;
SQL> grant execute on dbms_lock to public;
```

Note: Previous versions of ArcSDE maintained the locks in memory. Therefore, to upgrade the ArcSDE database from a previous version to ArcSDE for Oracle8*i*, the sde user must be granted privileges to create the sequences and triggers in the schemas of users who own tables listed in the TABLE_REGISTRY, LAYERS, or RASTER_COLUMNS tables. Following the completion of a successful upgrade, the privileges can be revoked, and normal privileges assigned for the install operation can be granted.

Since ArcSDE for Oracle8 maintains its locks in memory, additional privileges are not required to upgrade a previous version of ArcSDE.

Grant the following list of privileges to the sde user if you are installing or upgrading a new ArcSDE for Oracle8.

grant create session to sde;
grant create table to sde;
grant create procedure to sde;
grant create sequence to sde;
grant create trigger to sde;
grant unlimited tablespace to sde;

If you are creating a fresh install of ArcSDE for Oracle8*i*, grant the following list of privileges to the sde user.

grant select any table to sde;
grant create session to sde;
grant create table to sde;
grant create procedure to sde;
grant create sequence to sde;

```
grant create trigger to sde;
grant unlimited tablespace to sde;
```

To upgrade a previous version of an ArcSDE database to ArcSDE for Oracle8*i*, grant the following list of privileges to complete the upgrade process. Following the successful completion of the upgrade process, you can revoke these privileges and grant the previous list of privileges to the sde user.

```
grant select any table to sde;
grant create any sequence to sde;
grant create any procedure to sde;
grant execute any procedure to sde;
grant drop any procedure to sde;
grant select any sequence to sde;
grant create any view to sde;
grant drop any view to sde;
grant create any trigger to sde;
grant drop any sequence to sde;
```

Note: For ArcSDE for Oracle8*i* the sde user must always be granted "select any table" privileges.

Creating Oracle users

All ArcSDE users must be able to create the SDE_LOGFILES and SDE_LOGFILE_DATA tables and the associated indexes, triggers, and sequences when they connect for the first time. ArcSDE returns an SE_NO_ACCESS (-15) error message if the user does not have the required privileges to create the tables.

The SDE_LOGFILES and SDE_LOGFILE_DATA tables and associated indexes are created according to the parameters sde logfile storage parameters specified in the DBTUNE table. For more information about these storage parameters, see Chapter 3, ‘Configuring DBTUNE storage parameters’.

The following list of privileges is required for all ArcSDE users connecting for the first time.

```
grant create session to sde;
grant create table to sde;
grant create procedure to sde;
grant create sequence to sde;
grant create trigger to sde;
grant unlimited tablespace to sde;
```

Once the user has successfully connected for the first time, privileges can be revoked since the SDE_LOGFILES and SDE_LOGFILE_DATA tables now exist. The table below lists the types of users DBAs typically create and the privileges assigned to them.

Title	Description	Privileges
Viewer	The viewer is allowed to connect to an ArcSDE database. Other users grant select privileges on their tables and feature classes to the viewer or to the public role. The DBA can create a role that can be granted select privileges on data objects owned by other users. The role can be granted to the viewer.	create session select on other user's data objects
Editor	The editor is allowed to connect to an ArcSDE database. Other users grant select and insert, update, or delete on data objects they own to editor. The DBA may create a role that can be granted select, insert, update, and delete privileges on data objects owned by other users. The role can be granted to the editor.	create session select, insert, update, or delete on other user's data objects
Creator	The creator is allowed to connect to an ArcSDE database and create data objects. The creator may grant privileges on their objects to other users or roles. Other users can grant select and insert, update, or delete on data objects they own to creator. The DBA may create a role that can be granted select, insert, update, and delete privileges on data objects owned by other users. The role can be granted to the creator.	create session create table create procedure create sequence create trigger unlimited tablespace select, insert, update, or delete on other user's objects

ArcSDE returns an SE_NO_ACCESS (-15) error message if the user does not have the required privileges to create the tables in their default tablespace.

When you create an Oracle user, assign your users a default tablespace and a temporary tablespace.

Note: If you do not specifically assign a temporary or default tablespace to a user, Oracle uses the SYSTEM tablespace by default. Since the SYSTEM tablespace holds the Oracle system tables, a vital part of the database, it is important not to use it for anything else. Using the SYSTEM tablespace to store temporary segments, fragments the tablespace and eventually degrades performance.

This is the basic Oracle user creation syntax:

```
CREATE USER <USERNAME>
IDENTIFIED BY <PASSWORD>
DEFAULT TABLESPACE <DEFAULT TABLESPACE>
TEMPORARY TABLESPACE <TEMPORARY TABLESPACE>
QUOTA UNLIMITED ON <DEFAULT TABLESPACE>
QUOTA UNLIMITED ON <TEMPORARY TABLESPACE>;
```

These are the basic privileges that must be granted to all ArcSDE Oracle users until they connect for the first time.

```
GRANT CREATE SESSION TO <USERNAME>;
GRANT CREATE TABLE TO <USERNAME>;
GRANT CREATE PROCEDURE TO <USERNAME>;
GRANT CREATE SEQUENCE TO <USERNAME>;
GRANT CREATE TRIGGER TO <USERNAME>;
GRANT UNLIMITED TABLESPACE TO <USERNAME>;
```

Connect as the user to create the sde_logfiles and sde_logfile_data tables. To create a user of type viewer or editor, revoke the following list of privileges.

```
REVOKE CREATE TABLE FROM <USERNAME>;
REVOKE CREATE PROCEDURE FROM <USERNAME>;
REVOKE CREATE SEQUENCE FROM <USERNAME>;
REVOKE CREATE TRIGGER FROM <USERNAME>;
REVOKE UNLIMITED TABLESPACE FROM <USERNAME>;
```

For the viewer, grant select privileges on the specific data objects you wish the user to have permission to display or query. If you have a large community of viewers, create a role that can be granted select access on the data objects.

To grant or revoke select access to complex data objects, such as feature datasets or standalone feature classes, you should use ArcCatalog. Use the sdelayer administration command's grant or revoke operation to grant or revoke select access if you have not installed ArcGIS Desktop. The access can be granted directly to a user or to a role.

For the editor, grant select privileges and editing (insert, update, or delete) privileges on the specific data objects you wish the users to have permissions to query and edit. If you have a lot of editors, save time by creating a role and granting the select and edit privileges to it. Then grant the role to each editor.

In this example the DBA creates the user SAM with the password TREE_TOP. The default tablespace in which SAM will create his tables and indexes that are not assigned a tablespace is GIS1.

Note: The ArcSDE administrator creates DBTUNE configuration keywords that hold the tablespace and other storage parameters Oracle assigns to tables and indexes when it creates them. For more information about DBTUNE configuration keywords and how to create and use them, see Chapter 3, 'Configuring DBTUNE storage parameters'.

The temporary tablespace used when SAM creates indexes and performs sorts is TEMP1.

```
SQL> CREATE USER SAM
2    IDENTIFIED BY TREE_TOP
3    DEFAULT TABLESPACE GIS1
4    TEMPORARY TABLESPACE TEMP1
5    QUOTA UNLIMITED ON GIS1
6    QUOTA UNLIMITED ON TEMP1;
```

To create SAM's logfile tables (sde_logfiles and sde_logfile_data) and their associated sequence generator and trigger, the DBA grants the user SAM the following privileges.

```
SQL> GRANT CREATE SESSION TO SAM;
SQL> GRANT CREATE TABLE TO SAM;
SQL> GRANT CREATE PROCEDURE TO SAM;
SQL> GRANT CREATE SEQUENCE TO SAM;
SQL> GRANT CREATE TRIGGER TO SAM;
SQL> GRANT UNLIMITED TABLESPACE TO SAM;
```

The DBA connects to the ArcSDE database as SAM to create the logfile tables in SAM's schema. The sdelayer administration command describe operation provides a simple way to do this.

```
$ sdelayer -o describe -u sam -p tree_top
```

Revoke all but the create session privileges since SAM is an editor and is not allowed to create schema.

```
SQL> REVOKE CREATE TABLE FROM SAM;
SQL> REVOKE CREATE PROCEDURE FROM SAM;
SQL> REVOKE CREATE SEQUENCE FROM SAM;
SQL> REVOKE CREATE TRIGGER FROM SAM;
SQL> REVOKE UNLIMITED TABLESPACE FROM SAM;
```

Create sde_viewer and sde_editor roles. The DBA has determined that all users that own schema should grant select privileges on their data objects to the sde_viewer role and that they should grant insert, update, and delete to the sde_editor role.

```
SQL> CREATE ROLE SDE_VIEWER;
SQL> CREATE ROLE SDE_EDITOR;
```

The DBA grants both the sde_viewer and sde_editor roles to SAM.

```
SQL> GRANT SDE_VIEWER TO SAM;
SQL> GRANT SDE_EDITOR TO SAM;
```

Betty, a creator, uses the grant operation of the sdelayer command to grant select access on her roads feature class to the sde_viewers role. All viewers granted the sde_viewers role will have select access to Betty's roads feature class.

```
$ sdelayer -o grant -l roads,feature -A select -U sde_viewers -u betty -p cdn
```

Betty also grants insert, update, and delete access to the sde_editors role. Now editors granted the sde_editors role, such as SAM, will be make changes to Betty's roads feature class.

```
$ sdelayer -o grant -l roads,feature -A insert -U sde_editors -u betty -p cdn
$ sdelayer -o grant -l roads,feature -A update -U sde_editors -u betty -p cdn
$ sdelayer -o grant -l roads,feature -A delete -U sde_editors -u betty -p cdn
```

Updating the DBTUNE file

After you have created the tablespaces for your tables and indexes, update the DBTUNE file. DBTUNE files are always located under the etc directory of SDEHOME. The dbtune.sde file is the default DBTUNE file that the ArcSDE setup program uses to populate the DBTUNE table.

Create the keywords in the dbtune.sde file that will contain the Oracle configuration parameters of the feature classes and tables that you intend to create with the ArcGIS programs ArcCatalog and ArcToolbox or the many ArcSDE administration tools.

For a detailed discussion on the maintenance of the DBTUNE table, refer to Chapter 3, 'Configuring DBTUNE storage parameters'. This chapter describes DBTUNE parameters that can be applied to each of the spatial storage methods supported by ArcSDE for Oracle. The supported spatial storage formats are described in appendixes C, D, and E.

Creating tables, feature classes, and raster column

ArcInfo and ArcSDE offer several ways to create and maintain the tables, indexes, and feature classes of an ArcSDE database. Chapter 4, 'Managing tables, feature classes, and raster columns', describes in detail the possible methods for creating tables and feature classes using either ArcInfo or ArcSDE tools.

Setting the Oracle initialization parameters

Whenever you start an Oracle instance, it reads its initialization parameters from the init.ora file. These parameters define the characteristics of the instance. This section describes some of the parameters that control allocation of shared memory. For a detailed discussion of the Oracle initialization parameters, refer to *Oracle8 Server Tuning*.

The init.ora file is located under the ORACLE_BASE/admin/<ORACLE_SID>/pfile directory or folder. Init.ora is a common name given to the initialization file of an Oracle database instance. For any given instance, the file is actually called init<oracle SID>.ora. For example, if the Oracle SID is *gis*, the init.ora file for this instance would be called initgis.ora.

Managing Oracle's memory

Care must be taken when setting the initialization parameters that affect memory. Setting these parameters beyond the limits imposed by the physical memory resource of the host machine significantly degrades performance. This section provides a few general rules regarding configuration of System Global Area (SGA) as well as memory structures affecting the size of an Oracle user's private area, the PGA. The SGA is a block of shared memory that Oracle allocates and shares with all sessions. For more information about the SGA, refer to the *Oracle8 Concepts Guide*.

SGA must not swap

You should not create an SGA that is larger than two-thirds the size of your server's physical RAM. Your virtual memory must be able to accommodate both the SGA and the requirements of all active processes on the server.

Avoid excessive paging

Using your operating system tools (vmstat on UNIX systems and the task manager on Windows NT), check for excessive paging. A high degree of paging can be the result of an SGA that is too large.

Configure enough virtual memory

As a rule Oracle recommends that your swap space be at least two to four times the size of your physical RAM. The required size of the swap file UNIX or the page file on Windows NT depends on the number of active ArcSDE sessions. For every ArcSDE session, a gsrvr process and a corresponding Oracle process is started. To determine the memory usage of these processes, use the ps -elf command on UNIX systems and the Processes tab of the Windows NT Task Manager. You must deduct the size of the Oracle SGA from the Oracle user processes. The total size of the ArcSDE gsrvr processes, the ArcSDE giomgr processes, Oracle user processes, Oracle background processes, operating system processes, and any other process running on the server must be able to fit into virtual memory.

For ArcSDE client applications that connected directly to an Oracle8*i* instance, the gsrvr process does not exist. Also, if the ArcSDE service is not used because all client applications connect directly to the Oracle8*i* instance, the giomgr process will not be started either. For this reason direct connections have a smaller memory print since the gsrvr process is absent.

Redo log buffer

The redo log buffer is a component of the Oracle SGA that holds uncommitted changes to the database. The log buffer is flushed to the current online redo log file whenever a user issues a

commit and the buffer becomes one third full or every three seconds. The size of the redo log buffer is controlled by the LOG_BUFFER parameter. Because of the rapid rate at which the log buffer is flushed, it does not need to be that large.

Oracle recommends that you set this parameter to 500 KB or 128 KB multiplied by the number of CPUs.

If you have less than 4 CPUs, set this parameter to 512000 (500 KB).

log_buffer = 512000

Otherwise, set log_buffer to 128 KB * the number of CPUs.

Setting the log_buffers to very large values in the hope of processing huge loading transactions may in fact result in a performance reduction. Latch contention between transactions may occur if the log buffer is set too large.

To determine if the redo log buffer is large enough, while the system is active examine the Oracle dynamic table v$sysstat. Compare the values of the *redo log space requests* and the *redo entries.* Oracle recommends that you increase the size of the redo log buffers if the ratio of these values is greater than 1:5,000.

```
select name, value
from v$sysstat
where name in ( 'redo entries' , 'redo log space requests' );
```

Shared pool

The shared pool is another component of the Oracle SGA that holds both the data dictionary cache and the library cache. The data dictionary cache holds information about data objects, free space, and privileges. The library cache holds the most recently parsed SQL statements. Generally, if the shared pool is large enough to satisfy the resource requirements of the library cache, it is already large enough to hold the data dictionary cache. The size of the shared pool is controlled by the SHARED_POOL_SIZE parameter.

Set this parameter to at least 55 MB.

shared_pool_size = 55,000,000

Very active geodatabases supporting volatile utility or parcel editing systems may require the shared_pool_size to be set as high as 200 MB.

Of the three SGA buffers, the shared pool is the most important. If the SGA is already as large as it can be, given the size of your physical memory, reduce the size of the buffer cache to accommodate a larger shared pool.

Buffer cache

The buffer cache is another component of the Oracle SGA that stores the most recently used data blocks. Data blocks are the Oracle atomic unit of data transfer. Oracle reads and writes data blocks to and from the database whenever the user edits or queries it. The size of the buffer cache is controlled by the DB_BLOCK_BUFFERS parameter.

For optimum performance, increase the size of the buffer cache without causing the operating system to page excessively and/or swap the SGA. Oracle recommends that the SGA not be larger than two-thirds of the physical RAM.

To estimate the size of the buffer cache, first determine how much physical RAM your server has. Multiply this number by 0.66 to determine the target size of the SGA. Deduct the SHARED_POOL_SIZE and LOG_BUFFER to return the amount of memory available to the buffer cache. Reduce this number by 10 percent to account for Oracle's internal memory usage. Finally, divide by the database block size to determine the DB_BLOCK_BUFFERS setting. (The recommended minimum data block size for ArcSDE is at least 8 KB; however, we have found overall performance does improve with larger block sizes.)

```
memory available to SGA = physical RAM * 2 / 3

memory available to buffer cache = (memory available to SGA -
                                    (shared_pool_size + log_buffer)) * 0.9

db_block_buffers = memory available to buffer cache / db_block_size
```

Oracle recommends that the buffer cache hit ratio be at least 95 percent. In other words, for every data block request made to the Oracle server, 95 percent of the time the data blocks were in the buffer cache and only 5 percent of the time did they have to be retrieved from disk. Examine the performance of the buffer cache after the system has been in use for some time. Compare the values of the *db block gets*, *consistent gets*, and *physical reads* in the Oracle dynamic view V$SYSSTAT. If the *physical reads* are greater than 5 percent of the sum of the *db block gets*, and the *consistent gets* increase the size of the buffer cache:

```
select name, value
from v$sysstat
where name in ( 'db block gets', 'consistent gets','physical reads');
```

Buffer cache hit ratio = 1 - (physical reads / (db block gets + consistent gets))

You should not increase the buffer cache at the expense of the shared pool.

Sort area

The sort area is a component of each session's PGA and not the SGA.

As the name implies, Oracle uses sort area to perform sorting. Larger sort areas reduce the time required to build an index. As Oracle constructs an index, it writes the index blocks to the sort area. When the sort area becomes full, its contents are transferred to the temporary tablespace. The batch of index data blocks transferred to the temporary tablespace is called a run. The larger the sort area, the lower the frequency Oracle must write runs to temporary disk space.

You must be careful not to make the sort area too large because it is allocated per session to the PGA and not per instance as is the SGA. Also, you should be aware that Oracle allocates sort area for each table referenced within a join. Therefore, it is theoretically possible for Oracle to allocate the maximum sort area for each table referenced in a join. Generally the logic of the query prevents this from happening. However, be aware of the dynamic nature of sort area.

Sort area is controlled by the SORT_AREA_SIZE parameter.

For the construction of the indexes during the creation of the database, set the SORT_AREA_SIZE parameter very large since few sessions are active, and the indexes are created faster if more sort area is available. For 2 GB of RAM, setting the sort area to 200 MB is not unreasonable if you are using one session to create indexes on tables that have millions of rows of data.

Once the database is constructed you should reduce the size of the sort area to account for the increased number of sessions. ArcInfo applications accessing a multiversioned geodatabase generally use little sort area. A sort area of 1 MB will prevent I/O to temporary tablespace for these types of applications.

Set SORT_AREA_SIZE to 1 MB.

```
sort_area_size = 1048576
```

You can determine if SORT_AREA_SIZE is large enough by comparing the value of *sorts (memory)* and *sorts (disk)* of the Oracle dynamic view v$sysstats. If the sorts performed on *disk* are greater than 10 percent of those performed in *memory*, consider increasing the sort area.

```
select name, value
from v$sysstat
where name in ('sorts (memory)', 'sorts (disk)');
```

Prepage the SGA

Set the PRE_PAGE_SGA to true for servers that are running a single Oracle instance. Prepaging the SGA increases the amount of time required to start the Oracle server as well as the amount of time required for users to connect. However, it does reduce the number of page

faults—which occur whenever Oracle must allocate another page to the SGA—while the server is active.

```
pre_page_sga = true
```

Enabling the optional Oracle8*i* startup trigger

ArcSDE for Oracle8*i* includes an optional startup trigger that is run whenever the Oracle8*i* instance is started. The startup trigger cleans up any orphaned session information that remains in the ArcSDE system tables following an instance failure. The startup trigger is optional because ArcSDE invariably cleans up the orphaned metadata during its normal operation. The startup trigger merely offers a guarantee that orphaned metadata will not be present following Oracle8*i* instance startup.

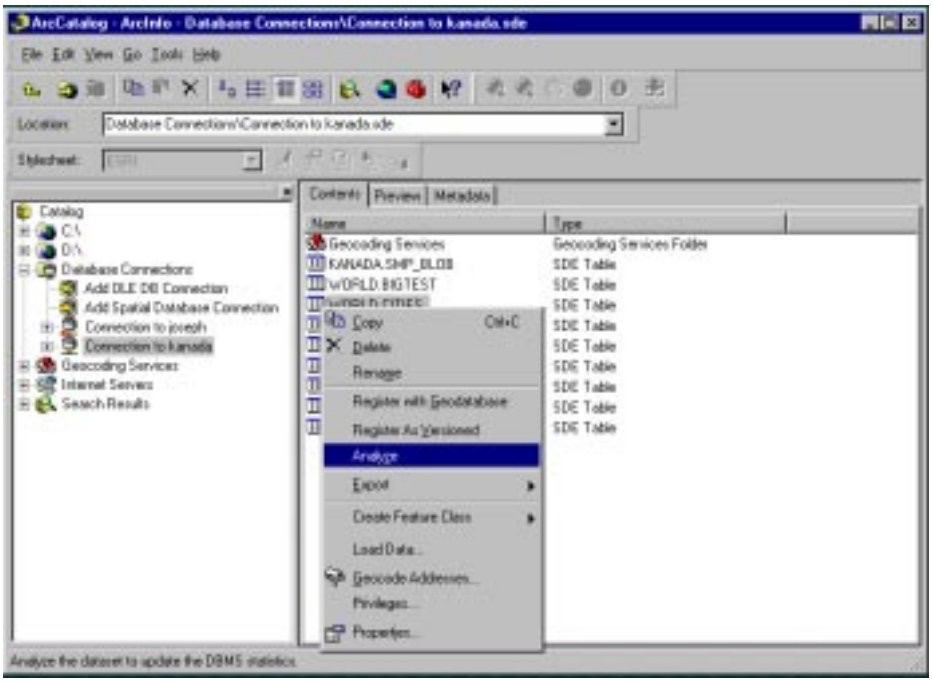
To create the startup trigger run the SQL arcsde_database_startup.sql script as the Oracle8*i* SYS user. The script is located at $SDEHOME/etc/tools/oracle on UNIX systems and %SDEHOME%\etc\tools\oracle on Windows NT.

Updating Oracle statistics

The ArcSDE server has been built to work with either the cost-based optimizer or the rule-based optimizer. As a result you should set the init.ora initialization variable OPTIMIZER_MODE to CHOOSE, allowing the optimizer to choose the cost-based approach if it encounters a hint or if you have computed statistics.

Updating ArcSDE compressed binary statistics

For optimal performance of feature classes created with the ArcSDE compressed binary storage format, keep the statistics up-to-date.



In ArcCatalog, to update the statistics of all of the tables and indexes within a feature dataset, right-click on the feature dataset and click on Analyze. To update the tables and indexes within a feature class, right-click on the feature and click on Analyze.

From the command line use the UPDATE_DBMS_STATS operation of the sdetable administration command to update the statistics for all the tables and indexes of a feature class. It is better to use the UPDATE_DBMS_STATS operation rather than individually analyzing the tables with the Oracle SQL ANALYZE statement because it updates the statistics for all the tables of a feature class that require statistics. To have the UPDATE_DBMS_STATS operation update the statistics for all the required tables, do not specify the -K (schema object) option.

```
sdetable -o update_dbms_stats -t roads -m compute -u av -p mo
```

When the feature class is registered as multiversioned, the ‘adds’ and ‘deletes’ tables are created to hold the business table’s added and deleted records. The version registration process automatically updates the statistics for all the required tables at the time it is registered.

Periodically update the statistics of dynamic tables and indexes to ensure that the Oracle cost-based optimizer continues to choose an optimum execution plan. To save time, you can analyze all of the data objects within a feature dataset in ArcCatalog.

If you decide to update the statistics of all or some of the feature class tables with the Oracle ANALYZE statement, you should never compute statistics on a spatial index table. ArcSDE creates a composite row index, (S<n>_IX1), on the spatial index table. The Oracle cost-based optimizer may ignore the composite index if statistics for this table are present. For more information on the Oracle SQL ANALYZE statement, refer to the *Oracle8 SQL Reference Manual*.

If you do not have enough temporary tablespace to use compute statistics on larger tables, use the -m option to estimate statistics. The tables will be estimated at a sample rate of 33 percent.

```
sdetable -o update_dbms_stats -t roads -m estimate -u av -p mo
```

You should consider increasing the size of your temporary tablespace to compute statistics rather than estimate them as it provides more accurate statistics for the Oracle cost-based optimizer.

The statistics of a table's indexes are automatically computed when the table is analyzed, so there is no need to analyze the indexes separately. However, if you need to do so you can use the UPDATE_DBMS_STATS -n option with the index name.

The example below illustrates how the statistics for the f2_ix1 index of the roads feature table can be updated.

sdetable -o update_dbms_stats -t roads -K f -n F2_IX1 -u av -p mo

For more information on analyzing geodatabase objects from ArcCatalog, refer to *Building a Geodatabase*.

For more information on the sdetable administration command and the UPDATE_DBMS_STATS operation, refer to the *ArcSDE Developer Help*.

Updating Oracle Spatial geometry type statistics

The business table of a feature class created with the Oracle Spatial geometry type storage method keeps the statistics up-to-date. Update the statistics of the business table containing an Oracle Spatial column with Analyze from ArcCatalog or with the sdetable UPDATE_DBMS_STATS operation.

```
sdetable -o update_dbms_stats -t roads -m compute -u av -p mo
```

You may also update the statistics using the Oracle ANALYZE statement. Use the compute statistics option if there is enough temporary tablespace available to permit the operation. Otherwise, use the estimate statistics option with as high a sample rate as possible.

```
SQL> analyze table roads compute statistics;
```

For more information on the Oracle ANALYZE statement, refer to the *Oracle8 SQL Reference Manual*.

Updating Oracle Spatial normalized statistics

The tables of a feature class constructed with the Oracle Spatial normalized storage method do not need to have their statistics updated because ArcSDE does not apply any hints on the SQL statements used to query or edit these tables.

CHAPTER 3

Configuring DBTUNE storage parameters

DBTUNE storage parameters allow you to control how ArcSDE clients create objects within an Oracle database. They determine such things as which tablespace a table or index is created in. The storage parameters define the extent size of the data object they stored as well as other Oracle specific storage attributes. They let you specify one of the four available storage formats to store the geometry of a spatial column.

The DBTUNE table

The DBTUNE storage parameters are maintained in the DBTUNE metadata table. The DBTUNE table along with all other metadata tables is created during the setup phase that follows the installation of the ArcSDE software.

The DBTUNE table has the following definition:

```
Name             Null?     Datatype

keyword          not null  varchar2(32)
parameter_name   not null  varchar2(32)
config_string    null      varchar2(2048)
```

The keyword field stores the configuration keywords. Within each configuration keyword, there are a number of storage parameters, and the names of these are stored in the parameter_name field. Each storage parameter has a configuration string stored in the config_string field.

After creating the DBTUNE table, the setup phase of the ArcSDE 8.1 installation populates the table with the contents of the dbtune.sde file, which it expects to find under the etc directory of the SDEHOME directory.

If the DBTUNE table already exists, the ArcSDE setup phase will not alter its contents, should you decide to run it again.

Editing the DBTUNE table

Although you are free to edit the contents of the DBTUNE table using a SQL interface such as SQL*Plus, the sdedbtune administration tool has been provided to enable you to export the contents of the table to a file. The file can then be edited with a UNIX file-based editor, such as "vi", or a Windows NT file-based editor such as "notepad". After updating the file, you can repopulate the DBTUNE table using the import operation of the sdedbtune command.

In the following example, the DBTUNE table is exported to the dbtune.out file, and the file is edited with the UNIX "vi" file-based editor.

```
$ sdedbtune -o export -f dbtune.out -u sde -p fredericton


ArcSDE   8.1               Wed Oct  4 22:32:44 PDT 2000
Attribute        Administration Utility
----------------------------------------------------

        Successfully exported to file SDEHOME\etc\dbtune.out

$ vi dbtune.out

$ sdedbtune -o import -f dbtune.out -u sde -p fredericton -N


ArcSDE   8.1               Wed Oct  4 22:32:44 PDT 2000
Attribute        Administration Utility
----------------------------------------------------

        Successfully imported from file SDEHOME\etc\dbtune.out
```

The sdedbtune administration tool always exports the file in the etc directory of the ArcSDE home directory. You cannot relocate the file to another directory with a qualifying pathname. By not allowing the relocation of the file, the sdedbtune command ensures they remain under the ownership of the ArcSDE administrator.

Arranging storage parameters by keyword

Storage parameters of the DBTUNE table are grouped by keyword. When the contents of the DBTUNE table are exported to a file, the keywords are prefixed by two pound signs “##”. The ‘END’ clause terminates each keyword.

Keywords define the storage configuration of simple objects, such as tables and indexes, and complex objects such as feature classes, network classes, and raster columns. ESRI client

applications and some ArcSDE administration tools assign DBTUNE configuration keywords to these objects. The pound signs '##' are not included when the configuration keywords are assigned.

DEFAULTS keyword

Each DBTUNE table has a fully populated DEFAULTS configuration keyword. The DEFAULTS configuration keyword can be selected whenever you create a table, index, feature class, or raster column. If you do not select a keyword for one of these objects, the DEFAULTS configuration keyword is used. If you do not include a storage parameter in a configuration keyword that you have defined, ArcSDE substitutes the storage parameter from the DEFAULTS configuration keyword.

The DEFAULTS configuration keyword relieves you of the need to define all the storage parameters for each of your configuration keywords. The storage parameters of the DEFAULTS configuration keyword should be populated with values that represent the average storage configuration of your data.

During installation, if the ArcSDE software detects a missing DEFAULTS configuration keyword storage parameter in the dbtune.sde file, it automatically adds the storage parameter. If you import a DBTUNE file with the sdedbtune command, the command automatically adds default storage parameters that are missing. ArcSDE will detect the presence of the following list of storage parameters and insert the storage parameter and the default configuration string.

```
##DEFAULTS

ATTRIBUTE_BINARY        "LONGRAW"
A_INDEX_ROWID   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
A_INDEX_SHAPE   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
A_INDEX_STATEID "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
A_INDEX_USER    "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
A_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 MINEXTENTS 1 PCTINCREASE 0)"
B_INDEX_ROWID   "PCTFREE 10 INITRANS 2 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
B_INDEX_SHAPE   "PCTFREE 10 INITRANS 2 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
B_INDEX_USER    "PCTFREE 10 INITRANS 2 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
B_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 1 STORAGE (FREELISTS 4
                 MINEXTENTS 1 PCTINCREASE 0)"
D_INDEX_DELETED_AT      "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                 MINEXTENTS 1 PCTINCREASE 0)"
D_INDEX_STATE_ROWID     "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                 MINEXTENTS 1 PCTINCREASE 0)"
D_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 MINEXTENTS 1 PCTINCREASE 0)"
```

```
F_INDEX_AREA    "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
F_INDEX_FID     "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
F_INDEX_LEN     "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
F_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 MINEXTENTS 1 PCTINCREASE 0)"
GEOMETRY_STORAGE  "SDEBINARY"
S_INDEX_ALL     "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
S_INDEX_SP_FID  "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0)"
S_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 MINEXTENTS 1 PCTINCREASE 0)"
UI_TEXT         ""

END
```

Setting the system table DATA_DICTIONARY configuration keyword

During the execution of the sdesetupora80 or sdesetupora8i administration tool, the ArcSDE and geodatabase system tables and indexes are created with the storage parameters of the DATA_DICTIONARY configuration keyword. You may customize the configuration keyword in the dbtune.sde file prior to running the sdesetup* tool. In this way you can change default storage parameters of the DATA_DICTIONARY configuration keyword.

Edits to all of the geodatabase system tables and most of the ArcSDE system tables occur when schema change occurs. As such, edits to these system tables and indexes usually happen during the initial creation of an ArcGIS database with infrequent modifications occurring whenever a new schema object is added.

Four of the ArcSDE system tables—VERSION, STATES, STATE_LINEAGES, and MVTABLES_MODIFIED—participate in the ArcSDE versioning model and record events resulting from changes made to multiversioned tables. If your site makes extensive use of a multiversioned database, these tables and their associated indexes are very active. Separating these objects into their own tablespace allows you to position their data files with data files that experience low I/O activity and thus minimize disk I/O contention.

If the dbtune.sde file does not contain the DATA_DICTIONARY configuration keyword, or if any of the required parameters are missing from the configuration keyword, the following records will be inserted into the DATA_DICTIONARY when the table is created. (Note that the DBTUNE file entries are provided here for readability.)

```
##DATA_DICTIONARY

B_INDEX_ROWID               "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                             INITIAL 40K NEXT 40K MINEXTENTS 1 MAXEXTENTS 200
                             PCTINCREASE 0)"
```

```
B_INDEX_USER                "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                             INITIAL 40K NEXT 40K MINEXTENTS 1 MAXEXTENTS 200
                             PCTINCREASE 0)"

B_STORAGE                   "PCTFREE 10 PCTUSED 90 INITRANS 4
                             STORAGE (FREELISTS 4 INITIAL 40K NEXT 40K
                             MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

STATE_LINEAGES_TABLE        "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                             INITIAL 40M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200)"

STATES_TABLE                "PCTFREE 10 PCTUSED 90 INITRANS 4
                             STORAGE (FREELISTS 4 INITIAL 8M NEXT 1M
                             MINEXTENTS 1 MAXEXTENTS 200)"

STATES_INDEX                "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                             INITIAL 1M NEXT 128K MINEXTENTS 1 MAXEXTENTS 200)"

MVTABLES_MODIFIED_TABLE     "PCTFREE 10 PCTUSED 90 INITRANS 4
                             STORAGE (FREELISTS 4 INITIAL 2M NEXT 1M
                             MINEXTENTS 1 MAXEXTENTS 200)"

MVTABLES_MODIFIED_INDEX     "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                             INITIAL 2M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200)"

VERSIONS_TABLE              "PCTFREE 10 PCTUSED 90 INITRANS 4
                             STORAGE (FREELISTS 4 INITIAL 256K
                             NEXT 128K MINEXTENTS 1 MAXEXTENTS 200)"

VERSIONS_INDEX              "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                             INITIAL 128K NEXT 128K MINEXTENTS 1
                             MAXEXTENTS 200)"

END
```

Setting the storage format—the GEOMETRY_STORAGE parameter

ArcSDE for Oracle provides four spatial data storage formats. The GEOMETRY_STORAGE parameter indicates which geometry storage method is to be used. The GEOMETRY_STORAGE parameter has the following values:

- ArcSDE compressed binary stored in LONG RAW data type. This is the default spatial storage method of ArcSDE for Oracle8 and Oracle8*i*.

  Set the GEOMETRY_STORAGE parameter to SDEBINARY if you wish to store your spatial data in this format. If the GEOMETRY_STORAGE parameter is not set, the SDEBINARY format is assumed.

- ArcSDE compressed binary stored as a BLOB data type. This data type can be replicated through Oracle Advanced Replication. This data type is available in ArcSDE for Oracle8*i*.

Set the GEOMETRY_STORAGE parameter to SDELOB if you wish to store your spatial data in this format. If you wish to make this format the default, set the GEOMETRY_STORAGE parameter to SDELOB in the DEFAULTS configuration keyword.

- Oracle Spatial normalized schema (relational model). In the normalized geometry schema, the coordinate values for a shape are stored as DBMS numeric data types in a separate geometry table. Access from a business table to a shape is through a foreign key—the Geometry ID, or GID. This data storage format or schema can result in multiple rows of data for a single feature, depending on how many x,y points define the feature (for example, the coast of Norway might occupy many rows). This implementation conforms to the normalized geometry model defined by the OpenGIS® Simple Features Specification for SQL. This storage format can be used in both ArcSDE for Oracle8 and Oracle8*i*.

  Set the GEOMETRY_STORAGE parameter to NORMALIZED if you wish to store your spatial data in this format. If you wish to make this format the default, set the GEOMETRY_STORAGE parameter to NORMALIZED in the DEFAULTS configuration keyword.

- Oracle Spatial geometry type. In this object-relational model, Oracle8*i* extends the database model to include an SDO_GEOMETRY type in the Oracle DBMS. This storage format is not available for ArcSDE for Oracle8. It is only available for ArcSDE for Oracle8*i*.

  Set the GEOMETRY_STORAGE parameter to SDO_GEOMETRY if you wish to store your spatial data in this format. If you wish to make this format the default, set the GEOMETRY_STORAGE parameter to SDO_GEOMETRY in the DEFAULTS configuration keyword.

The default value for GEOMETRY_STORAGE is SDEBINARY.

If all of the feature classes in your database use the same geometry storage method, set the GEOMETRY_STORAGE parameter once in the DEFAULTS configuration keyword. To change the default GEOMETRY_STORAGE from SDEBINARY to SDO_GEOMETRY, the following change is made:

```
## DEFAULTS
GEOMETRY_STORAGE        SDO_GEOMETRY
<other parameters>
END
```

For convenience, four predefined configuration keywords are provided in the dbtune.proto file to allow the use of each of the supported geometry storage methods. These configurations are defined as follows:

```
## SDEBINARY
GEOMETRY_STORAGE        SDEBINARY
END

##SDELOB
GEOMETRY_STORAGE        SDELOB
END

## SDO_GEOMETRY
GEOMETRY_STORAGE        SDO_GEOMETRY
END

## NORMALIZED
GEOMETRY_STORAGE        NORMALIZED
END
```

Setting the COMPRESS_ROLLBACK_SEGMENT storage parameter

Periodically compressing the versioned database's state-tree is a required maintenance procedure. The state-tree can be compressed with either the compress operation of the sdeversion administration command or the SE_state_compress_tree C application programming interface (API) function. The transactions of the compress operation tend to be rather large, and we recommend that you create a separate large rollback segment to contain their changes. The COMPRESS_ROLLBACK_SEGMENT storage parameter stores the name of a rollback segment that you have created for this purpose. Add the COMPRESS_ROLLBACK_SEGMENT storage parameter to the DEFAULTS configuration keyword.

For more information on creating the rollback segment used for compressing the state-tree, see Chapter 2, 'Essential Oracle configuring and tuning'.

Changing the attribute binary storage format

By default, ArcSDE defines attribute columns it creates to store binary data as LONG RAW. However, you can direct ArcSDE to define a binary attribute column as BLOB by setting the ATTRIBUTE_BINARY storage parameter to BLOB. If the storage parameter is not set in the DEFAULTS configuration keyword when a DBTUNE file is imported by the sdedbtune

administration tool, ArcSDE inserts the ATTRIBUTE_BINARY storage parameter under the DEFAULTS configuration keyword with a configuration string set to LONGRAW.

Changing the appearance of DBTUNE configuration keywords in the ArcInfo user interface

ArcSDE 8.1 introduces two new storage parameters that will support the ArcInfo user interfaces UI_TEXT and UI_NETWORK_TEXT. ArcSDE administrators can add one of these storage parameters to each configuration keyword to communicate to the ArcInfo schema builders the intended use of the configuration keyword. The configuration string of these storage parameters will appear in ArcInfo interface DBTUNE configuration keyword scrolling lists.

The UI_TEXT storage parameter should be added to configuration keywords that will be used to build tables, feature classes, and indexes.

The UI_NETWORK_TEXT storage parameter should be added to parent network configuration keywords.

Adding a comment to a configuration keyword

The COMMENT storage parameter allows you to add informative text that describes such things as a configuration keyword's intended use, the last time it was changed, or who created it.

LOG FILE configuration keywords

Log files are used by ArcSDE to maintain temporary and persistent sets of selected records. Whenever a user connects to ArcSDE for the first time, the SDE_LOGFILES and SDE_LOGFILE_DATA tables and indexes are created.

You may create a configuration keyword for each user that begins with the LOGFILE_<username>. For example, if the user's name is STANLEY, ArcSDE will search the DBTUNE table for the LOGFILE_STANLEY configuration keyword. If this configuration keyword is not found, ArcSDE will use the storage parameters of the LOGFILE_DEFAULTS configuration keyword to create the SDE_LOGFILES and SDE_LOGFILE_DATA tables.

ArcSDE always creates the DBTUNE table with a LOGFILE_DEFAULTS configuration keyword. If you do not specify this configuration keyword in a DBTUNE file imported by the sdedbtune command, ArcSDE will populate the DBTUNE table with default LOGFILE_DEFAULTS storage parameters. Further, if the DBTUNE file lacks some of the LOGFILE_DEFAULTS configuration keyword storage parameters, ArcSDE supplies the rest. Therefore, the LOGFILE_DEFAULTS configuration keyword is always fully populated.

If a user-specific configuration keyword exists, but some of the storage parameters are not present, the storage parameters of the LOGFILE_DEFAULTS configuration keyword are used.

Creating a log file configuration keyword for each user allows you to position their sde log files onto separate devices by specifying the tablespace the log file tables and indexes are created in. Most installations of ArcSDE will function well using the LOGFILE_DEFAULTS storage parameters supplied with the installed dbtune.sde file. However, for applications making use of sde log files, such as ArcInfo, ArcEditor™, and ArcView®, it may help performance by spreading the log files across the file system. Typically log files are updated whenever a selection set exceeds 100 records.

If the imported DBTUNE file does not contain a LOGFILE_DEFAULTS configuration keyword, or if any of the log file storage parameters are missing, ArcSDE will insert the following records:

```
##LOGFILE_DEFAULTS

LD_INDEX_DATA_ID  "PCTFREE 10 INITRANS 2 STORAGE (FREELISTS 4 MINEXTENTS 1
                   PCTINCREASE 0) NOLOGGING"
LD_INDEX_ROWID    "PCTFREE 10 INITRANS 2 STORAGE (FREELISTS 4 MINEXTENTS 1
                   PCTINCREASE 0) NOLOGGING"
LD_STORAGE        "PCTFREE 10 PCTUSED 90 INITRANS 1 STORAGE (FREELISTS 4
                   MINEXTENTS 1 PCTINCREASE 0)"
LF_INDEXES        "PCTFREE 10 INITRANS 2 STORAGE (FREELISTS 4 MINEXTENTS 1
                   PCTINCREASE 0) NOLOGGING"
LF_STORAGE        "PCTFREE 10 PCTUSED 90 INITRANS 1 STORAGE (FREELISTS 4
                   MINEXTENTS 1 PCTINCREASE 0)"
UI_TEXT ""

END
```

Defining the storage parameters

Configuration keywords may include any combination of three basic types of storage parameters: meta parameters, table parameters, and index parameters.

Meta parameters

Meta parameters define the way certain types of data will be stored, the environment of a configuration keyword, or a comment that describes the configuration keyword.

Table parameters

Table parameters define the storage configuration of an Oracle table. The table parameter is appended to an Oracle CREATE TABLE statement during its creation by ArcSDE. Valid

entries for an ArcSDE table parameter include the parameters to the right of the SQL CREATE TABLE statement's columns list.

For example, a business table created with the following Oracle CREATE TABLE statement:

```
CREATE TABLE roads (road_id integer, name varchar2(32), surface_code integer)
tablespace roads_tabsp
storage (initial 10M next 1M minextents 1 maxextents 100 pctincrease 0
freelists 4)
initrans 4 pctfree 10 pctused 90;
```

would be entered into a DBTUNE file B_STORAGE table parameter with the following configuration string:

```
B_STORAGE "tablespace roads_tabsp storage (initial 10M next 1M minextents 1
maxextents 100 pctincrease 0 freelists 4) initrans 4 pctfree 10 pctused 90"
```

Index parameters

Index parameters define the storage configuration of an Oracle index. The index parameter is appended to an Oracle CREATE INDEX statement during its creation by ArcSDE. Valid entries in an ArcSDE index parameter include all parameters to the right of the SQL CREATE INDEX statement's column list.

For example, an index created with the following Oracle CREATE INDEX statement:

```
CREATE INDEX roads_idx on roads (road_id)
tablespace roads_idx_tabsp
storage (initial 1M next 512K minextents 1 maxextents 100 pctincrease 0
freelists 4)
initrans 4 pctfree 10;
```

would be entered into a B_INDEX_USER storage parameter with the following configuration string:

```
B_INDEX_USER "tablespace roads_idx_tabsp storage(initial 1M next 512K
minextents 1 maxextents 100 pctincrease 0 freelists 4) initrans 4 pctfree 10"
```

The business table storage parameter

A business table is any Oracle table created by an ArcSDE client, the sdetable administration command, or the ArcSDE C API SE_table_create function.

Use the DBTUNE table's B_STORAGE storage parameter to define the storage configuration of a business table.

The business table index storage parameters

Three index storage parameters exist to support the creation of business table indexes.

The B_INDEX_USER storage parameter holds the storage configuration for user-defined indexes created with the C API function SE_table_create_index and the create_index operation of the sdetable command.

The B_INDEX_ROWID storage parameter holds the storage configuration of the index that ArcSDE creates on a register table's object ID column, commonly referred to as the ROWID.

Note: ArcSDE registers all tables that it creates. Tables not created by ArcSDE can also be registered with the alter_reg operation of the sdetable command or with ArcCatalog. The SDE.TABLE_REGISTRY system table maintains a list of the currently registered tables.

The B_INDEX_SHAPE storage parameter holds the storage configuration of the spatial column index that ArcSDE creates when a spatial column is added to a business table. This index is created by the ArcSDE C API function SE_layer_create. This function is called by ArcInfo when it creates a feature class and by the add operation of the sdelayer command.

Multiversioned table storage parameters

Registering a business table as multiversioned allows multiple users to maintain and edit their copy of the object. At appropriate intervals each user merges the changes they have made to their copy with the changes made by other users and reconciles any conflicts that arise when the same rows are modified.

ArcSDE creates two tables—the adds table and the deletes table—for each table that is registered as multiversioned.

The A_STORAGE storage parameter maintains the storage configuration of the adds table. Four other storage parameters hold the storage configuration of the indexes of the adds table. The adds table is named A<n>, where <n> is the registration ID listed in the SDE.TABLE_REGISTRY system table. For instance, if the business table ROADS is listed with a registration ID of 10, ArcSDE create the adds table as A10.

The A_INDEX_ROWID storage parameter holds the storage configuration of the index that ArcSDE creates on the multiversion object ID column, commonly referred to as the ROWID. The adds table ROWID index is named A<n>_ROWID_IX1, where <n> is the business table's registration ID, which the adds table is associated with.

The A_INDEX_STATEID storage parameter holds the storage configuration of the index that ArcSDE creates on the adds table's SDE_STATE_ID column. The SDE_STATE_ID column index is called A<n>_STATE_IX2, where <n> is the business table's registration ID, which the adds table is associated with.

The A_INDEX_SHAPE storage parameter holds the storage configuration of the index that ArcSDE creates on the adds table's spatial column. If the business table contains a spatial column, the column and the index on it are duplicated in the adds table. The adds table's spatial column index is called A<n>_IX1_A, where <n> is the layer ID of the feature class as it is listed in the SDE.LAYERS table.

The A_INDEX_USER storage parameter holds the storage configuration of user-defined indexes that ArcSDE creates on the adds table. The user-defined indexes on the business tables are duplicated on the adds table.

The D_STORAGE storage parameter holds the storage configuration of the deletes table. Two other storage parameters hold the storage configuration of the indexes that ArcSDE creates on the deletes table. The deletes table is named D<n>, where <n> is the registration ID listed in the SDE.TABLE_REGISTRY system table. For instance, if the business table ROADS is listed with a registration ID of 10, ArcSDE creates the deletes table as D10.

The D_INDEX_STATE_ROWID storage parameter holds the storage configuration of the D<n>_IDX1 index that ArcSDE creates on the deletes table's SDE_STATE_ID and SDE_DELETES_ROW_ID columns.

The D_INDEX_DELETED_AT storage parameter holds the storage configuration of the D<n>_IDX2 index that ArcSDE creates on the deletes table's SDE_DELETED_AT column.

Note: If a configuration keyword is not specified when the registration of a business table is converted from single-version to multiversion, the adds and deletes tables and their indexes are created with the storage parameters of the configuration keyword the business table was created with.

Feature class storage parameters

A feature class created with an ArcSDE compressed binary storage (LONG RAW or BLOB datatype) format adds two tables to the Oracle database—the feature table and the spatial index table. Three indexes are created on the feature table, and two indexes are created on the spatial index table. The storage parameters for these tables and indexes follow the same pattern as the B_STORAGE and B_INDEX_* storage parameters of the business table.

The F_STORAGE storage parameter holds the Oracle CREATE TABLE storage configuration of the feature table. The feature table is created as F_<n>, where <n> references the layer ID of the table's feature class found in the SDE.LAYERS table.

The F_INDEX_FID storage parameter holds the Oracle CREATE INDEX storage configuration of the feature tables spatial column index. The spatial column is created as

F_<n>_IX1, where <n> references the layer ID of the index's feature class found in the SDE.LAYERS table.

The F_INDEX_AREA storage parameter holds the Oracle CREATE INDEX storage configuration of the feature tables area column index. The spatial column is created as F_<n>_AREA, where <n> references the layer ID of the index's feature class found in the SDE.LAYERS table.

The F_INDEX_LEN storage parameter holds the Oracle CREATE INDEX storage configuration of the feature table's length column index. The spatial column is created as F_<n>_LEN, where <n> references the layer ID of the index's feature class found in the SDE.LAYERS table.

The S_STORAGE storage parameter holds the Oracle CREATE TABLE storage configuration of the spatial index table. The spatial index table is created as S_<n>, where <n> references the layer ID of the spatial index table's feature class found in the SDE.LAYERS table.

The S_INDEX_ALL storage parameter holds the Oracle CREATE INDEX storage configuration of the spatial table first index. The spatial index table is created as S_<n>_IX1, where <n> references the layer ID of the index's feature class found in the SDE.LAYERS table.

The S_INDEX_SP_FID storage parameter holds the Oracle CREATE INDEX storage configuration of the spatial table second index. The spatial index table is created as S_<n>_IX2, where <n> references the layer ID of the index's feature class found in the SDE.LAYERS table.

Raster table storage parameters

A raster column added to a business table is actually a foreign key reference to raster data stored in a schema consisting of four tables and five supporting indexes.

The RAS_STORAGE storage parameter holds the Oracle CREATE TABLE storage configuration of the RAS table.

The RAS_INDEX_ID storage parameter holds the Oracle CREATE TABLE storage configuration of the RAS table index.

The BND_STORAGE storage parameter holds the Oracle CREATE TABLE storage configuration of the BND table index.

The BND_INDEX_ COMPOSITE storage parameter holds the Oracle CREATE INDEX storage configuration of the BND table's composite column index.

The BND_INDEX_ID storage parameter holds the Oracle CREATE INDEX storage configuration of the BND table's rid column index.

The AUX_STORAGE storage parameter holds the Oracle CREATE TABLE storage configuration of the AUX table.

The AUX_INDEX_COMPOSITE storage parameter holds the Oracle CREATE INDEX storage configuration of the AUX table's index.

The BLK_STORAGE storage parameter holds the Oracle CREATE TABLE storage configuration of the BLK table.

The BLK_INDEX_COMPOSITE storage parameter holds the Oracle CREATE TABLE storage configuration of the BLK table's index.

Network class composite configuration keywords

The composite keyword is a unique type of configuration keyword designed to accommodate the tables of the ArcGIS network class. The network table's size variation requires a configuration keyword that provides configuration storage parameters for both large and small tables. Typically, the network descriptions table is very large in comparison with the others.

To accommodate the vast difference in the size of the network tables, the network composite configuration keyword is subdivided into elements. A network composite configuration keyword has three elements: the parent element defines the general characteristic of the configuration keyword and the junctions feature class; the description element defines the configuration of the DESCRIPTIONS table and its indexes; and the network element defines the configuration of the remaining network tables and their indexes.

The parent element does not have a suffix, and its configuration keyword looks like any other configuration keyword. The description element is demarcated by the addition of the ::DESC suffix to the parent element's configuration keyword, and the network element is demarcated by the addition of the ::NETWORK suffix to the parent element's configuration keyword.

For example, if the parent element configuration keyword is ELECTRIC, the network composite configuration keyword would appear in a DBTUNE file as follows:

```
##ELECTRIC

COMMENT  This configuration keyword is dedicated to the electrical geometric
network class

UI_NETWORK_TEXT "The electrical geometrical network class configuration
keyword"
```

```
B_STORAGE     "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90 STORAGE
(INITIAL 500M NEXT 100M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

B_INDEX_ROWID "TABLESPACE BUSINESS_INDEX INITRANS 4 PCTFREE 10 STORAGE
(INITIAL 100M NEXT 50M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

B_INDEX_SHAPE "TABLESPACE BUSINESS_INDEX INITRANS 4 PCTFREE 10 STORAGE
(INITIAL 100M NEXT 50M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

B_INDEX_USER  "TABLESPACE BUSINESS_INDEX INITRANS 4 PCTFREE 10 STORAGE
(INITIAL 100M NEXT 50M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

F_STORAGE     "TABLESPACE FEATURE INITRANS 4 PCTFREE 10 PCTUSED 90 STORAGE
(INITIAL 500M NEXT 100M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

F_INDEX_FID   "TABLESPACE FEATURE_INDEX INITRANS 4 PCTFREE 10 STORAGE (INITIAL
100M NEXT 50M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

F_INDEX_LEN   "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL 100M
NEXT 50M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

F_INDEX_AREA  "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL 100M
NEXT 50M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

S_STORAGE      "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90 STORAGE
(INITIAL 200M NEXT 20M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

S_INDEX_ALL    "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
200M NEXT 20M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

S_INDEX_SP_FID  "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
50M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_STORAGE       "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90 STORAGE
(INITIAL 100M NEXT 50M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

A_INDEX_ROWID    "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_INDEX_SHAPE    "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_INDEX_USER     "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_INDEX_STATEID  "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

D_STORAGE        "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90 STORAGE
(INITIAL 20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

D_INDEX_DELETED_AT   "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE
(INITIAL 20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

D_INDEX_STATE_ROWID   "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE
(INITIAL 20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

END

##ELECTRIC::DESC
```

```
B_STORAGE        "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90 STORAGE
(INITIAL 500M NEXT 100M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

B_INDEX_ROWID    "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
100M NEXT 50M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

B_INDEX_USER     "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
100M NEXT 50M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_STORAGE        "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90 STORAGE
(INITIAL 500M NEXT 100M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

A_INDEX_ROWID    "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_INDEX_SHAPE   "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_INDEX_USER    "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_INDEX_STATEID  "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

D_STORAGE         "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90
STORAGE (INITIAL 20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

D_INDEX_DELETED_AT   "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE
(INITIAL 20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

D_INDEX_STATE_ROWID   "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE
(INITIAL 20M NEXT 10M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

END

##ELECTRIC::NETWORK

B_STORAGE        "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90 STORAGE
(INITIAL 1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

B_INDEX_ROWID    "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

B_INDEX_USER     "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_STORAGE        "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90 STORAGE
(INITIAL 1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

A_INDEX_ROWID    "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_INDEX_SHAPE    "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_INDEX_USER     "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

A_INDEX_STATEID   "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE (INITIAL
1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"
```

```
D_STORAGE         "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 PCTUSED 90
STORAGE (INITIAL 1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0)"

D_INDEX_DELETED_AT   "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE
(INITIAL 1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

D_INDEX_STATE_ROWID   "TABLESPACE BUSINESS INITRANS 4 PCTFREE 10 STORAGE
(INITIAL 1M NEXT 1M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) NOLOGGING"

END
```

Following the import of the DBTUNE file, these records would be inserted into the DBTUNE table.

```
SQL> select keyword, parameter_name from DBTUNE;

KEYWORD             PARAMETER_NAME
----------------    ----------------
ELECTRIC            COMMENT
ELECTRIC            UI_NETWORK_TEXT
ELECTRIC            B_STORAGE
ELECTRIC            B_INDEX_ROWID
ELECTRIC            B_INDEX_SHAPE
ELECTRIC            B_INDEX_USER
ELECTRIC            F_STORAGE
ELECTRIC            F_INDEX_FID
ELECTRIC            F_INDEX_LEN
ELECTRIC            F_INDEX_AREA
ELECTRIC            S_STORAGE
ELECTRIC            S_INDEX_ALL
ELECTRIC            S_INDEX_SP_FID
ELECTRIC            A_STORAGE
ELECTRIC            A_INDEX_ROWID
ELECTRIC            A_INDEX_SHAPE
ELECTRIC            A_INDEX_USER
ELECTRIC            A_INDEX_STATEID
ELECTRIC            D_STORAGE
ELECTRIC            D_INDEX_DELETED_AT
ELECTRIC            D_INDEX_STATE_ROWID
ELECTRIC::DESC      B_STORAGE
ELECTRIC::DESC      B_INDEX_ROWID
ELECTRIC::DESC      B_INDEX_USER
ELECTRIC::DESC      A_STORAGE
ELECTRIC::DESC      A_INDEX_ROWID
ELECTRIC::DESC      A_INDEX_STATEID
ELECTRIC::DESC      A_INDEX_USER
ELECTRIC::DESC      D_STORAGE
ELECTRIC::DESC      D_INDEX_DELETE_AT
ELECTRIC::DESC      D_INDEX_STATE_ROWID
ELECTRIC::NETWORK   B_STORAGE
ELECTRIC::NETWORK   B_INDEX_ROWID
ELECTRIC::NETWORK   B_INDEX_USER
ELECTRIC::NETWORK   A_STORAGE
ELECTRIC::NETWORK   A_INDEX_ROWID
ELECTRIC::NETWORK   A_INDEX_STATEID
ELECTRIC::NETWORK   A_INDEX_USER
ELECTRIC::NETWORK   D_STORAGE
ELECTRIC::NETWORK   D_INDEX_DELETE_AT
ELECTRIC::NETWORK   D_INDEX_STATE_ROWID
```

The network junctions feature class is created with the ELECTRIC configuration keyword storage parameters, the network descriptions table is created with the storage parameters of the ELECTRIC::DESC configuration keyword, and the remaining smaller network tables are created with the ELECTRIC::NETWORK configuration keyword.

The NETWORK_DEFAULTS configuration keyword

The NETWORK_DEFAULTS configuration keyword contains the default storage parameters for the ArcGIS network class. If the user does not select a network class composite configuration keyword from the ArcCatalog interface, the ArcGIS network is created with the storage parameters within the NETWORK_DEFAULTS configuration keyword.

Whenever a network class composite configuration keyword is selected, its storage parameters are used to create the feature class, table, and indexes of the network class. If a network composite configuration keyword is missing any storage parameters, ArcGIS substitutes the storage parameters of the DEFAULTS configuration keyword rather than the NETWORK_DEFAULTS configuration keyword. The storage parameters of the NETWORK_DEFAULTS configuration keyword are used when a network composite configuration keyword has not been specified.

If a NETWORK_DEFAULTS configuration keyword is not present in a DBTUNE file imported into the DBTUNE table, the following NETWORK_DEFAULTS configuration keyword is created.

```
##NETWORK_DEFAULTS

A_INDEX_ROWID   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_INDEX_SHAPE   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_INDEX_STATEID "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_INDEX_USER    "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 PCTINCREASE 0)"
B_INDEX_ROWID   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
B_INDEX_SHAPE   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
B_INDEX_USER    "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
B_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 PCTINCREASE 0)"
COMMENT "The base system initialization parameters for NETWORK_DEFAULTS"
D_INDEX_DELETED_AT  "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                     NOLOGGING"
D_INDEX_STATE_ROWID "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                     NOLOGGING"
D_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS
                 PCTINCREASE 0)"
```

```
F_INDEX_AREA    "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0) NOLOGGING"
F_INDEX_FID     "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0) NOLOGGING"
F_INDEX_LEN     "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0) NOLOGGING"
F_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 MINEXTENTS 1 PCTINCREASE 0)"
S_INDEX_ALL     "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0) NOLOGGING"
S_INDEX_SP_FID  "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 MINEXTENTS 1
                 PCTINCREASE 0) NOLOGGING"
S_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 MINEXTENTS 1 PCTINCREASE 0)"
UI_NETWORK_TEXT "The network default configuration"

END

##NETWORK_DEFAULTS::DESC

A_INDEX_ROWID   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_INDEX_SHAPE   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_INDEX_STATEID "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_INDEX_USER    "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 PCTINCREASE 0)"
B_INDEX_ROWID   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
B_INDEX_SHAPE   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
B_INDEX_USER    "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
B_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 PCTINCREASE 0)"
D_INDEX_DELETED_AT  "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                     NOLOGGING"
D_INDEX_STATE_ROWID "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                     NOLOGGING"
D_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 PCTINCREASE 0)"

END

##NETWORK_DEFAULTS::NETWORK

A_INDEX_ROWID   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_INDEX_SHAPE   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_INDEX_STATEID "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_INDEX_USER    "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
A_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 PCTINCREASE 0)"
B_INDEX_ROWID   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
```

```
B_INDEX_SHAPE   "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
B_INDEX_USER    "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                 NOLOGGING"
B_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 PCTINCREASE 0)"
D_INDEX_DELETED_AT  "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                     NOLOGGING"
D_INDEX_STATE_ROWID "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4 PCTINCREASE 0)
                     NOLOGGING"
D_STORAGE       "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE (FREELISTS 4
                 PCTINCREASE 0)"

END
```

ArcSDE storage parameters for Oracle Spatial

Several storage parameters exist to determine the storage of a feature class created as an Oracle Spatial SDO_GEOMETRY type.

The SDO_SRID identifies the Oracle Spatial coordinate reference description. Consult the *Oracle Spatial Users Guide and Reference* for a list of supported coordinate references.

ArcSDE provides storage parameters to define fixed values for the Oracle Spatial dimension information. If you do not define these storage parameters, Oracle Spatial calculates the dimensions from the data. Oracle Spatial allows you to define up to four dimensions. There are three basic parameters that are repeated for each dimension, delineated by the number of the dimension that is appended to the storage parameter's name.

SDO_DIMNAME_<n> stores the dimension's name.

SDO_LB_<n> stores the dimension's lower boundary.

SDO_UB_<n> stores the dimension's upper boundary.

SDO_TOLERANCE_<n> stores the dimension's precision.

Oracle Spatial provides three different spatial index methods: RTREE, FIXED, and HYBRID. The default is RTREE. The SDO_INDEX storage parameter lets you set the spatial index method to one of the methods offered by Oracle Spatial.

The SDO_INDEX_SHAPE storage parameter stores the spatial index's storage parameters. The parameters are a quoted string of a list of *parameter = value* elements that are passed to the PARAMETERS clause of the Oracle user-defined CREATE INDEX statement.

The SDO_COMMIT_INTERVAL, SDO_LEVEL, SDO_NUMTILES, SDO_MAXLEVEL, and SDO_ORDCNT storage parameters all affect the configuration of the spatial index. These

are actually Oracle Spatial parameters that have been documented in the *Oracle Spatial Users Guide and Reference*. For more information on how to set these parameters, see that document. You should be aware that in some cases Oracle will calculate the values for you based on the values of the spatial data being indexed. It is recommended that you use the Oracle defaults before setting these values yourself.

The ArcSDE SDO_VERIFY storage parameter determines whether the geometry data fetched from Oracle Spatial feature class should be examined and, if necessary, corrected.

Listed below is an ArcSDE DBTUNE configuration with storage parameters set to store a feature class created with an Oracle Spatial column.

```
##ORACLE_SPATIAL_FC

GEOMETRY_STORAGE            SDO_GEOMETRY

B_STORAGE                   "TABLESPACE BUSINESS PCTFREE 10 PCTUSED 90 INITRANS
                            4 STORAGE(FREELISTS 4 INITIAL 512000 NEXT 512000
                            MINEXTENTS 1 MAXEXTENTS 100 PCTINCREASE 0)"
B_INDEX_USER                "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                            INITIAL 512000 NEXT 512000 MINEXTENTS 1 MAXEXTENTS
                            100 PCTINCREASE 0) NOLOGGING"
B_INDEX_ROWID               "PCTFREE 10 INITRANS 4 STORAGE (FREELISTS 4
                            INITIAL 512000 NEXT 512000 MINEXTENTS 1 MAXEXTENTS
                            100 PCTINCREASE 0) NOLOGGING"

A_STORAGE                   "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE
                            (FREELISTS 4 INITIAL 512000 NEXT 512000 MINEXTENTS
                            1 MAXEXTENTS 100 PCTINCREASE 0)"
A_INDEX_USER                "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE
                            (FREELISTS 4 INITIAL 512000 NEXT 512000 MINEXTENTS
                            1 MAXEXTENTS 100 PCTINCREASE 0)"
A_INDEX_ROWID               "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE
                            (FREELISTS 4 INITIAL 512000 NEXT 512000 MINEXTENTS
                            1 MAXEXTENTS 100 PCTINCREASE 0)"
A_INDEX_STATEID             "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE
                            (FREELISTS 4 INITIAL 512000 NEXT 512000 MINEXTENTS
                            1 MAXEXTENTS 100 PCTINCREASE 0)"

D_STORAGE                   "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE
                            (FREELISTS 4 INITIAL 512000 NEXT 512000 MINEXTENTS
                            1 MAXEXTENTS 100 PCTINCREASE 0)"
D_INDEX_DELETED_AT          "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE
                            (FREELISTS 4 INITIAL 512000 NEXT 512000 MINEXTENTS
                            1 MAXEXTENTS 100 PCTINCREASE 0)"
D_INDEX_STATE_ROWID         "PCTFREE 10 PCTUSED 90 INITRANS 4 STORAGE
                            (FREELISTS 4 INITIAL 512000 NEXT 512000 MINEXTENTS
                            1 MAXEXTENTS 100 PCTINCREASE 0)"

SDO_COMMIT_INTERVAL         100
SDO_INDEX_SHAPE             "tablespace = spatial_index,initial = 409600, next
                            = 409600, minextents = 1, maxextents = 1000,
                            pctincrease = 0, btree_initial = 12384, btree_next
                            = 4096, btree_pctincrease = 0"
SDO_LAYER_GTYPE             "POINT"
SDO_LEVEL                   30
SDO_ORDCNT                  2
```

```
SDO_VERIFY                TRUE

SDO_DIMNAME_1             LONGITUDE1
SDO_LB_1                  -160.0
SDO_UB_1                   20.0
SDO_TOLERANCE_1           0.000050

SDO_DIMNAME_2             LATITUDE2
SDO_LB_2                  -68.0
SDO_UB_2                   60.0
SDO_TOLERANCE_2           0.000050

SDO_DIMNAME_3             ZVals
SDO_LB_3                  0.0
SDO_UB_3                  15000.0
SDO_TOLERANCE_3           0.000050

SDO_DIMNAME_4             MVals
SDO_LB_4                  0.0
SDO_UB_4                  5000.0
SDO_TOLERANCE_4           0.000050

END
```

Oracle default parameters

By default, Oracle stores tables and indexes in the user's default tablespace using the tablespace's default storage parameters. Determine a user's default tablespace by querying the DEFAULT_TABLESPACE field of the USER_USERS system table when connected as that user. As the Oracle DBA, query the DEFAULT_TABLESPACE field of the DBA_USERS table using a where clause to specify the user.

```
SQL> connect <user>/<password>
SQL> select default_tablespace from user_users;
```

or

```
SQL> connect system/<password>
SQL> select default_tablespace from dba_users where username = <user>;
```

Obtain a list of tablespace default storage parameters for a tablespace by querying USER_TABLESPACES.

```
SQL> connect <user>/<password>
SQL> select * from user_tablespaces where tablespace_name = <tablespace>;
```

Editing the storage parameters

To edit the storage parameters, the sdedbtune administration command allows you to export the DBTUNE table to a file located in the $SDEHOME/etc directory on UNIX servers and in the %SDEHOME%\etc folder on Windows servers. It is an ArcSDE configuration file that contains Oracle table and index creation parameters. These parameters allow the ArcSDE service to communicate to the Oracle server such things as:

- Which tablespace a table or index will be created in,
- The size of the initial and next extent,
- Other parameters that can be set on either the CREATE TABLE or CREATE INDEX statement.

Converting ArcSDE 8.0.2 storage parameters to ArcSDE 8.1 storage parameters

For ArcSDE 8.0.2 and predecessor versions of Spatial Database Engine™ (SDE®), the DBTUNE storage parameters were maintained in the dbtune.sde file. The storage parameters of these previous versions were mapped directly to each Oracle storage parameters. For example, the ArcSDE 8.0.2 F_TBLSP storage parameter holds the name of the feature table's tablespace.

The ArcSDE 8.1 storage parameters hold entire configuration strings of the table or index they represent. For example, the F_STORAGE storage parameter holds the configuration string of the feature table. Any legal Oracle storage parameter listed to the right of the columns clause of the Oracle CREATE TABLE statement can be listed in the F_STORAGE storage parameter. Therefore, the F_STORAGE storage parameter incorporates all of the ArcSDE 8.0.2 feature table storage parameters.

The conversion of ArcSDE 8.0.2 storage parameters to ArcSDE 8.1 occurs automatically when the ArcSDE 8.1 sdesetupora* utility reads the storage parameters from the ArcSDE 8.0.2 dbtune.sde file. The import operation of the sdedbtune command also converts an ArcSDE 8.0.2 DBTUNE file into ArcSDE 8.1 storage parameters before it writes them to the DBTUNE table. To see the results you can either use SQL*Plus to list the storage parameters of the DBTUNE table or write the storage parameters of the DBTUNE table to another file using the export operation of the sdedbtune command.

The following table lists the conversion of ArcSDE 8.0.2 storage parameters to ArcSDE 8.1 storage parameters.

The ArcSDE 8.0.2 business table and index parameter prefix is "A_". The ArcSDE 8.1 business table and index parameter prefix is "B_". The ArcSDE 8.0.2 business table storage parameters are converted to the, single ArcSDE 8.1 B_STORAGE storage parameter. The B_STORAGE parameter holds the entire business table's configuration string.

ArcSDE 8.0.2 storage parameters	ArcSDE 8.1 storage parameters
A_TBLSP ROADS	B_STORAGE "TABLESPACE ROADS STORAGE (FREELISTS 4 INITIAL 10M NEXT 5M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) INITRANS 5 MAXTRANS 255 PCTFREE 10 PCTUSED 90"
A_INIT 10M A_NEXT 5M A_MINX 1 A_MAXX 200 A_PCTI 0 A_ITRANS 5 A_MAXTRS 255 A_PCTFREE 10 A_PCTUSD 90	

The ArcSDE 8.0.2 business table index storage parameters are converted to ArcSDE 8.1 storage parameter configuration strings. The example below illustrates how the ArcSDE 8.0.2 storage parameters are converted into the ArcSDE 8.1spatial column index storage parameter B_INDEX_SHAPE. The other ArcSDE 8.1 business table index storage parameters B_INDEX_ROWID and B_INDEX_USER are also constructed this way.

ArcSDE 8.0.2 storage parameters	ArcSDE 8.1 storage parameters
INDEX_TABLESPACE ROADS_IX	B_INDEX_SHAPE "TABLESPACE ROADS_IX STORAGE (FREELISTS 4 INITIAL 10M NEXT 5M MINEXTENTS 1 MAXEXTENTS 200 PCTINCREASE 0) INITRANS 5 MAXTRANS 255 PCTFREE 10"
A_IX1_INIT 10M A_IX1_NEXT 5M A_MINX 1 A_MAXX 200 A_PCTI 0 A_ITRANS 5 A_MAXTRS 255 A_PCTFREE 10	

The ArcSDE 8.0.2 feature table storage parameters are converted to the ArcSDE 8.1 F_STORAGE storage parameter. The F_STORAGE parameter holds the entire feature table's configuration string.

ArcSDE 8.0.2 storage parameters

```
F_TBLSP      ROADS_F

F_INIT       10M
F_NEXT       5M
F_MINX       1
F_MAXX       200
F_PCTI       0
F_ITRANS     5
F_MAXTRS     255
F_PCTFREE    10
F_PCTUSD     90
```

ArcSDE 8.1 storage parameters

```
F_STORAGE  "TABLESPACE ROADS_F
            STORAGE (FREELISTS 4
                     INITIAL 10M
                     NEXT 5M
                     MINEXTENTS 1
                     MAXEXTENTS 200
                    PCTINCREASE 0)
           INITRANS 5
           MAXTRANS 255
           PCTFREE 10
           PCTUSED 90"
```

The ArcSDE 8.0.2 feature table index storage parameters are converted to ArcSDE 8.1 storage parameter configuration strings. The example below illustrates how the ArcSDE 8.0.2 storage parameters are converted into the ArcSDE 8.1fid column index storage parameter F_INDEX_FID. The other ArcSDE 8.1 feature table index storage parameters F_INDEX_AREA and F_INDEX_LEN are also constructed this way.

ArcSDE 8.0.2 storage parameters

```
INDEX_TABLESPACE  ROADS_F_IX

F_IX1_INIT        10M
F_IX1_NEXT        5M
F_MINX            1
F_MAXX            200
F_PCTI            0
F_ITRANS          5
F_MAXTRS          255
F_PCTFREE         10
```

ArcSDE 8.1 storage parameters

```
F_INDEX_FID      "TABLESPACE ROADS_F_IX
                  STORAGE (FREELISTS 4
                           INITIAL 10M
                           NEXT 5M
                           MINEXTENTS 1
                           MAXEXTENTS 200
                           PCTINCREASE 0)
                  INITRANS 5
                  MAXTRANS 255
                  PCTFREE 10"
```

The ArcSDE 8.0.2 spatial index table storage parameters are converted to the ArcSDE 8.1 S_STORAGE storage parameter. The S_STORAGE parameter holds the entire spatial index table's configuration string.

ArcSDE 8.0.2 storage parameters

```
S_TBLSP      ROADS_S

S_INIT       10M
S_NEXT       5M
S_MINX       1
S_MAXX       200
S_PCTI       0
S_ITRANS     5
S_MAXTRS     255
S_PCTFREE    10
S_PCTUSD     90
```

ArcSDE 8.1 storage parameters

```
S_STORAGE  "TABLESPACE ROADS_S
            STORAGE (FREELISTS 4
                     INITIAL 10M
                     NEXT 5M
                     MINEXTENTS 1
                     MAXEXTENTS 200
                     PCTINCREASE 0)
           INITRANS 5
           MAXTRANS 255
           PCTFREE 10
           PCTUSED 90"
```

The ArcSDE 8.0.2 spatial index table storage parameters are converted to ArcSDE 8.1 storage parameter configuration strings. The example below illustrates how the ArcSDE 8.0.2 index storage parameters are converted into the ArcSDE 8.1 storage parameter S_INDEX_ALL. The S_INDEX_SP_FID storage parameter is converted the same way except ArcSDE 8.0.2 storage parameters S_IX2_INIT and S_IX2_NEXT are used.

ArcSDE 8.0.2 storage parameters

```
INDEX_TABLESPACE ROADS_S_IX

S_IX1_INIT       10M
S_IX1_NEXT       5M
S_MINX           1
S_MAXX           200
S_PCTI           0
S_ITRANS         5
S_MAXTRS         255
S_PCTFREE        10
```

ArcSDE 8.1 storage parameters

```
S_INDEX_ALL      "TABLESPACE ROADS_S_IX
                  STORAGE (FREELISTS 4
                           INITIAL 10M
                           NEXT 5M
                           MINEXTENTS 1
                           MAXEXTENTS 200
                           PCTINCREASE 0)
                  INITRANS 5
                  MAXTRANS 255
                  PCTFREE 10"
```

The complete list of ArcSDE 8.1 storage parameters

Parameter Name	Value	Parameter Description	Default Value
STATES_LINEAGES_TABLE	<string>	State_lineages table	B_STORAGE
STATES_TABLE	<string>	States table	B_STORAGE
STATES_INDEX	<string>	States indexes	B_INDEX_USER
MVTABLES_MODIFIED_TABLE	<string>	Mvtables_modified table	B_STORAGE
MVTABLES_MODIFIED_INDEX	<string>	Mvtables_modified index	B_INDEX_USER
VERSIONS_TABLE	<string>	Versions table	B_STORAGE
VERSIONS_INDEX	<string>	Version index	B_INDEX_USER
COMPRESS_ROLLBACK_SEGMENT	<string>	Version compression rollback segment	Oracle defaults
B_STORAGE	<string>	Business table	Oracle defaults
B_INDEX_ROWID	<string>	Business table object ID column index	Oracle defaults
B_INDEX_SHAPE	<string>	Business table spatial column index	Oracle defaults
B_INDEX_USER	<string>	Business table user index(s)	Oracle defaults
F_STORAGE	<string>	Feature table	Oracle defaults
F_INDEX_FID	<string>	Feature table fid column index	Oracle defaults
F_INDEX_AREA	<string>	Feature table area column index	Oracle defaults

Parameter Name	Value	Parameter Description	Default Value
F_INDEX_LEN	<string>	Feature table length column index	Oracle defaults
S_STORAGE	<string>	Spatial index table	Oracle defaults
S_INDEX_ALL	<string>	Spatial index table first index	Oracle defaults
S_INDEX_SP_FID	<string>	Spatial index table second index	Oracle defaults
A_STORAGE	<string>	Adds table	Oracle defaults
A_INDEX_ROWID	<string>	Adds table object ID column index	Oracle defaults
A_INDEX_SHAPE	<string>	Adds table spatial column index	Oracle defaults
A_INDEX_STATEID	<string>	Adds table sde_state_id column index	Oracle defaults
A_INDEX_USER	<string>	Adds table index	Oracle defaults
D_STORAGE	<string>	Deletes table	Oracle defaults
D_INDEX_ STATE_ROWID	<string>	Deletes table sde_states_id and sde_deletes_row_id column index	Oracle defaults
D_INDEX_DELETED_AT	<string>	Deletes table sde_deleted_at column index	Oracle defaults
LF_STORAGE	<string>	Sde log files table	Oracle defaults
LF_INDEXES	<string>	Sde log file table column indexes	Oracle defaults
LD_STORAGE	<string>	Sde log file data table	Oracle defaults
LD_INDEX_DATA_ID	<string>	Sde log file data table	Oracle defaults

Parameter Name	Value	Parameter Description	Default Value
LD_INDEX_ROWID	<string>	SDE log file data table SDE rowid column index	Oracle defaults
RAS_STORAGE	<string>	Raster RAS table	Oracle defaults
RAS_INDEX_ID	<string>	Raster RAS table RID index	Oracle defaults
BND_STORAGE	<string>	Raster BND table	Oracle defaults
BND_INDEX_COMPOSITE	<string>	Raster BND table composite column index	Oracle defaults
BND_INDEX_ID	<string>	Raster BND table RID column index	Oracle defaults
AUX_STORAGE	<string>	Raster AUX table	Oracle defaults
AUX_INDEX_COMPOSITE	<string>	Raster AUX table composite column index	Oracle defaults
BLK_STORAGE	<string>	Raster BLK table	Oracle defaults
BLK_INDEX_COMPOSITE	<string>	Raster BLK table composite column index	Oracle defaults
ATTRIBUTE_BINARY	<string>	Set this storage parameter to longraw or blob.	longraw
GEOMETRY_STORAGE	<string>	Set this storage parameter to sdebinary, sdelob, normalized, or sdo_geometry	SDEBINARY
SDO_COMMIT_INTERVAL	integer	Specifies the Oracle Spatial Geometry Types index commit interval	Use Oracle Default
SDO_DIMNAME_1	string	The name of the first dimension for Oracle Spatial Geometry Types only	X

Parameter Name	Value	Parameter Description	Default Value
SDO_DIMNAME_2	string	The name of the second dimension for Oracle Spatial Geometry Types only	Y
SDO_DIMNAME_3	string	The name of the third dimension for Oracle Spatial Geometry Types only	Z
SDO_DIMNAME_4	string	The name of the fourth dimension for Oracle Spatial Geometry Types only	M
SDO_INDEX	string	The Oracle Spatial Geometry Types index type (FIXED, HYBRID, RTREE)	Oracle Defaults
SDO_INDEX_SHAPE	string	The Oracle Spatial Geometry types spatial index storage parameters	Oracle Default
SDO_LAYER_GTYPE	POINT	Specifies special processing for Oracle Spatial Geometry Types point data	Set only for POINT data
SDO_LB_1	real number	Lower dimension boundary for Oracle Spatial Geometry Type and Normalized Schema	Based on extent of data loaded
SDO_LB_2	real number	Lower dimension boundary for Oracle Spatial Geometry Type and Normalized Schema	Based on extent of data loaded
SDO_LB_3	real number	Lower dimension boundary for Oracle Spatial Geometry Types only	Based on extent of data loaded
SDO_LB_4	real number	Lower dimension boundary for Oracle Spatial Geometry Types only	Based on extent of data loaded

Parameter Name	Value	Parameter Description	Default Value
SDO_LEVEL	integer	Specifies the desired fixed-size tiling level for Oracle Spatial Geometry Types only	Computed by SDO_TUNE.ESTIMATE_TILING_LEVEL
SDO_MAXLEVEL	integer	Specifies the maximum tiling level for Oracle Spatial Geometry Types only	Computed by SDO_TUNE.ESTIMATE_TILING_LEVEL
SDO_NUMTILES	integer	Specifies the number of variable-sized tiles to be used in tessellating an object for Oracle Spatial Geometry Type and Normalized Schema	Computed by SDO_TUNE.ESTIMATE_TILING_LEVEL
SDO_ORDCNT	integer	The number of ordinates in a row (for Oracle Spatial Normalized Schema Only)	16 (2 for POINT data)
SDO_SRID	integer	Oracle Spatial coordinate reference identifier assigned to the SDO_GEOMETRY column	NULL
SDO_TOLERANCE_1	real number	The precision of the dimension for Oracle Spatial Geometry Type and Normalized Schema	.0005
SDO_TOLERANCE_2	real number	The precision of the dimension for Oracle Spatial Geometry Type and Normalized Schema	.0005
SDO_TOLERANCE_3	real number	The precision of the dimension for Oracle Spatial Geometry Types only	.0005
SDO_TOLERANCE_4	real number	The precision of the dimension for Oracle Spatial Geometry Types only	.0005

Parameter Name	Value	Parameter Description	Default Value
SDO_UB_1	real number	Upper dimension boundary for Oracle Spatial Geometry Type and Normalized Schema	Based on extent of data loaded
SDO_UB_2	real number	Upper dimension boundary for Oracle Spatial Geometry Type and Normalized Schema	Based on extent of data loaded
SDO_UB_3	real number	Upper dimension boundary for Oracle Spatial Geometry Types only	Based on extent of data loaded
SDO_UB_4	real number	Upper dimension boundary for Oracle Spatial Geometry Types only	Based on extent of data loaded
SDO_VERIFY	boolean	If TRUE, ArcSDE will verify and correct as necessary all geometries as they are accessed from the Oracle Spatial Geometry Type or Normalized Schema	FALSE

CHAPTER 4

Managing tables, feature classes, and raster columns

A fundamental part of any database is creating and loading the tables. Tables with spatial columns are called standalone feature classes. Attribute-only (nonspatial) tables are also an important part of any database. This chapter will describe the table and feature class creation and loading process.

Data creation

There are numerous applications that can create and load data within an ArcSDE Oracle database. These include:

1. ArcSDE administration commands located in the bin directory of SDEHOME:

   - sdelayer—creates and manages feature classes.
   - sdetable—creates and manages tables.
   - sdeimport—takes an existing sdeexport file and loads the data into a feature class.
   - shp2sde—loads an ESRI shapefile into a feature class.
   - cov2sde—loads a coverage, Map LIBRARIAN layer, or an ArcStorm™ layer into a feature class.
   - tbl2sde—loads an attribute-only dBASE® or INFO™ file into a table.
   - sdegroup—a specialty feature class creation command that combines the features of an existing feature class into single multipart features and stores them in a new

feature class for background display. The generated feature class is used for rapid display of a large amount of geometry data. The attribute information is not retained, and spatial searches cannot be performed on these feature classes.

These are all run from the operating system prompt. Command references for these tools are in the ArcSDE developer help.

Other applications include:

2. ArcGIS Desktop—use ArcCatalog or ArcToolbox to manage and populate your database.
3. ArcInfo Workstation—use the Defined Layer interface to create and populate the database.
4. ArcView GIS 3.2—use the Database Access extension.
5. MapObjects®—custom Component Object Model (COM) applications can be built to create and populate databases.
6. ArcSDE CAD Client extension—for AutoCAD® and MicroStation® users.
7. Other third party applications built with either the C or Java™ APIs.

This document focuses primarily on the ArcSDE administration tools but does provide some ArcGIS Desktop examples as well. In general, most people prefer an easy-to-use graphic user interface like the one found in ArcGIS Desktop. For details on how to use ArcCatalog or ArcToolbox (another desktop data loading tool), please refer to the ArcGIS books:

- *Using ArcCatalog*
- *Using ArcToolbox*
- *Building a Geodatabase*

Creating and populating a feature class

The general process involved with creating and loading a feature class is:

1. Create the business table.
2. Record the business table and the spatial column in the ArcSDE LAYERS and GEOMETRY_COLUMNS system tables, thus adding a new feature class to the database.

3. Switch the feature class to load_only_io mode (optional step to improve bulk data loading performance. It is OK to leave feature class in normal_io mode to load data.).
4. Insert the records (load data).
5. Switch the feature class to normal_io mode (builds the indexes).
6. Version the data (optional).
7. Grant privileges on the data (optional).

In the following sections, this process is discussed in more detail and illustrated with some examples of ArcSDE administration commands usage and ArcInfo data-loading utilities through the ArcCatalog and ArcToolbox interfaces.

Creating a feature class "from scratch"

There are two basic ways to create a feature class. You can create a feature class from scratch (requiring considerably more effort), or you can create a feature class from existing data such as a coverage or ESRI shapefile. Both methods are reviewed below with the "from scratch" method being first.

Creating a business table

You may create a business table with either the SQL CREATE TABLE statement or with the ArcSDE sdetable command. The sdetable command allows you to include a dbtune configuration keyword containing the storage parameters of the table.

Although the table may be up to 256 columns, ArcSDE requires that only one of those columns be defined as a spatial column.

In this example, the sdetable command is used to create the 'roads' business table.

```
sdetable -o create -t roads -d 'road_id integer, name string(32), shape
integer' -k roads -u beetle -p bug
```

The table is created using the dbtune configuration keyword (-k) 'roads' by user beetle.

The same table could be created with a SQL CREATE TABLE statement using the Oracle SQL*Plus interface.

```
create table roads
(road_id     integer,
name         varchar(32),
shape        integer)
tablespace beetle_data
storage (initial 16K next 8K);
```

At this point you have created a table in the database. ArcSDE does not yet recognize it as a feature class. The next step is to record the spatial column in the ArcSDE LAYERS and GEOMETRY_COLUMNS system tables and thus add a new feature class to the database.

Adding a feature class

After creating a business table, you must add an entry for the spatial column in the ArcSDE LAYERS system tables before the ArcSDE server can reference it. Use the sdelayer command with the "-o add" operation to add the new feature class.

In the following example, the roads feature class is added to the ArcSDE database. Note that to add the feature class, the roads table name and the spatial column are combined to form a unique feature class reference. To understand the purpose of the –e, –g, and –x options, refer to the sdelayer command reference in the ArcSDE developer help.

```
sdelayer -o add -l roads,shape -e l+ -g 256,0,0 -x 0,0,100 -u beetle -p bug -k
roads
```

If the spatial column of the feature class is stored in either LONG RAW or BLOB ArcSDE compressed binary format, the feature and spatial index tables are created. The feature class tables and indexes are stored according to the storage parameters of the **roads** configuration keywords in the DBTUNE table. Upon successful completion of the previous sdetable command—to create a table—and the sdelayer command—to record the feature class in the ArcSDE system tables—you have an empty feature class in normal_io mode.

Switching to load-only mode

Switching the feature class to load-only mode drops the spatial index and makes the feature class unavailable to ArcSDE clients. Bulk loading data into the feature class in this state is much faster due to the absence of index maintenance. Use the sdelayer command to switch the feature class to load-only mode by specifying the "-o load_only_io" operation.

```
sdelayer -o load_only_io -l roads,shape -u beetle -p bug
```

Note: A feature class, registered as multiversioned, cannot be placed in the load-only I/O mode. However, the grid size can be altered with the -o alter operation. The alter operation will apply an exclusive lock on the feature class, preventing all modifications by ArcInfo until the operation is complete.

Inserting records into the feature class

Once the empty feature class exists, the next step is to populate it with data. There are several ways to insert data into a feature class, but probably the easiest method is to convert an existing shapefile or coverage or import a previously exported ArcSDE sdeexport file directly into the feature class.

In this first example, shp2sde is used with the init operation. The init operation is used on newly created feature classes or can be used on feature classes when you want to "overwrite"

data that's already there. Don't use the init operation on feature classes that already contain data unless you want to remove the existing data. Here, the shapefile, 'rdshp', will be loaded into the feature class, 'roads'. Note that the name of the spatial column ('shape' in this case) is included in the feature class (-l) option.

```
shp2sde -o init -l roads,shape -f rdshp -u beetle -p bug
```

Similarly, we can also use the cov2sde command:

```
cov2sde -o init -l roads,shape -f rdcov -u beetle -p bug
```

Switching the table to normal_io mode

After data has been loaded into the feature class, you must switch the feature class to normal_io mode to re-create all indexes and make the feature class available to clients. For example:

```
sdelayer -o normal_io -l roads,shape -u beetle -p bug
```

Versioning your data

Optionally, you may enable your feature class as multiversioned. Versioning is a process that allows multiple representations of your data to exist without requiring duplication or copies of the data. ArcMap requires data to be multiversioned to edit it. For further information on versioning data, refer to the *Building a Geodatabase* book.

In this example, the feature class called 'states' will be registered as multiversioned using the sdetable alter_reg operation.

```
sdetable -o alter_reg -t states -c ver_id -C SDE -V multi -k GEOMETRY_TYPE
```

Granting privileges on the data

Once you have the data loaded, it is often necessary for other users to have access to the data for update, query, insert, or delete operations. Initially, only the user who has created the business table has access to it. In order to make the data available to others, the owner of the data must grant privileges to other users. The owner can use the sdelayer command to grant privileges. Privileges can be granted to either another user or to a role.

In this example, a user called 'beetle' gives a user called 'spider' SELECT privileges on a feature class called 'states'.

```
sdelayer -o grant -l states,feature -U spider -A SELECT -u beetle -p bug
```

The full list of -A keywords are:

SELECT. The user may query the selected object(s) data.

DELETE. The user may delete the selected object(s) data.

UPDATE. The user may modify the selected object(s) data.

INSERT. The user may add new data to the selected object(s) data.

If you include the -I grant option, you also grant the recipient the privilege of granting other users and roles the initial privilege.

Creating and loading feature classes from existing data

We have reviewed the "from scratch" method of creating a schema and then loading it. This next section reviews how to create feature classes from existing data. This method is simpler since the creation and load process is completed at once.

Each of the ArcSDE administration commands, shp2sde, cov2sde, and sdeimport, includes a "-o create" operation, which allows you to create a new feature class within the ArcSDE database. The create operation does all of the following:

- Creates the business table using the input data as the template for the schema
- Adds the feature class to the ArcSDE system tables
- Puts the feature class into load-only mode
- Inserts data into the feature class
- When all the records are inserted, puts the feature class into normal_io mode

shp2sde

shp2sde converts shapefiles into ArcSDE feature classes. The spatial column definition is read directly from the shapefile. You can use the shpinfo command to display the shapefile column definitions. As part of the create operation, you can specify which spatial storage format you wish to adopt for the data storage by including a "–k" option that references to a configuration keyword containing a GEOMETRY_STORAGE parameter.

In this example, Oracle Spatial geometry type is selected as the storage format by including the configuration keyword "GEOMETRY_TYPE". The keyword GEOMETRY_TYPE, defined in the DBTUNE table, also sets a number of additional parameters for this storage type, which will be used to create the Oracle Spatial index. See Appendix D, 'Oracle Spatial Geometry Type', for additional information on Oracle Spatial and specifics about how it can be configured.

```
shp2sde -o create -f rdshp -l roads,shape -k GEOMETRY_TYPE -u beetle -p bug
```

cov2sde

The cov2sde command converts ArcInfo coverages, ArcInfo Librarian™ library feature classes, and ArcStorm library feature classes into ArcSDE feature classes. The create operation derives the spatial column definition from the coverage's feature attribute table. Use the ArcInfo describe command to display the ArcInfo data source column definitions.

In this example, an ArcStorm library, 'roadlib', is converted into the feature class, 'roads'.

```
cov2sde -o create -l roads,shape -f roadlib,arcstorm -g 256,0,0 -x 0,0,100 -e
l+ -u beetle -p bug
```

sdeimport

The sdeimport command converts ArcSDE export files into ArcSDE feature classes. In this example, the roadexp ArcSDE export file is converted into the feature class 'roads'.

```
sdeimport -o create -l roads,shape -f roadexp -u beetle -p bug
```

After using these commands to create and load data, you may optionally need to enable multiversioning on the feature class and grant privileges on the feature class to other users.

Appending data to an existing feature class

A common requirement for data management is to be able to append data to existing feature classes. The data loading commands described thus far have a –o append operation for appending data. A feature class must exist prior to using the append operation. If the feature class is multiversioned, it must be in an "open" state. It is also advisable to change the feature class to load-only I/O mode and pause the spatial indexing operations before loading the data to improve the data-loading performance. The spatial indexes will be re-created when the feature class is put back into normal I/O mode. Because the feature class has been defined, the metadata exists and is not altered by the append operation.

In the shp2sde example below, a previously created 'roads' feature class appends features from a shapefile, 'rdshp2'. All existing features, loaded from the 'rdshp' shapefile, remain intact, and ArcSDE updates the feature class with the new features from the rdshp2 shapefile.

```
sdelayer -o load_only_io -l roads,shape -u beetle -p bug
shp2sde -o append -f rdshp2 -l roads,shape -u beetle -p bug
sdelayer -o normal_io -l roads,shape -u beetle -p bug
sdetable -o update_dbms_stats -t roads -u beetle -p bug
```

Note the last command in the sequence. The sdetable update_dbms_stats operation updates the table and index statistics required by the Oracle cost-based optimizer. Without the statistics the optimizer may not be able to select the best execution plan when you query the table. For more information on updating statistics, see Chapter 2, 'Essential Oracle configuring and tuning'.

Creating and populating raster columns

Raster columns are created from the ArcGIS Desktop using ArcCatalog or ArcMap. To create a raster column, you will first need to convert the image file into a format acceptable to ArcSDE. Then after the image has been converted to the ESRI raster file format, you can convert it into a raster column.

For more information on creating raster columns using either ArcCatalog or ArcToolbox, refer to *Building a Geodatabase.*

To estimate the size of your raster data, refer to Appendix A, 'Estimating the size of your tables and indexes'.

To understand how ArcSDE stores rasters in Oracle, refer to Appendix B, 'Storing raster data'.

Creating views

There are times when a DBMS view is required in your database schema. ArcSDE provides the sdetable create_view operation to accommodate this need. The view creation is much like any other Oracle view creation. If you want to create a view using a layer and you want the resulting view to appear as a feature class to client applications, include the feature class's spatial column in the view definition. As with the other ArcSDE commands, see the ArcSDE developer help for more information.

Exporting data

As with importing data, there are also client applications that export data from ArcSDE as well. With ArcSDE, the following command line tools exist:

sdeexport—creates an ArcSDE export file to easily move feature class data between Oracle instances and to other supported DBMSs

sde2shp—creates an ESRI shapefile from an ArcSDE feature class

sde2cov—creates a coverage from an ArcSDE feature class

sde2tbl—creates a dBASE or INFO file from a DBMS table

Schema modification

There will be occasions when it is necessary to modify the schema of some tables. You may need to add or remove columns from a table. The ArcSDE command to do this is sdetable with the –o alter option. ArcCatalog offers an easy-to-use tool for this and other schema operations such as modifying the spatial index (grids) and adding and dropping column indexes.

Using the ArcGIS Desktop ArcCatalog and ArcToolbox applications

So far the discussion has focused on ArcSDE command line tools that create feature class schemas and load data into them. While robust, these commands can be daunting for the first-time user. In addition, if you are using ArcGIS Desktop, you may have to use ArcCatalog to create feature datasets and feature classes within those feature datasets to use specific ArcGIS Desktop functionality. For that reason, we provide a glimpse of how to use ArcToolbox and ArcCatalog to load data. Please refer to the ArcInfo documentation on ArcCatalog, ArcToolbox, and the geodatabase for a full discussion of these tools.

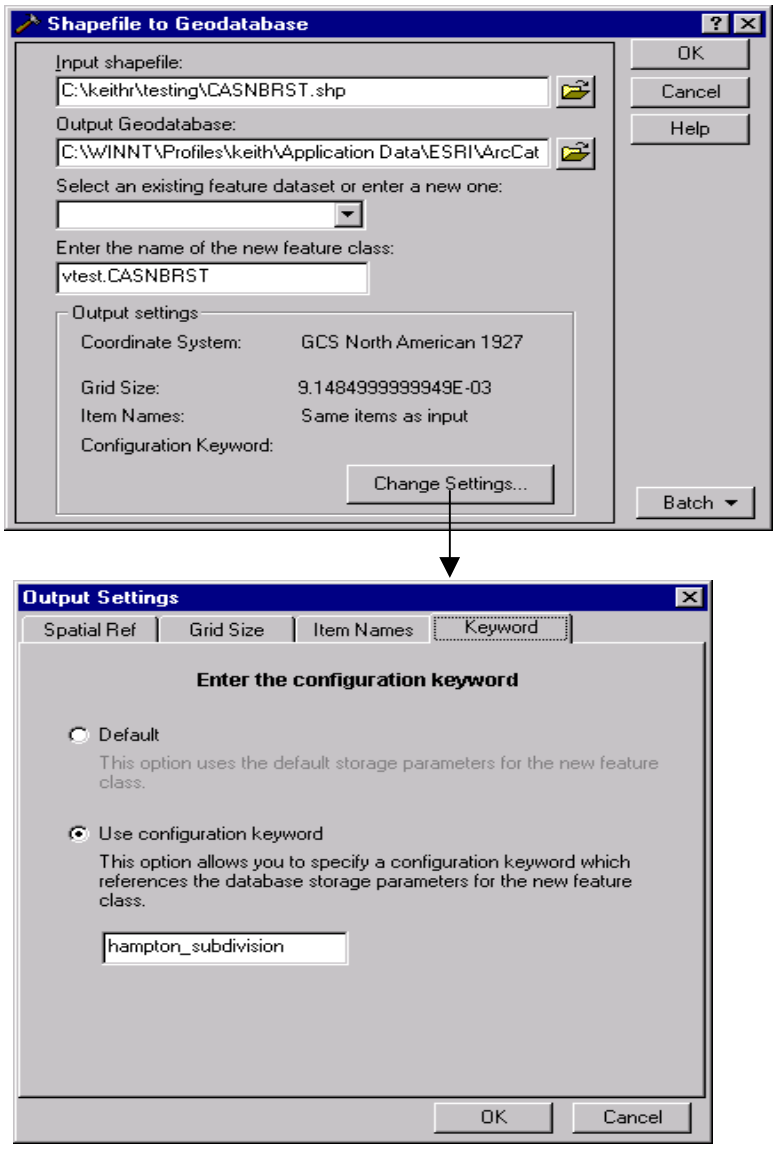
Loading data

You can convert ESRI shapefiles, coverages, Map LIBRARIAN layers, and ArcStorm layers into geodatabase feature classes with the ArcToolbox and ArcCatalog applications. ArcToolbox provides a number of tools that enable you to convert data from one format to another.

ArcToolbox operations, such as the ArcSDE administration commands shp2sde, cov2sde, and sdeimport, accept configuration keywords. By using a configuration keyword with the GEOMETRY_STORAGE storage parameter, the user can choose one of the four Oracle spatial storage methods supported by ArcSDE 8.1.

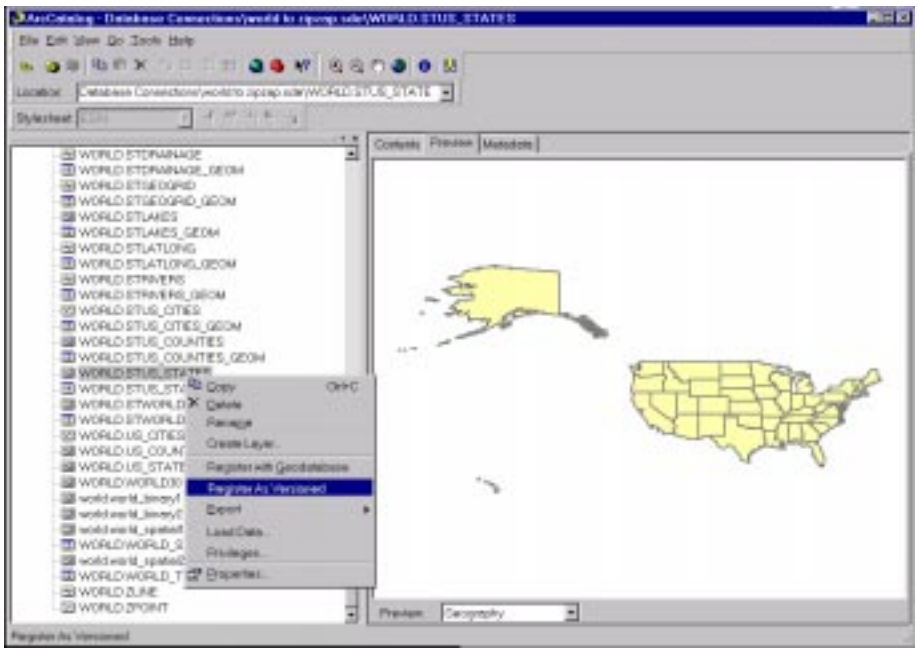
In the ArcToolbox Shapefile to Geodatabase wizard, you can see that a configuration keyword has been specified for the loading of the hampton_streets shapefile into the geodatabase. Since the geodatabase is maintained by an ArcSDE 8.1 service operating on an Oracle 8*i* database, you can store the resulting feature class using the Oracle Spatial geometry type format. This keyword has set the GEOMETRY_STORAGE parameter to SDO_GEOMETRY, indicating to ArcSDE that the resulting feature class should be stored as an Oracle Spatial geometry type.

The shapefile CASNBRST.shp is converted to a feature class vtest.CASNBRST using ArcToolbox.



Versioning your data

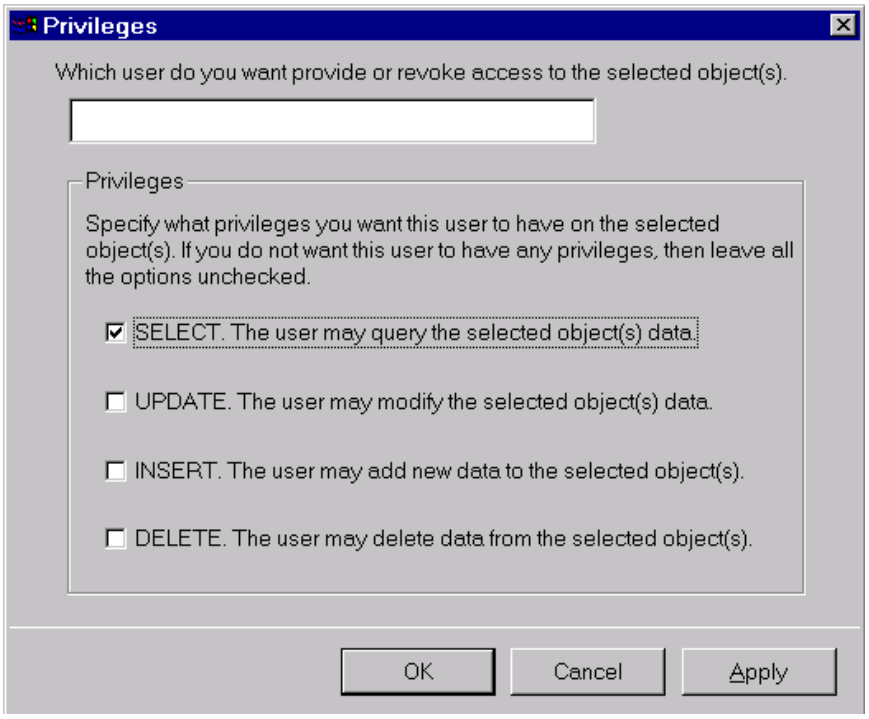
ArcCatalog also provides a means for registering data as multiversioned. Simply right-click the feature class to be registered as multiversioned and select the Register As Versioned context menu item.



A feature class is registered as multiversioned from within ArcCatalog.

Granting privileges

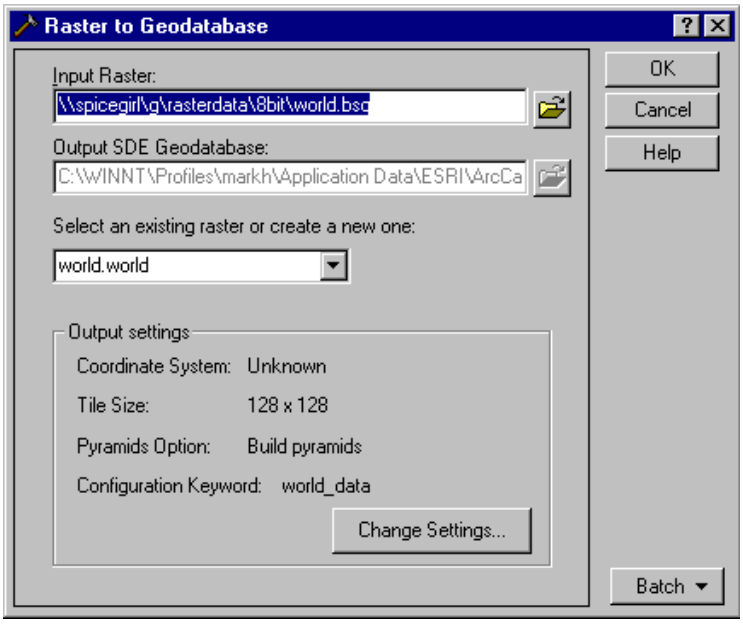
Using ArcCatalog, right-click on the data object class and click on the Privileges context menu. From the Privileges context menu assign privileges specifying the username and the privilege you wish to grant to or revoke from a particular user.



The ArcCatalog Privileges menu allows the owner of an object class, such as a feature dataset, feature class, or table, to assign privileges to other users or roles.

Creating a raster column with ArcCatalog

Using ArcCatalog, right-click on the database connection, point to Import, and click on Raster to Geodatabase. Navigate to the raster file to import. Click Change Settings if you want to change the coordinate reference system, tile size, pyramids option, or configuration keyword. Click OK to import the raster file into the Oracle database.


Raster to Geodatabase
Input Raster:
\\spicegirl\g\rasterdata\8bit\world.bsq
Output SDE Geodatabase:
C:\WINNT\Profiles\markh\Application Data\ESRI\ArcCa
Select an existing raster or create a new one:
world.world
Output settings
Coordinate System: Unknown
Tile Size: 128 x 128
Pyramids Option: Build pyramids
Configuration Keyword: world_data
Change Settings...
OK
Cancel
Help
Batch

CHAPTER 5

Connecting to Oracle

Beginning with ArcSDE 8.1, ArcSDE client applications can connect to either an ArcSDE service or directly to an Oracle8*i* instance. The direct connection capability, added during the ArcSDE 8.1 release, was achieved by embedding the ArcSDE application server technology into the ArcSDE client software. Any application programmed with the functionality of the ArcSDE 8.1 C libraries can connect directly to an Oracle8*i* instance.

ArcSDE client applications that connect to an ArcSDE service send spatial requests to the service. The ArcSDE service converts the spatial requests into SQL statements and submits them to the Oracle instance. Upon receiving results from the Oracle instance, the ArcSDE service converts the result into spatial data recognizable to the ArcSDE client.

At ArcSDE 8.1, the functionality of the ArcSDE service has been linked into the ArcSDE C API, allowing ArcSDE client applications to connect directly to Oracle8*i* instances. Spatial requests are converted to SQL statements by the ArcSDE client applications instead of the ArcSDE service.

Before you can connect to an ArcSDE service, you must install and configure the ArcSDE product. The sde user must be created, and the sde setup program (sdesetupora80 for Oracle 8 or sdesetupora8i for Oracle8*i*) must be run to create and populate the ArcSDE system tables and required stored procedures. As well, ArcSDE must be able to reference an ArcSdeServer license from a license manager accessible through the network.

Since a direct connection to an Oracle8*i* instance does not require the presence of an ArcSDE service, the ArcSDE product does not need to be installed. You are, however, required to run the ArcSDE setup program (sdesetupora8i for Oracle8*i*), which creates the necessary ArcSDE system tables in the sde users schema. Also, to obtain a read–write connection to the Oracle8*i* database, an ArcSDE client application must reference a valid ArcSdeServer license. If an ArcSdeServer license cannot be referenced, access is restricted to read-only.

The ArcSDE setup program is located in the bin directory of all ESRI products capable of connecting to ArcSDE. If you do not already have one, an ArcSdeServer license can be obtained from ESRI Customer Support.

To connect directly to an Oracle8*i* instance, you must configure the Oracle Net8 listener process, on the database host, to listen for Oracle client connections. You must also install the Oracle client on your client machine. The sections that follow provide details on how to set up the client and server machines to perform a direct connection to an Oracle8*i* instance.

For more information regarding an ArcSDE service, refer to the *ArcSDE Installation Guide* for installation instructions and the *Managing ArcSDE Services* for configuration and connection instructions.

All ArcSDE client applications, such as ArcMap or ArcCatalog, function the same way regardless of whether a user connects to an ArcSDE service or directly to an Oracle8*i* instance. The only difference occurs during the entry of the connection information.

Creating the Net8 listener service

To establish a connection to an Oracle8*i* instance that is running on a remote computer, you must configure and start the Oracle Net8 listener process. Oracle allows you to configure the Net8 listener to listen on just about any network protocol that might exist in today's diverse computer network. The discussion and the examples provided in this document are limited to the widely used TCP/IP network protocol.

Oracle offers a Java-based GUI on both the Windows NT and the UNIX server that simplifies the task of configuring the Oracle listener process. Provided is a simple walk-through of the Oracle Net8 Configuration Assistant. For a more in-depth discussion of the Net8 Configuration Assistant and other Oracle utilities, please refer to the Oracle8*i* online documentation.

On Windows NT launch the Net 8 Configuration Assistant by clicking Programs>Oracle> Ora*HOME*>Net8 Configuration Assistant. On UNIX systems launch the Net8 Configuration Assistant by running $ORACLE_HOME/bin/netca.

After the 'Welcome' panel appears choose the Listener configuration radio button and click Next.

The Net8 Configuration Assistant edits the listener.ora file normally located under the %ORACLE_HOME%\network\admin folder on Windows NT and the $ORACLE_HOME/network/admin directory on UNIX systems.

The Net8 Configuration Assistant will create a listener in the listener.ora file that looks something like this:

```
# LISTENER.ORA Network Configuration File:
D:\Oracle\Ora81\network\admin\listener.ora
# Generated by Oracle configuration tools.
LISTENER =
  ( DESCRIPTION_LIST =
    (  DESCRIPTION =
      ( ADDRESS_LIST =
        ( ADDRESS = ( PROTOCOL = TCP )( HOST = bruno )( PORT = 1521 ))
      )
    )
  )

SID_LIST_LISTENER =
  ( SID_LIST =
    ( SID_DESC =
      ( GLOBAL_DBNAME = bruno.esri.com )
      ( ORACLE_HOME = D:\oracle\ora81 )
      ( SID_NAME = bruno )
    )
  )
```

Note: For this particular listener.ora file, the GLOBAL_DBNAME parameter was manually entered after the Net8 Configuration Assistant added the listener service. You may also need to manually enter this parameter to the listener.ora file, depending on your network configuration.

If you receive an ORA 12514 error when you try to connect to the listener service, manually enter the GLOBAL_DBNAME parameter.

On the ‘Listener Configuration, Listener Name’ panel, enter the listener name. Unless you are an experienced Oracle DBA, use the LISTENER default value. Click Next and continue on to the ‘Listener Configuration, Select Protocols’ panel.

Select the TCP protocol from the Available Protocols list and click the right arrow button to move the TCP protocol into the Selected Protocols list. Click Next to configure the TCP/IP network protocol adapter from the Listener Configuration, TCP/IP Protocol.

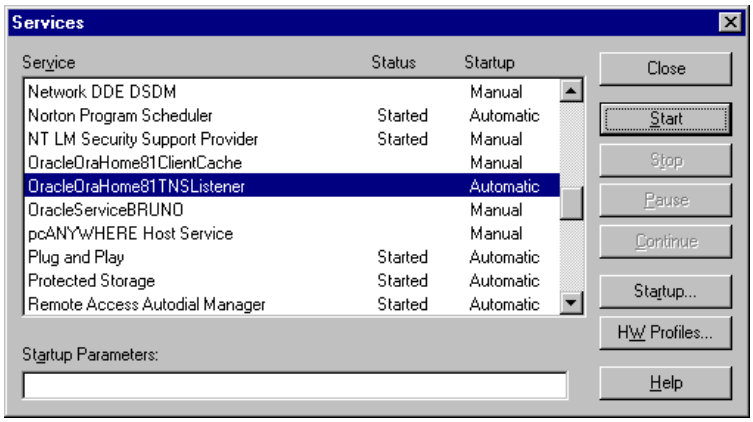
Choose the default ‘Use standard port number of 1521’ radio button. If you know that another software product is already using this port number, enter a different one.

Click Next to continue on to the ‘Listener Configuration, More Listeners?’ panel. You should not need to configure another listener, so choose the "No" radio button and click Next.

Click Next on the ‘Listener Configuration Done’ panel, which returns to the ‘Welcome’ panel. Click Finish.

Starting the Net8 listener service

Before you can connect to the listener service, you must start it. To start the listener service on Windows NT, click the Start>Settings>Control panel and double-click the Services icon in the Control Panel window. After the Services dialog box appears, scroll down until you find the Oracle Net8 listener service and click the Start button.



To start the Net8 listener process on a UNIX platform as the Oracle8*i* user, issue the **lsnrctl start** command at the operating system prompt.

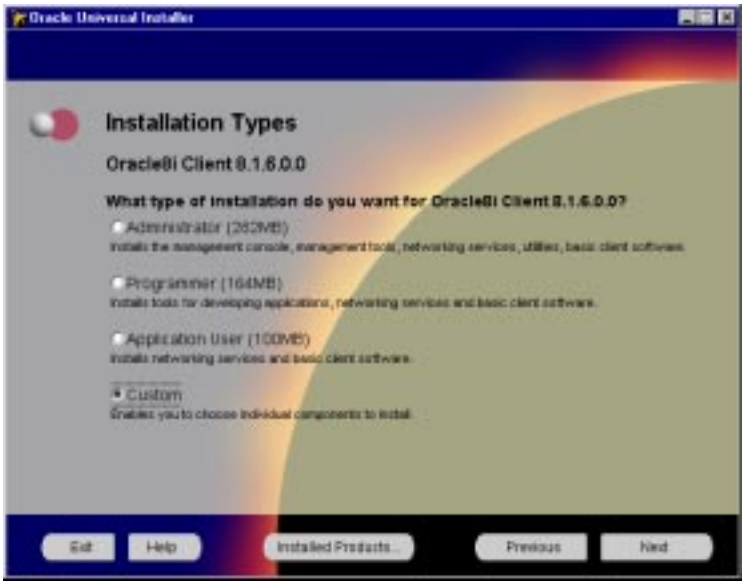
```
$ lsnrctl start

LSNRCTL for Solaris: Version 8.1.7.0.0 - Production on 12-JAN-2001 16:37:15

(c) Copyright 1998 Oracle Corporation.  All rights reserved.

Starting /ultra1/app/ora817/product/8.1.7/bin/tnslsnr: please wait...

TNSLSNR for Solaris: Version 8.1.7.0.0 - Production
System parameter file is
/ultra1/app/ora817/product/8.1.7/network/admin/listener.ora
Log messages written to
/ultra1/app/ora817/product/8.1.7/network/log/listener.log
Trace information written to
/ultra1/app/ora817/product/8.1.7/network/trace/listener.trc
Listening on: (DESCRIPTION=(ADDRESS=(PROTOCOL=ipc)(KEY=ultra)))
Listening on: (DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=ultra)(PORT=1521)))

Connecting to (DESCRIPTION=(ADDRESS=(PROTOCOL=IPC)(KEY=ultra)))
STATUS of the LISTENER
------------------------
Alias                     LISTENER
Version                   TNSLSNR for Solaris: Version 8.1.7.0.0 - Production
Start Date                12-JAN-2001 16:37:15
Uptime                    0 days 0 hr. 0 min. 0 sec
Trace Level               admin
Security                  OFF
SNMP                      OFF
Listener Parameter File
/ultra1/app/ora817/product/8.1.7/network/admin/listener.ora
Listener Log File
/ultra1/app/ora817/product/8.1.7/network/log/listener.log
Listener Trace File
/ultra1/app/ora817/product/8.1.7/network/trace/listener.trc
Services Summary...
  ora817               has 1 service handler(s)
The command completed successfully
```

Net8 Client installation and configuration

To make a direct connection to an Oracle8*i* instance, Oracle Client must be installed on your client machine. Oracle Client is shipped with the Oracle8*i* Enterprise Edition. Oracle Client includes the installation of the Oracle Net8 software, which is necessary to connect to an Oracle server.

After you start the Oracle Universal installer and complete the preliminary panels, choose the Oracle8*i* Client radio button from the Available Products panel and click Next.

From the ‘Installation Types’ panel select the Custom radio button and click Next.



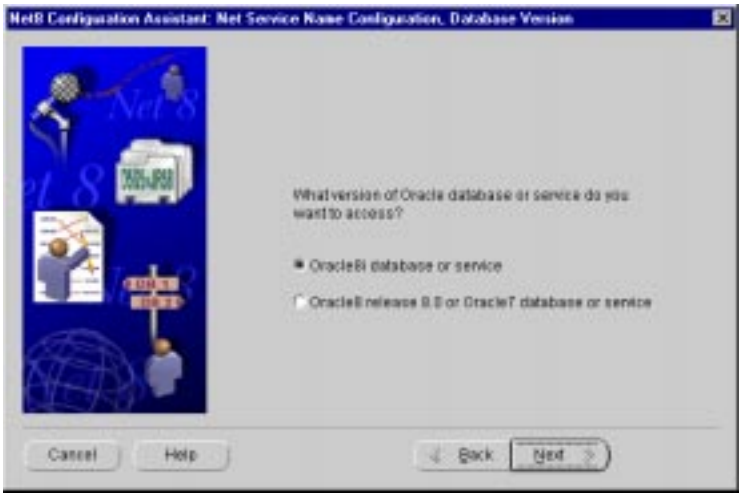
From the ‘Available Product Components, Oracle 8*i* Client’ panel you need to check at least the Net8 Products and Net8 Client boxes to enable a direction connection to an Oracle8*i* instance. Click Next to proceed to the Installation Summary panel and click Next again to install the Net8 products of the Oracle8*i* Client. Immediately following the installation of the software, the Net8 Configuration Manager appears, which allows you to configure the net service name needed to connect to a remote Oracle database.

When the 'Net8 Configuration Assistant Welcome' panel appears, check 'Perform typical configuration' and click Next to add the net service name. Alternatively, you can click Cancel to defer the configuration of the net service name. Clicking Cancel returns control to the Oracle Universal Installer installation summary panel.

On the 'Net8 Configuration Assistant Welcome' panel that follows click, the 'No, I will create net service names myself. I would like to create the first one now.' radio button.

From the ‘Net8 Configuration Assistant: Welcome’ panel, choose the ‘Local Net Service Name configuration’ radio button and click Next to proceed to the 'Net Service Name Configuration, Database Version' panel.

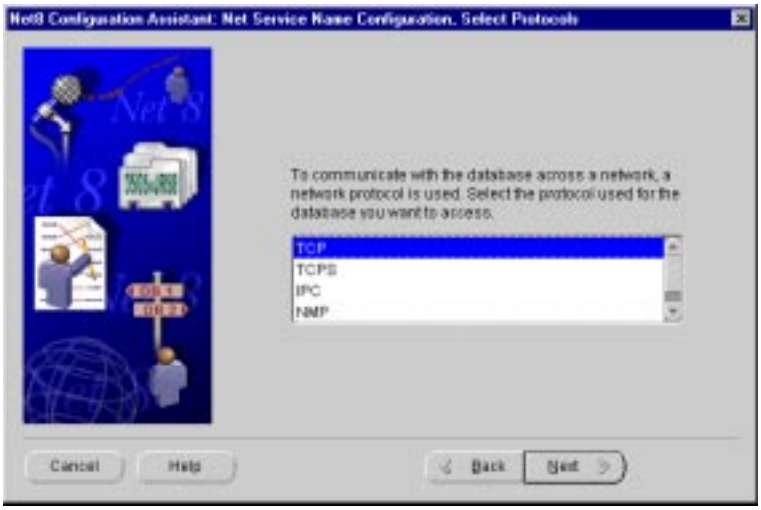
Since the ArcSDE direct connection method works only with Oracle8*i*, choose the ‘Oracle8*i* database or service’ radio button. Click Next and continue to the ‘Net Service Name Configuration, Service Name’ panel.



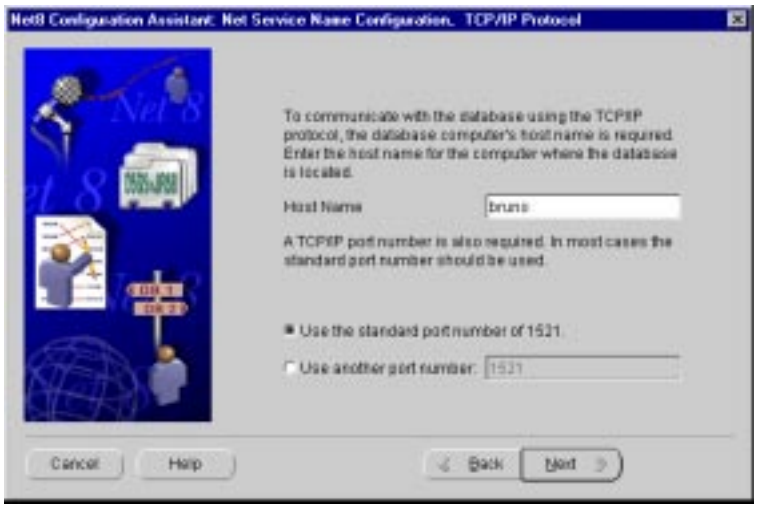
Although the service name can be anything you want it to be, for some Oracle applications such as Advance Replication it is required to be the global database name. By convention, you should use the global database name as it is easier to keep track of. The global database name is formed by concatenating the DB_NAME (database name) and the DB_DOMAIN (database

domain) together and separating them by a period. In this example the database name, *bruno*, and the database domain, *esri.com*, concatenate to form the global database name *bruno.esri.com*. Click Next to continue to the Net Service Name Configuration, Select Protocols panel.

In the previous section we created a listener that listens on the TCP/IP protocol. Select the TCP protocol and click Next to proceed to the 'Net Service Name Configuration, TCP/IP Protocol' panel.



Enter the host name of the computer that the database is running on. The host name should be listed in your NIS hosts file. You can also enter the computer's IP address, although you should set up and use the host name since it is easier to recognize. Choose the 'Use the standard port number of 1521.' radio button unless you were forced to use a different port number when you configured the listener. Click Next to continue to the Net Service Name Configuration, Test.



You should test the connection of the service name that you have just created. You can return later to test the connection, but if you are ready to test it now, choose the 'Yes, perform a test' radio button and click Next. The 'Net Service Name Configuration, Connecting' panel will appear with the results of the connection test. If the Details dialog box does not contain 'Connecting…Test successful.', there is a problem with the connection. The first thing to look at is the username and password used to make the connection. By default, the Net8 Configuration Assistant defaults to scott as the username and tiger as the password. If necessary, click Change Login to use a different username and password. When you click OK on the 'Change Login' panel, Net8 Configuration Assistant will attempt the connection again. If you are still unable to connect to the listener, contact Oracle Technical Support for help.

Following a successful connect test, click Next to proceed to the 'Net Service Name Configuration Done' panel. Click Next on this panel to return to the 'Welcome' panel. Click Finish. The tnsnames.ora file has been updated and can now be referenced by an Oracle8*i* client software product to make a connection to an Oracle8*i* database.

The entry made to the tnsnames.ora file by the Net* Configuration Assistant should look something like this:

```
BRUNO.ESRI.COM =
  ( DESCRIPTION =
    ( ADDRESS_LIST =
      ( ADDRESS = ( PROTOCOL = TCP )( HOST = bruno )(PORT = 1521 ))
    )
    ( CONNECT_DATA =
      ( SERVICE_NAME = bruno.esri.com )
    )
  )
```

Configuring ArcSDE applications for Oracle8*i* direct connections

ArcSDE applications that have linked in the client libraries of the ArcSDE for Oracle8*i* C API are capable of connecting directly to Oracle8*i* instances. When connecting to a remote Oracle8*i* instance, the Oracle Client software must be installed on the local machine, and the net service name containing the connection information to the remote Oracle8*i* instance must be configured in the Oracle Client tnsnames.ora file.

Once these tasks have been completed, it is possible to further configure the ArcSDE client application to connect to a particular Oracle8*i* instance, by default. In addition, should you fail to establish a connection to a properly configured Oracle8*i* instance, proper configuration of the ArcSDE client application will provide a location of error log files.

Configuring the ArcSDE etc directory

As an option, the additional files can be created in the etc directory of ArcSDE client application to capture error messages and establish a default Oracle8*i* connection environment. An ArcSDE client application will search for the etc directory under the SDEHOME environment variable.

SDEHOME is determined by an ArcSDE client application using the following search criteria:

1. If the SDEHOME environment variable is set in the system environment, the etc directory, if one exists, must be located in the directory defined by the value of the SDEHOME environment variable.

2. If the SDEHOME environment variable is not set and the ARCHOME environment variable is, the etc directory, if one exists, must be located in the directory defined by the value of the ARCHOME environment variable.

3. Finally, if neither the SDEHOME nor the ARCHOME environment variables is set, the etc directory must be located in the directory defined by the registry key value of HKEY_LOCAL_MACHINE / SOFTWARE / ESRI / ArcInfo / Desktop / 8.0 / SourceDir.

Create the dbinit.sde file in the etc directory and add Oracle LOCAL variable for Windows NT and TWO_TASK on UNIX systems to this file to set the default connection to a particular Oracle8*i* instance (see Configuring Net Service Names below).

If the etc directory exists, upon initial connection to the Oracle8*i* instance, the ArcSDE application creates the sde.errlog file within the etc directory. All subsequent error messages will be written to this file. Therefore, if you cannot establish a connection to the Oracle8*i* instance, look in the sde.errlog for possible further information as to what the problem may be.

Connecting to an Oracle8*i* net service name or an ArcSDE service

ESRI application software uses the same graphical user interface to connect directly to an Oracle8*i* instance as it does to an ArcSDE service. Refer to the ESRI application product documentation for more information on exactly how to connect directly to a net service name containing the connection information to an Oracle8*i* instance.

The example provided here uses the ArcMap GUI to illustrate how the entry of the direct connection information for the net service name to an Oracle8*i* instance and an ArcSDE service connection differ.

Connecting to Oracle8*i* instance from ArcMap

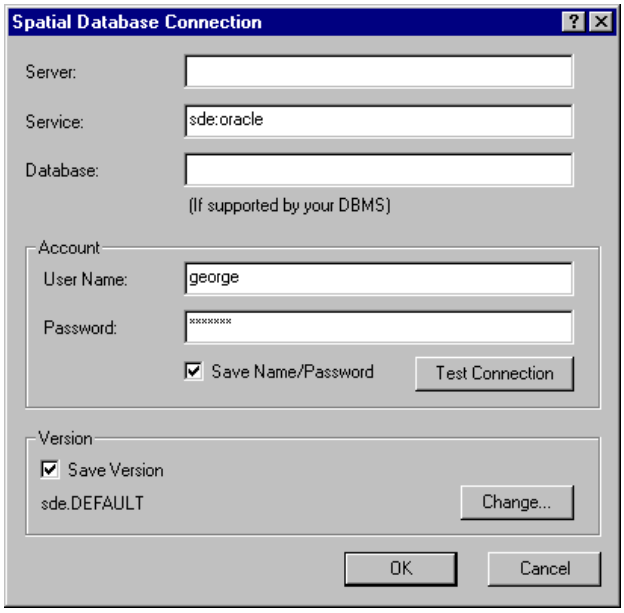
In the example, the SDE Connections dialog box appears after a double-click on the Database Connections followed by a double-click on Add SDE Connection.

To connect to an Oracle 8*i* instance, enter sde:oracle in the Service field.

In the User Name field, enter the Oracle8*i* username. The username in this example is gus.

In the Password field, enter the Oracle8*i* password, optionally, followed by the at sign "@" and the Oracle8*i* net service name. If you do not enter the net service name in the Password field, the net service name must be set in either the dbinit.sde file or as a system variable in the environment (TWO_TASK if your local machine is UNIX or LOCAL if your local machine is Windows NT).

The Server and Database fields are not required to establish a direct connection to an Oracle8*i* instance.



Connecting to an ArcSDE service from ArcMap

In the example, the SDE Connections dialog box appears after a double-click on the Database Connections followed by a double-click on Add SDE Connection.

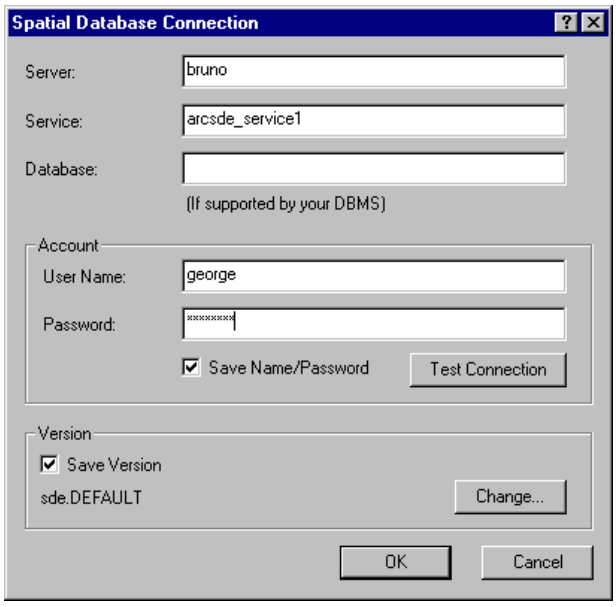
To connect to an ArcSDE service, enter the server name in the Server field.

In the Service field, enter the ArcSDE service.

In the User Name field, enter the Oracle username.

In the Password field, enter the Oracle password.

The Database field is not required for connections to ArcSDE for Oracle services but is required for some of the other ArcSDE implementations such as ArcSDE for SQL Server.



Troubleshooting direct connection problems

Some of the more common problems that occur when you try to establish a direct connection to Oracle8*i* are listed below.

Oracle server was not started

Symptom: You try to connect to the Oracle8*i* instance, and you receive:

```
ORA 01034.
```

Cause: The Oracle8*i* instance has not been started.

Solution: Start the Oracle8*i* instance.

Oracle listener was not started

Symptom: You try to connect to the Oracle8*i* instance, and you receive:

```
ORA-12541: TNS:no listener.
```

Cause: The Oracle8*i* listener has not been started.

Solution: Start the Oracle8*i* listener.

Oracle username or password are incorrect

Symptom: You try to connect to an Oracle8*i* instance, and you receive:

```
ORA-01017: invalid username/password; logon denied error
```

Cause: Either the username or the password is incorrect.

Solution: Connect the username or password and try again. If you cannot remember the password, connect to Oracle as the DBA and change the password with the ALTER USER command. If you cannot remember the username, connect to Oracle as the DBA and list the available usernames from the DBA_USERS table.

Net service name does not exist

Symptom: You try to connect to an Oracle8*i* instance, and you receive:

```
ORA-12154: TNS:could not resolve service name
```

Cause: Oracle could not find the net service name in the tnsnames.ora file.

Solution: Check the spelling of the net service name and reenter if misspelled. If you are sure you entered the net service name correctly, examine the net service name in the tnsnames.ora file to make sure that it was entered correctly.

Net service name cannot be resolved in listener

Symptom: You try to connect to an Oracle8*i* instance, and you receive:

```
ORA-12514: TNS:listener could not resolve SERVICE_NAME given in
connect descriptor
```

Cause: Although the net service name was found in the tnsnames.ora file, and connection information was able to locate the listener service running on the remote host, Oracle was not able to locate to the Oracle 8*i* instance.

Solution: A common cause of this problem is the absence of the GLOBAL_DBNAME parameter in the listener.ora file. Examine the listener.ora file. If the GLOBAL_DBNAME parameter is missing, add it and restart the listener again. Retry the connection.

The Oracle instance is not an Oracle8*i* instance

Symptom: You try to connect to a noninstance, and you receive:

```
ERROR in clearing lock and process tables.
Error:  -51
DBMS error code: 6550
ORA-06550: line 1, column 219:
PLS-00201: identifier 'SDE.PINFO_UTIL' must be declared
ORA-06550: line 1, column 219:
PL/SQL: Statement ignored


Couldn't initialize shared memory, error = -51.
Cannot Attach to Shared Memory -1
```

Cause: The Oracle instance is not 8*i*, or the sdesetupora8i program was not run. Make sure the sdesetupora8i program has been run. The sdeseupora8i program will only run on an Oracle8*i* instance.

Solution: Check your Oracle version by querying the dynamic view V$VERSION. If the Oracle version is not at least Oracle 8.1, you cannot establish a direct connection.

CHAPTER 6

National language support

Storing data in an ArcSDE Oracle database using character sets other than the Oracle default, US7ASCII, requires some extra configuration on both the client and the server. This section provides guidelines for configuring both the Oracle database and the ArcSDE client environment to enable the use of character sets other than US7ASCII.

Oracle database character sets

By default, an Oracle database is created with a US7ASCII character set. The character set is selected when the database is created with the CREATE DATABASE statement and cannot be changed afterwards. To change a character set the database must be re-created and the data reloaded. Consult the *Oracle8i National Language Support Guide* to determine the character set that is right for your data.

Setting the NLS_LANG variable on the client

Once the ArcSDE Oracle database has been created with the proper character set, data can be loaded into it using a variety of applications such as ArcGIS Desktop and the ArcSDE administration tools shp2sde and cov2sde. To properly convert and preserve the characters, you must set the Oracle NLS_LANG variable in the client applications system environment.

For instance, using ArcToolbox installed on Windows NT to convert a coverage containing German attribute data into an Oracle database on a UNIX server created with the Western European character set WE8ISO8859P1, you would set the NLS_LANG to GERMAN_GERMANY.WE8ISO8859P1. To set the NLS_LANG variable for ArcToolbox, click Start, Settings, and Control Panel. Double-click on the System icon and select the Environment tab after the System menu appears. Click on the System Variables scrolling list

and enter NLS_LANG in the Variable: input line and GERMAN_GERMANY.WE8ISO8859P1 in the Value: input line. Click Set and then OK.

Setting the NLS_LANG variable for Windows NT clients

Be careful setting the NLS_LANG on the Windows NT platform because there are actually two different codepage environments on this platform. Windows applications such as ArcGIS Desktop run in the Windows American National Standards Institute (ANSI) codepage environment, while ArcSDE administration tools and C and Java API applications invoked from the MS–DOS Command Prompt run in the original equipment manufacturer (OEM) codepage environment. Some languages require two different NLS_LANG settings for the language character set component for each of these codepage environments.

For instance, in the above example the NLS_LANG variable would be set to GERMAN_GERMANY.WE8PC850 if the data was loaded from the MS–DOS Command Prompt using the ArcSDE administration tool shp2sde. If you use both Windows applications and MS–DOS applications together, then you should set the NLS_LANG variable for MS–DOS applications when you open the MS–DOS Command Prompt using the MS–DOS SET command.

SET NLS_LANG = GERMAN_GERMANY.WE8PC850

To determine if your language requires a separate language character set, consult the *Oracle8*i *National Language Support Guide*.

For more information on ArcInfo national language support, refer to the National Language Support section of the Systems Administration chapter found on your ArcDoc™ CD.

CHAPTER 7

Backup and recovery

This chapter provides you with some basic backup and recovery guidelines. You should refer to the backup and recovery guidelines presented in the *Oracle8 Backup and Recovery Guide*.

Which archive mode should you use

Oracle has two archive modes: NOARCHIVELOG and ARCHIVELOG. Databases operating under NOARCHIVELOG mode (the default) do not archive the online redo log files. If a media failure occurs, a NOARCHIVELOG mode database can only be recovered to the point of the last backup. A database operating under ARCHIVELOG mode can be recovered to the point prior to the media failure by applying the last backup and the changes stored in archived redo log files.

Often databases are created and initially loaded under the NOARCHIVELOG mode because if a media failure occurs, the same effort is required regardless of whether the database was reloaded using the archived online redo log files or the original source data. In addition, huge log files are created, and maintaining these is unnecessary since the original source data is readily available.

After the initial data load is complete and the database goes into production, the changes become difficult to re-create. Switch to ARCHIVELOG mode to ensure point-in-time recovery of the database in the event of a media failure.

Operate the database in NOARCHIVELOG mode and make frequent backups only if you can afford to reenter the changes made since the last backup. You can use exp, Oracle's export utility, to supplement a full backup. If changes are made to a known set of data objects between full backups, you can export the objects. The export files are applied following the restore of the full backup in the event of a disk failure. You can also back up the entire Oracle database with the Oracle export utility and then make cumulative and incremental backups.

Switching from NOARCHIVELOG to ARCHIVELOG

An Oracle database created in NOARCHIVELOG mode can be switched to ARCHIVELOG mode. Before you make this change, Oracle recommends that you make a full backup of the database in case the database is somehow corrupted.

If you have created large online redo log files greater than 100 MB, you should consider creating new smaller and more manageable ones. You should also consider creating more online redo log files. If you were loading your data with only three large online redo log files, you should create at least four log files before you switch the database to ARCHIVELOG mode. The additional file ensures that the archive process is always finished copying the log files to the archive destination before the database needs to make them current. If the database must make a log file current before the archive process has finished copying it, the database will halt updates until it is finished.

Add the LOG_ARCHIVE_START and LOG_ARCHIVE_DEST parameters.

```
LOG_ARCHIVE_START = TRUE
LOG_ARCHIVE_DEST = <pathname_to_archives>/arch%t_%s.dbf
```

Setting LOG_ARCHIVE_START to true automatically archives the online redo log files. If you do not set this parameter or set it to false, you will have to manually archive the log files. For information on how to perform a manual archive, consult the *Oracle8 Server Administrator's Guide*.

After you have backed up the Oracle database, switch the database to ARCHIVELOG mode.

```
$ svrmgrl

Oracle Server Manager Release 3.1.6.0.0 - Production

(c) Copyright 1997, Oracle Corporation.  All Rights Reserved.

Oracle8i Enterprise Edition Release 8.1.6.0.0 - Production
With the Partitioning and Java options
PL/SQL Release 8.1.6.0.0 - Production

SVRMGR> connect internal
Connected.
SVRMGR> shutdown normal
Database closed.
Database dismounted.
Oracle instance shut down.
SVRMGR>startup mount
Total System Global Area           245317008 bytes
Fixed Size                             64912 bytes
Variable Size                      103677952 bytes
Database Buffers                   131072000 bytes
Redo Buffers                        10502144 bytes
Database mounted.
SVRMGR> alter database archivelog;
Statement Processes
```

```
SVRMGR> alter database open;
Statement processed.
SVRMGR>
```

Note: After the database successfully reopens in ARCHIVELOG mode, you should shut it down again and make another full backup. If you don't, your last full backup will have recorded that the database was in NOARCHIVELOG mode, and you will not be able to apply the online redo log files following the restoration of the backup.

Backing up the database

Base the frequency of your backups on the rate at which the data in your database is changing. The more changes that occur, the more frequently backups should occur.

If your Oracle database is operating under ARCHIVELOG mode, you have several variations that you may add to your backup strategy in addition to the periodic full backup. Databases operating under the NOARCHIVELOG mode are restricted to full backups with the possible addition of Oracle export files. For more information on different Oracle database backup strategies, refer to the *Oracle8 Backup and Recovery Guide*.

Regardless of which archiving mode you are using, you should make regular full backups of the Oracle database. A full backup should include the Oracle database and, if you have started an ArcSDE service, the dbtune.sde, giomgr.defs, dbinit.sde, and services.sde files.

Recovering the database

For the recovery of an Oracle database, refer to the *Oracle8 Backup and Recovery Guide.* Once the Oracle database has been recovered, if necessary, restore the ArcSDE installation from the ArcSDE media. Restore the dbtune, giomgr.defs, dbinit.sde, and services.sde files from your backup tapes to the SDEHOME etc directory.

You should test your backup before you need it. If you have just loaded your database, you should do a full backup and then recover the database from tape to make sure the recovery process will work when you need it.

APPENDIX A

Estimating the size of your tables and indexes

The formulas provided in this appendix provide approximations of the actual sizes of the Oracle tables and indexes created by ArcSDE.

The business table

The following calculation of business table size is based on the calculations provided in *Oracle8 Administrator's Guide.*

1. Determine the data block size. Do this by connecting to the database as the DBA and querying the db_block_size parameter stored in the v$parameter file.

```
$ sqlplus system/<password>
```

```
SQL> select value from v$parameter where name = 'db_block_size';
```

2. Remove the header from the data block space.

```
space after headers(sph) = db_block_size - 86 - ((INITRANS -1) * 24)
```

3. Calculate the available space by removing the percent free from the space after headers.

```
available space = ceil(sph * (1 - PCTFREE / 100)) - 4
```

4. Reduce the available space further by 5 percent.

```
available space = (available space * 0.95)
```

5. Calculate the row size. You may use the formulas described in Step 3 of Appendix A in the *Oracle8 Administrator's Guide* to calculate the row size. However, if you can create the table and load about 100 sample records into it, you can obtain the most accurate estimate of row size by analyzing the table and then querying user_tables for the table's avg_row_len.

```
$ sqlplus <username>/<password>
```

```
SQL> create table <table_name> . . .
SQL> insert into table <table_name> . . .
SQL> analyze table <table_name> compute statistics;
SQL> select avg_row_len from user_tables where table_name = <table_name>;
```

6. Compute the number of rows that can be stored by each data block.

```
rows per data block = floor(available space / row size)
```

7. Compute the number of data blocks required to store the table. You will need to estimate the number of rows you expect the table to contain.

```
total data blocks = total rows / rows per data block
```

8. Compute tablespace required to store the table in bytes.

```
tablespace size = data block size * total data blocks
```

The feature table

Use the steps listed in the business table size calculation to calculate the size of the feature table. If you cannot load a sample feature class, use the following formula to calculate the row size:

row size = feature header + (average points per geometry) * 0.586 * coordinate factor

The feature header varies depending on the type of geometry the feature class stored and whether z-values and/or measures are stored. Table A.1 lists the feature header sizes for the various combinations.

	x,y	**x,y,z**	**x,y,m**	**x,y,z,m**
points	85	103	121	139
lines	93	111	129	147
polygons	101	119	137	155

Table A.1 Feature headers vary according to the geometry type of the feature class and whether z-values and/or measures are stored along with each x,y coordinate pair. The geometry type is listed by row, while the coordinate type is listed by column.

The coordinate factor varies depending on whether it will store z-values and/or measures. Table A.2 lists the possible coordinate factors.

Coordinate type	Coordinate factor
x,y	8
x,y,z	12
x,y,m	12
x,y,z,m	16

Table A.2 Coordinate factors vary depending on the type of coordinates stored.

If the features store annotation, the row size will be larger. Calculating the space required to store annotation can be rather complex with the annotation text, leader line, placement, and metadata. Most annotation will occupy between 100 and 300 bytes of space per feature. Therefore, increase the row size by 200 bytes if your features include annotation.

The spatial index table

You can use the steps listed in calculating the business table to calculate the size of the spatial index table except for the row size. The row size for the spatial index table is always 43 bytes.

However, the size of the spatial index table can be fairly accurately estimated given the number of records in a feature class's business table.

spatial index table size = number of business table records * 1.3

This formula assumes that the spatial index table contains an average of 1.3 grid cells for each feature.

Use steps 6, 7, and 8, listed in the business table, to calculate the amount of space required to store the spatial index table.

The version delta tables

When you register a business table as multiversioned, three tables are created to maintain the deltas: the adds table, the deletes table, and the equivalency table. Depending on how the versions are managed, these tables may remain relatively small, or they may become quite

large. The adds table receives one record for each record that is added to a business table version. The deletes table receives a record each time a record is deleted from a business table version. The equivalency table receives records each time versions are merged. The function of the equivalency table is rather complex, but its main role is to maintain integrity of versioned records that have been copied between versions. As a result, it can grow exponentially depending on the number of merges that occur.

The most difficult part of estimating space for the delta tables is trying to predict how many rows they will contain. Partly it will depend on how many versions the table is involved in. In other words, how many records are added or deleted throughout the life of a version will affect the size of the adds and deletes tables. The number of times the version of one work order is copied to another will affect the size of the equivalency table.

The size of the delta tables also depends on how often records are removed. These tables shrink only when the states preceding the level 0 version are compressed. This occurs only after a version branching directly off the root of the version tree completes and is removed from the system. The compression of states that follows will cause the changes of the states between the level 0 version and the next version following the one removed to be written to the business table and deleted from the delta tables.

For most applications the delta tables should not be expected to grow beyond 10,000 records. However, there are applications where several versions of the database must be maintained over a long period. In these cases as many as 30,000 records per delta table can be expected.

The adds table

The table definition of the adds table is identical to that of the business table with the addition of the SDE_STATE_ID column. Therefore, to compute the space required to store the adds table use the calculations for the business table and increase the row size of the adds table by 4 bytes to account for the addition of the SDE_STATES_ID column.

The record count for the adds table will be an estimate of the number of records added to the versioned business table after it has been registered as multiversioned. Records are removed from the adds table only when a version next to the 0 version is removed and its states are compressed.

The deletes table

The record count depends on the number of records deleted from the business table after it was registered as multiversioned. Records are removed from the deletes table only when a version next to the 0 version is removed and its states are compressed.

Calculate the size of the deletes table with the following formula:

deletes table size = 5.4 * number of rows.

For more information on versioning, refer to *Building a Geodatabase*.

The network tables

There are 10 standard network tables created whenever you create a geodatabase network class. Optionally, the application designer may also create weights for the network, in which case two tables are created for each weight.

The size of the network tables depends on the number of rows in the base tables. A network class is basically the logical combination of point and linestring feature classes. In network terms, linestring features are referred to as junctions.

The first step in determining the size of the network tables is to establish the total number of edges and junctions.

The total number of edges is calculated by adding up all the linestring features in the network.

A junction must exist at the endpoint of each linestring. If a point feature does not exist at the endpoint of a linestring, a logical junction is created within the network tables. For endpoints of two or more linestrings that share the same coordinate position, only one junction exists. So some of the endpoints will share the same coordinate position, and some will not. Some will have a point feature at the endpoint, and some will not. As a rough guide assume that half of your linestring endpoints share the same coordinate position and that the total number of junctions required by the network is equal to the number of edges.

Once you have the junction and edge totals, you can determine the size of the network tables using the following formulas.

Description table (N_<n>_DESC)

The number of rows in the description table is equal to the sum of the junctions and edges.

The size of the description table is calculated as

size in bytes = number of rows * 7.4

Edge description table (N_<n>_EDESC)

The number of rows in the edge description table is calculated as

number of rows = number of edges / 1638

The size of the edge description table is calculated as

size in bytes = number of rows * 6250

Edge status table (N_<n>_ESTATUS)

The number of rows in the edge status table is calculated as the

number of rows = number of edges / 65536

size in bytes = number of rows * 10000

Edge topology table (N_<n>_ETOPO)

The number of rows in the edge topology table is calculated as the

number of rows = number of edges / 4096

The size of the edge topology table is calculated as

size in bytes = number of rows * 6336

Flow direction table (N_<n>_FLODIR)

The number of rows in the flow direction table is calculated as

number of rows = number of edges / 65536

The size of the flow direction table is calculated as

size in bytes = number of rows * 40960

Junction description table (N_<n>_JDESC)

The number of rows in the junction description table is calculated as

number of rows = number of junctions / 1638

The size of the junction description table is calculated as

size in bytes = number of rows * 24986

Junction status table (N_<n>_JSTATUS)

The number of rows in the junction status table is calculated as

number of rows = number of junctions / 65536

The size of the junction status table is calculated as

size in bytes = number of rows * 40960

Junction topology table (N_<n>_JTOPO)

The number of rows in the junction topology table is calculated as

number of rows = number of junctions / 2048

The size of the junction topology table is calculated as

size in bytes = number of rows * 24865

Junction overflow topology table (N_<n>_JTOPO2)

The number of rows in the junction overflow topology table is calculated as

number of rows = number of junctions / 20480

The size of the junction overflow topology table is calculated as

size in bytes = number of rows * 29257

Property table (N_<n>_PROP)

The number of rows in the network properties table is always 10.

number of rows = 10

The size of the network properties table is approximately 250 bytes.

size in bytes = 250

The network properties table will always occupy one data block.

Edge weight table (N_<n>_E<w>)

The number of rows in an edge weight table is calculated as

number of rows = number of edges / 2048

The size of the junction overflow topology table is calculated as

size in bytes = number of rows * 24865

Junction weight table (N_<n>_J<w>)

The number of rows in the junction overflow topology table is calculated as

number of rows = number of junctions / 2048

The size of the junction overflow topology table is calculated as

size in bytes = number of rows * 24865

The raster data tables

Four raster data tables are created whenever a user adds a raster column to a business table. A row is added to the sde raster_columns system table for each raster column created in the database. Each new raster column is given a unique ID called a rastercolumn_id. The rastercolumn_id is used in the naming of the raster data tables.

Raster data schema consists of four tables and their associated indexes. The four tables and their associated indexes are:

1. The raster table (SDE_RAS_<raster_column_id>) stores one record for each raster. The number of raster table rows is always less than or equal to the number of business table rows. If each row of the business table has an image stored in the raster tables, then the number of rows is equal. If some of the business table rows do not have an image associated with them, then the number for raster tables is less.

   The raster table has a single unique index on the raster_id column (SDE_RAS_<raster_column_id>_UK).

2. The raster bands table (SDE_BND_<raster_column_id>) stores one record for each raster band. The one-to-many relationship between the raster table and the raster bands table is maintained by the primary/foreign key raster_id column. The number of rows in the raster bands table can be determined by multiplying the number of images bands by the number of raster table rows.

   The raster bands table has two unique indexes, one on the rasterband_id column (SDE_BND_<raster_column_id>_UK1) and the other a composite of the raster_id and sequence_nbr columns (SDE_BND_<raster_column_id>_UK2).

3. The data stored in the raster auxiliary table (SDE_AUX_<raster_column_id>) is optional. Therefore, a zero-to-many relationship exists between the raster bands table and the raster auxiliary table. The tables are joined on the primary/foreign key relationship of the rasterband_id column. The raster auxiliary table stores one record of metadata about each band. For example, if the image has a color map associated with it, one record will be added to the auxiliary table for each record in the raster band table. If the you elect to create statistics for the raster, one record will be added for each record in the raster bands table. If you are not sure how much metadata will be stored for each raster, you don't need to be too overly concerned since the size of this table is very small.

   The raster auxiliary table has one unique index, a composite of the type and rasterband_id columns (SDE_AUX_<raster_column_id>_UK).

4. The raster blocks table (SDE_BLK_<raster_column_id>) stores the raster band pixels as blocks defined by the block's dimensions. A one-to-many relationship exists between the raster bands table and the raster blocks table. The number of rows in the raster blocks table can be estimated by first determining the pixels required to complete a block, dividing this number into the total number of pixels within a band, and multiplying the result by the number of bands in the raster. If you have elected to store a resolution pyramid, multiply the result by 1.33 to account for the resolution pyramid blocks.

   The raster blocks table has one unique index—a composite of the rasterband_id, rrd_factor, row_nbr, and col_nbr columns (SDE_BLK_<raster_column_id>_UK).

Raster table (SDE_RAS_<raster_column_id>)

On the average, 2,400 raster table rows fit in a 16 KB Oracle data block, given an Oracle data block percent free of 10 percent and initial transactions of 4. To roughly estimate the number of data blocks required to store the rows of the raster table, divide the total number of rows you expect the table to have by 2,400.

Raster bands table (SDE_BND_<raster_column_id>)

On the average, 190 raster band table rows fit within a 16 KB Oracle data block, given an Oracle data block percent free of 10 percent and initial transactions of 4. To roughly estimate the number of data blocks required to store the rows of the raster bands table, divide the total number of rows you expect the table to have by 190.

Raster auxiliary table (SDE_AUX_<raster_column_id>)

On the average, six raster auxiliary table rows fit within a 16 KB Oracle data block, given an Oracle data block percent free of 10 percent and initial transactions of 4. To roughly estimate the number of data blocks required to store the rows of the raster auxiliary table, divide the total number of rows you expect the table to have by 6.

Raster blocks table (SDE_BLK_<raster_column_id>)

The size of the raster blocks table varies depending on whether you have built a resolution pyramid and whether an image compression method has been applied. The addition of the pyramid will increase the number of rows in the raster blocks table from the base level by a factor of one third.

The pixel depth affects the row size of the raster block. Single bit pixels require less storage space than do 4-bit pixels, which in turn require less space than 8-bit pixels, and so on.

The pixel dimension of the raster blocks also affects the row size of the raster blocks. Larger dimensions require more space. For example, the storage space of a 64 x 64 pixel raster block requires a quarter of the space of a 128 x 128 raster block.

Compression reduces the total size of the stored image in a manner similar to the algorithmic compression of ASCII files. The software interrogates rows of pixels searching for equal valued groups and storing a single value and the pixel count, rather than a string of equal values. Compression reduces the row size of the raster blocks.

Compression results vary from image to image; however, Table A.3 provides a general guideline for the number of Oracle 16 KB data blocks required to store raster block table rows, given the image's pixel depth. To compute the total number of 16 KB Oracle data blocks required, multiply the expected number of rows in the raster block's table by the appropriate Oracle data blocks per row factor in Table A.3. If you created the database with an Oracle data block size of 8, multiply the result by 2.

Table A.1 Number of 16 KB Oracle data blocks required to store a row of the raster blocks table for a given pixel depth.

	Pixel Depth			
Compression	**1-bit**	**8-bit**	**16-bit**	**32-bit**
None	0.17	1.5	2.6	4.5
LV77	0.01	0.55	0.78	1.08

The indexes

All of the indexes, with the exception of the spatial index tables S<n>_IX1, index single-integer columns. The spatial index table's S<n>_IX1 indexes all of the columns of the table. Since the definition of the indexes is fixed, the size of the indexes can be based on the number of rows they index. The space for all indexes, except the spatial index table's S<n>_IX index, can be calculated using the following formula:

adjusted size = 500 rows per data block * (1 - PCTFREE)

total data blocks = table rows / adjusted size

tablespace size = total data blocks * data block size

For the S<n>_IX1 index the formula is

adjusted size = 150 rows per data block * (1 - PCTFREE)

total data blocks = table rows / adjusted size

tablespace size = total data blocks * data block size

APPENDIX B

Storing raster data

A raster is a rectangular array of equally spaced cells that, taken as a whole, represent thematic, spectral, or picture data. Raster data can represent everything from qualities of land surface such as elevation or vegetation to satellite images, scanned maps, and photographs.

You are probably familiar with raster formats such as tagged image file format (TIFF), Joint Photographic Experts Group (JPEG), and Graphics Interchange Format (GIF) that your Internet browser renders. These rasters are composed one or more bands. Each band is segmented into a grid of square pixels. Each pixel is assigned a value that reflects the information it represents at a particular position.

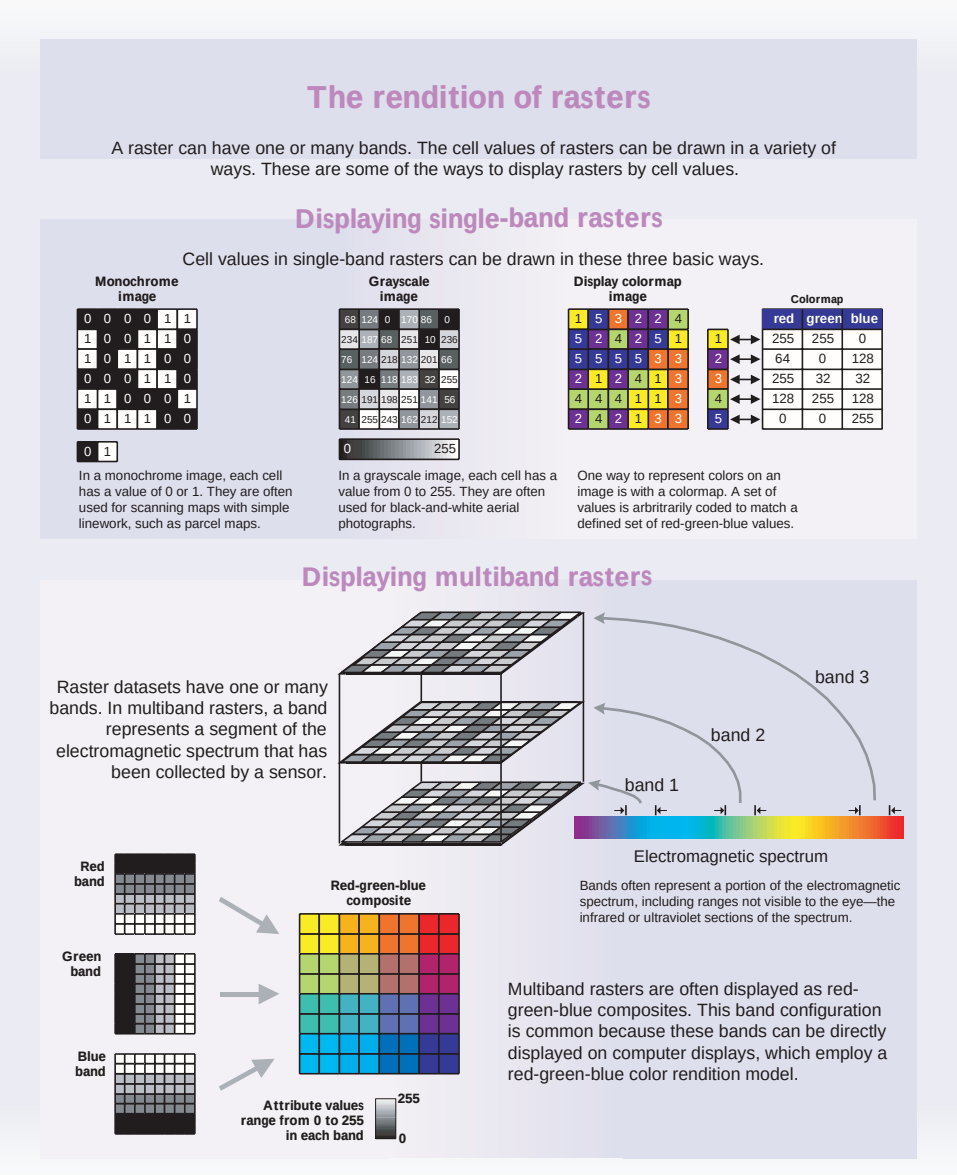
For an expanded discussion of the type of raster data supported by ESRI products, review Chapter 9, 'Cell-based modeling with rasters', in *Modeling Our World*.

ArcSDE stores raster datasets similar to the way it stores compressed binary feature classes (see Appendix C, 'ArcSDE compressed binary'). A raster column is added to a business table, and each cell of the raster column contains a reference to a raster stored in a separate raster table. Therefore, each row of a business table references an entire raster.

ArcSDE stores the raster bands in the raster band table. ArcSDE joins the raster band table to the raster table on the raster_id column. The raster band table's raster_id column is a foreign key reference to the raster table's raster_id primary key.

ArcSDE automatically stores any existing image metadata, such as image statistics, color maps, or bitmasks, in the raster auxiliary table. The rasterband_id column of the raster auxiliary table

is a foreign key reference to the primary key of the raster band table. ArcSDE joins the two tables on this primary/foreign key reference when accessing a raster band's metadata.



The raster blocks table stores the pixels of each raster band. ArcSDE tiles the pixels into blocks according to a user-defined dimension. ArcSDE does not have a default dimension; however, applications that store raster data in ArcSDE do. ArcToolbox and ArcCatalog, for example, use

default raster block dimensions of 128 by 128 pixels per block. The dimensions of the raster block along with the compression method, if one is specified, determine the storage size of each raster block. You should select raster block dimensions that, combined with the compression method, allow each row of the raster block table to fit within an Oracle data block. For Oracle databases, storing raster data should be created with a 16 KB Oracle data block size. See Appendix A, 'Estimating the size of your tables and indexes', for more information on estimating the size of your raster tables and indexes.

The raster blocks table contains the rasterband_id column, which is a foreign key reference to the raster band table's rasterband_id primary key. ArcSDE joins these tables together on the primary/foreign key reference when accessing the blocks of the raster band.

ArcSDE populates the raster blocks table according to a declining resolution pyramid. The height of the pyramid is determined by the number of levels specified by the application. The application, such as ArcToolbox or ArcCatalog, may allow you to define the levels, or it may request that ArcSDE calculate them, or it may offer both possible choices.

The pyramid begins at the base, or level 0, which contains the original pixels of the image. The pyramid proceeds toward the apex by coalescing four pixels from the previous level into a single pixel at the current level. This process continues until less than four pixels remain or until ArcSDE exhausts the defined number of levels.

The apex of the pyramid is reached when the uppermost level has less than four pixels. The additional levels of the pyramid increase the number of raster block table rows by one third. However, since it is possible for the user to specify the number of levels, the true apex of the pyramid may not be obtained, limiting the number of records added to the raster blocks table.

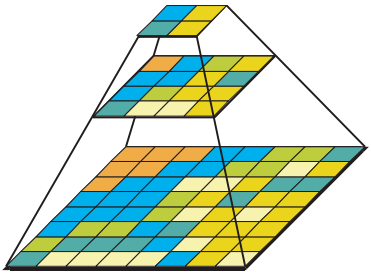


Figure B.2 When you build a pyramid, more rasters are created by progressively downsampling the previous level by a factor of two until the apex is reached. As the application zooms out and the raster cells grow smaller than the resolution threshold, ArcSDE selects a higher level of the pyramid. The purpose of the pyramid is to optimize display performance.

The pyramid allows ArcSDE to provide the application with a constant resolution of pixel data regardless of the rendering window's scale. Data of a large raster transfers quicker to the client when a pyramid exists since ArcSDE can transfer fewer cells of a reduced resolution.

Raster schema

When you import a raster into an ArcSDE database, ArcSDE adds a raster column to the business table of your choice. You may name the raster column whatever you like, so long as it conforms to Oracle's column naming convention. ArcSDE restricts one raster column per business table.

The raster column is a foreign key reference to the raster_id column of the raster table created during the addition of the raster column. Also joined to the raster table's raster_id primary key, the raster band table stores the bands of the image. The raster auxiliary table, joined one-to-one to the raster band table by rasterband_id, stores the metadata of each raster band. The rasterbands_id also joins the raster band table to the raster blocks table in a many-to-one relationship. The raster blocks table rows store blocks of pixels, determined by the dimensions of the block.

Figure B.3 When ArcSDE adds a raster column to a table, it records that column in the sde user's raster_columns table. The rastercolumn_id table is used in the creation of the table names of the raster, raster band, raster auxiliary, and raster blocks table.

The sections that follow describe the schema of the tables associated with the storage of raster data. Refer to Figure B.3 for an illustration of these tables and the manner in which they are associated with one another.

RASTER_COLUMNS table

When you add a raster column to a business table, ArcSDE adds a record to the RASTER_COLUMNS system table maintained in the sde user's schema. ArcSDE also creates four tables to store the raster images and metadata associated with each one.

NAME	DATA TYPE	NULL?
rastercolumn_id	NUMBER(38)	NOT NULL
description	VARCHAR2(65)	NULL
database_name	VARCHAR2(32)	NULL
owner	VARCHAR2(32)	NOT NULL
table_name	VARCHAR2(160)	NOT NULL
raster_column	VARCHAR2(32)	NOT NULL
cdate	NUMBER(38)	NOT NULL
config_keyword	VARCHAR2(32)	NULL
minimum_id	NUMBER(38)	NULL
base_rastercolumn_id	NUMBER(38)	NOT NULL
rastercolumn_mask	NUMBER(38)	NOT NULL
srid	NUMBER(38)	NULL

Raster columns table

- rastercolumn_id (SE_INTEGER_TYPE)—The table's primary key.
- description (SE_STRING_TYPE)—The description of the raster table.
- database_name (SE_STRING_TYPE)—Field is always NULL for Oracle.
- owner (SE_STRING_TYPE)—The owner of raster column's business table.
- table_name (SE_STRING_TYPE)—The business table name.
- raster_column (SE_STRING_TYPE)—The raster column name.
- cdate (SE_INTEGER_TYPE)—The date the raster column was added to the business table.
- config_keyword (SE_STRING_TYPE)—The DBTUNE configuration keyword whose storage parameters determine how the tables and indexes of the raster are stored in the Oracle database. For more information on DBTUNE configuration keywords and their storage parameters, review Chapter 3, 'Configuring DBTUNE storage parameters'.
- minimum_id (SE_INTEGER_TYPE)—Defined during the creation of the raster, establishes value of the raster table's raster_id column.

- base_rastercolumn_id (SE_INTEGER_TYPE)—If a view of the business table is created that includes the raster column, an entry is added to the RASTER_COLUMNS table. The raster column entry of the view will have its own rastercolumn_id. The base_rastercolumn_id will be the rastercolumn_id of the business table used to create the view. This base_rastercolumn_id maintains referential integrity to the business table. It ensures that actions performed on the business table raster column are reflected in the view. For example, if the business table's raster column is dropped, it will also be dropped from the view (essentially removing the view's raster column entry from the RASTER_COLUMNS table).
- rastercolumn_mask (SE_INTEGER_TYPE)— currently not used, maintained for future use.
- srid (SE_INTEGER_TYPE)—The spatial reference ID (srid) is a foreign key reference to the SPATIAL_REFERENCES table. For images that can be georeferenced, the srid establishes the X and Y offset translation factor and the scale factor for storage of the image coordinates into the 32-bit integer ArcSDE coordinate storage system. It also stores the coordinate reference system the image was created under.

Business table

In the example that follows, the fictitious BUILD_FOOTPRINTS business table contains the raster column house_image. This is a foreign key reference to the raster table created in the users schema. In this case the raster table contains a record for each raster of a house. It should be noted that images of houses cannot be georeferenced. Therefore, the SRID column of the RASTER_COLUMN record for this raster is NULL.

NAME	DATA TYPE	NULL?
building_id	NUMBER(38)	NOT NULL
building_footprint	NUMBER(38)	NOT NULL
house_picture	NUMBER(38)	NOT NULL

BUILDING_FOOTPRINTS business table with house image raster column

- building_id (SE_INTEGER_TYPE)—the table's primary key
- building_footprints (SE_INTEGER_TYPE)—a spatial column and foreign key reference to a feature table containing the building footprints
- house_image (SE_INTEGER_TYPE)—a raster column and foreign key reference to a raster table containing the images of the houses located on each building footprint

Raster table (SDE_RAS_<rastercolumn_id>)

The raster table, created as SDE_RAS_<raster_column_id> in the Oracle database, stores a record for each image stored in a raster column. The raster_column_id is assigned by ArcSDE whenever a raster column is created in the database. A record for each raster column in the database is stored in the ArcSDE RASTER_COLUMNS system table maintained in the sde user's schema.

NAME	DATA TYPE	NULL?
raster_id	NUMBER(38)	NOT NULL
raster_flags	NUMBER(38)	NULL
description	VARCHAR2(65)	NULL

Raster description table schema (SDE_RAS_<raster_column_id>)

- raster_id (SE_INTEGER_TYPE)—The primary key of the raster table and unique sequential identifier of each image stored in the raster table
- raster_flags (SE_INTEGER_TYPE)—A bitmap set according to the characteristics of a stored image
- description (SE_STRING_TYPE)—A text description of the image (not implemented at ArcSDE 8.1)

Raster band table (SDE_BND_<rastercolumn_id>)

Each image referenced in a raster may be subdivided into one or more raster bands. The raster band table, created as SDE_BND_<rastercolumn_id>, stores the raster bands of each image stored in the raster table. The raster_id column of the raster band table is a foreign key reference to the raster table's raster_id primary key. The rasterband_id column is the raster band table's primary key. Each raster band in the table is uniquely identified by the sequential rasterband_id.

NAME	DATA TYPE	NULL?
rasterband_id	NUMBER(38)	NOT NULL
sequence_nbr	NUMBER(38)	NOT NULL
raster_id	NUMBER(38)	NOT NULL
name	VARCHAR2(65)	NULL
band_flags	NUMBER(38)	NOT NULL
band_width	NUMBER(38)	NOT NULL
band_height	NUMBER(38)	NOT NULL
band_types	NUMBER(38)	NOT NULL
block_width	NUMBER(38)	NOT NULL
block_height	NUMBER(38)	NOT NULL
block_origin_x	NUMBER(64)	NOT NULL

```
block_origin_y   NUMBER(64)          NOT NULL
eminx            NUMBER(64)          NOT NULL
eminy            NUMBER(64)          NOT NULL
emaxx            NUMBER(64)          NOT NULL
emaxy            NUMBER(64)          NOT NULL
cdate            NUMBER(64)          NOT NULL
mdate            NUMBER(64)          NOT NULL
```

Raster band table schema

- rasterband_id (SE_INTEGER_TYPE)—The primary key of the raster band table that uniquely identifies each raster band.
- sequence_nbr (SE_INTEGER_TYPE)—An optional sequential number that can be combined with the raster_id as a composite key as a second way to uniquely identify the raster band.
- raster_id (SE_INTEGER_TYPE)—The foreign key reference to the raster table's primary key. Uniquely identifies the raster band when combined with the sequence_nbr as a composite key.
- name (SE_STRING_TYPE)—The name of the raster band.
- band_flags (SE_INTEGER_TYPE)—A bitmap set according to the characteristics of the raster band.
- band_width (SE_INTEGER_TYPE)—The pixel width of the band.
- band_height (SE_INTEGER_TYPE)—The pixel height of the band.
- band_types (SE_INTEGER_TYPE)—A bitmap band compression data.
- block_width (SE_INTEGER_TYPE)—The pixel width of the band's tiles.
- block_height (SE_INTEGER_TYPE)—The pixel height of the band's tiles.
- block_origin_x (SE_FLOAT_TYPE)—The leftmost pixel.
- block_origin_y (SE_FLOAT_TYPE)—The bottom-most pixel.

If the image has a map extent, the optional eminx, eminy, emaxx, and emaxy will hold the coordinates of the extent.

- eminx (SE_FLOAT_TYPE)—The band's minimum x-coordinate.
- eminy (SE_FLOAT_TYPE)—The band's minimum y-coordinate.

- emaxx (SE_FLOAT_TYPE)—The band's maximum x-coordinate.
- emaxy (SE_FLOAT_TYPE)—The band's maximum y-coordinate.
- cdate (SE_FLOAT_TYPE)—The creation date.
- mdate (SE_FLOAT_TYPE)—The last modification date.

Raster blocks table (SDE_BLK_<rastercolumn_id>)

Created as SDE_BLK_<rastercolumn_id>, the raster blocks table stores the actual pixel data of the raster images. ArcSDE evenly tiles the bands into blocks of pixels. Tiling the raster band data enables efficient storage and retrieval of the raster data. The raster blocks can be configured so that the records of the raster block table fit with an Oracle data block, avoiding the adverse effects of data block chaining.

The rasterband_id column of the raster block table is a foreign key reference to the raster band table's primary key. A composite unique key is formed by combining the rasterband_id, rrd_factor, row_nbr, and col_nbr columns.

NAME	DATA TYPE	NULL?
rasterband_id	NUMBER(38)	NOT NULL
rrd_factor	NUMBER(38)	NOT NULL
row_nbr	NUMBER(38)	NOT NULL
col_nbr	NUMBER(38)	NOT NULL
block_data	LONG RAW or BLOB	NOT NULL

Raster block table schema

- rasterband_id (SE_INTEGER_TYPE)—The foreign key reference to the raster band table’s primary key.
- rrd_factor (SE_INTEGER_TYPE)—The reduced resolution dataset factor determines the position of the raster band block within the resolution pyramid. The resolution pyramid begins at 0 for the highest resolution and increases until the raster band’s lowest resolution level has been reached.
- row_nbr (SE_INTEGER_TYPE)—The block's row number.
- col_nbr (SE_INTEGER_TYPE)—The block's column number.
- block_data (SE_BLOB_TYPE)—The block's tile of pixel data.

Raster band auxiliary table (SDE_AUX_<rastercolumn_id>)

The raster band auxiliary table, created as SDE_AUX_<rastercolumn_id>, stores optional raster metadata such as the image color map, image statistics, and bitmasks used for image overlay and mosaicking. The rasterband_id column is a foreign key reference to the primary key of the raster band table.

NAME	DATA TYPE	NULL?
rasterband_id	NUMBER(38)	NOT NULL
type	NUMBER(38)	NOT NULL
object	LONG RAW or BLOB	NOT NULL

Raster auxiliary table schema

- rasterband_id (SE_INTEGER_TYPE)—The foreign key reference to the raster band table's primary key
- type (SE_INTEGER_TYPE)—A bitmap set according to the characteristics of the data stored in the object column
- object (SE_BLOB_TYPE)—May contain the image color map, image statistics, etc.

APPENDIX C

ArcSDE compressed binary

ArcSDE uses a compressed binary format to store geometry in either an Oracle binary LONG RAW or BLOB data type. ArcSDE stores compressed binary spatial data in the POINTS columns of the feature table. Compressing the geometry offers efficient storage and retrieval of spatial data by reducing the size of the geometry. Compressed binary stored in the LONG RAW data type is the default storage format for ArcSDE feature classes.

Compressed binary

ArcSDE verifies the geometry, compresses it, and sends it to the Oracle instance, where it is inserted into a feature table in compressed binary format. Compressing the geometry on the client offloads the task from the ArcSDE server and reduces the transmission time to send the geometry to the ArcSDE server. Storing compressed geometry data reduces the space required to store data by as much as 40 percent.

Compressed binary schema

A compressed binary feature class comprises three tables: the business table, the feature table, and the spatial index table.

The business table contains attributes and a spatial column. The spatial column is a key to the feature and spatial index tables.

The relationship between the business table and the feature table is managed through the spatial column and the FID column. This key, which is maintained by ArcSDE, is unique.

NAME	DATA TYPE	NULL?
fid	NUMBER(38)	NOT NULL
numofpts	NUMBER(38)	NOT NULL

entity	NUMBER(38)	NOT NULL
eminx	NUMBER(64)	NOT NULL
eminy	NUMBER(64)	NOT NULL
emaxx	NUMBER(64)	NOT NULL
emaxy	NUMBER(64)	NOT NULL
eminz	NUMBER(64)	NULL
emaxz	NUMBER(64)	NULL
min_measure	NUMBER(64)	NULL
max_measure	NUMBER(64)	NULL
area	NUMBER(64)	NOT NULL
len	NUMBER(64)	NOT NULL
points	LONG RAW or BLOB	NULL
anno_text	VARCHAR2(256)	NULL

Feature table schema

The feature table stores the geometry, annotation, and CAD in the POINTS column. The POINTS column may be defined as either LONG RAW or BLOB depending on the setting of the GEOMETRY_STORAGE DBTUNE storage parameter. Set the GEOMETRY_STORAGE DBTUNE storage parameter to SDEBINARY if you want to store the compressed binary spatial data in a column defined as LONG RAW; otherwise, set the storage parameter to SDELOB if you want to store the compressed binary spatial data in a column defined as BLOB.

For an expended discussion of the GEOMETRY_STORAGE DBTUNE storage parameter, see Chapter 3, ‘Configuring DBTUNE storage parameters’.

The ArcSDE datatype for each column is defined below.

- fid (SE_INTEGER_TYPE)—contains the unique ID that joins the feature table to the business table
- entity (SE_INTEGER_TYPE)—the type of geometric feature stored in the spatial column (e.g., point, linestring)
- numofpts (SE_INTEGER_TYPE)—the number of points defining the geometry
- eminx, eminy, emaxx, emaxy (SE_FLOAT_TYPE)—the envelope of the geometry
- eminz (SE_FLOAT_TYPE)—the minimum z-value in the geometry
- emaxz (SE_FLOAT_TYPE)—the maximum z-value in the geometry
- min_measure (SE_FLOAT_TYPE)—the minimum measure value in the geometry

- max_measure (SE_FLOAT_TYPE)—the maximum measure value in the geometry
- area (SE_FLOAT_TYPE)—the area of the geometry
- len (SE_FLOAT_TYPE)—the length or perimeter of the geometry
- points (SE_SHAPE_TYPE)—contains the byte stream of point coordinates that define the geometry
- anno_text (SE_STRING_TYPE)—contains the feature annotation string

NAME	DATA TYPE	NULL?
sp_fid	NUMBER(38)	NOT NULL
gx	NUMBER(38)	NOT NULL
gy	NUMBER(38)	NOT NULL
eminx	NUMBER(64)	NOT NULL
eminy	NUMBER(64)	NOT NULL
emaxx	NUMBER(64)	NOT NULL
emaxy	NUMBER(64)	NOT NULL

Spatial index table schema

The spatial index table defines the grid range and extent of all geometry in an ArcSDE feature class.

- sp_fid—contains the unique ID that joins the feature table to the business table
- gx/gy—defines the feature's extent in grid cells
- eminx/eminy/emaxx/emaxy—defines the extent of the feature in system units

In this example the FEATURE-ID column from the WELLS business table references features from the feature and spatial index tables:

WELL_ID	DEPTH	ACTIVE	FEATURE-ID
1	30029	Yes	101
2	13939	No	102
3	92891	No	103
…	…		…

FID	AREA	LEN	EMINX,EMINY,…	POINTS
101				<compressed feature>
102				<compressed feature>
103				<compressed feature>
…				**…**

SP_FID	GX	GY	{EMINX,EMINY,EMAXX,EMAXY}
101	70	100	
102	70	100	
103	71	100	
...			

A business/feature/spatial index key reference

The spatial grid index

The spatial grid index is a two-dimensional index that spans a feature class, like the reference grid you might find on a common road map. You may assign the spatial grid index one, two, or three grid levels, each with its own distinct cell size. The mandatory first grid level has the smallest cell size. The optional second and third grid cell levels are disabled by setting them to 0. If enabled, the second grid cell size must be at least three times larger than the first grid cell size, and the third grid cell size must be three times larger than the second grid cell size.

The spatial index table (S<feature class_id>) has seven integer columns that store the grid cell values, feature envelopes, and corresponding feature IDs. Adding a feature to a feature class adds one or more grid cells to the spatial index table. The number of records added to the spatial index table depends on the number of grid cells the feature spans.

The spatial index table contains two indexes. One index is on the SP_FID column, which contains the feature ID. The other is a composite index that includes all of the columns of the spatial index table. Since all of the columns of the spatial index table are indexed, the values of the table are read from the leaf blocks of the index and not the table data blocks. The result is less I/O and better performance. In addition, the spatial index table is not accessed whenever the feature class is queried. Therefore, when considering how to position the tables and indexes to reduce disk I/O contention, you should be concerned about the positioning of the indexes of the spatial index table but not the table itself.

Building the spatial index

Every time a feature class is added to a business table, a persistent spatial index is built for it.

The ArcSDE server manages the spatial index throughout the life of the feature class. As features are inserted, updated, or deleted, the spatial index is automatically updated.

A load-only mode disables spatial index management until loading completes. This boosts loading performance substantially and is imperative for bulk loading efforts (no queries are allowed in the load-only mode except native SQL-based queries).

Once loading has been completed, the spatial index is enabled by returning it to normal I/O mode. The conversion from normal I/O mode to load-only I/O mode reconstructs the spatial index.

Inserting, updating, or deleting a feature updates the spatial index when the feature class is in normal I/O mode.

ArcSDE overlays the extent of each feature onto the lowest grid level to obtain the number of grid cells. If the feature exceeds four cells, ArcSDE promotes the feature to the next highest grid level, if you have defined one. ArcSDE will continue to promote the feature until it fits within four cells or less or until the highest defined grid level is reached. On the highest defined grid level, geometries can be indexed by more than four grid cells.

ArcSDE adds the feature's grid cells to the spatial index table with their corresponding shape ID and feature envelope. The grid level is encoded with each grid cell.

In the example below, the feature class has two grid levels. Area shape 101 is located in grid cell 4 on level 1. A record is added to the spatial index table because the feature resides within four grid cells (in this case it is one). Area feature 102's envelope is located in cells 1 through 8 on level 1. Because the feature's envelope resides in more than four grid cells, the feature is promoted to level 2, where its envelope fits within two grid cells. Feature 102 is indexed at level 2, and two records are added to the spatial index table.

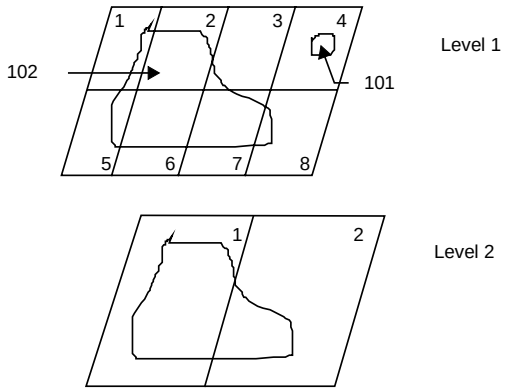


Figure 4.4 Shape 101 is indexed on grid level 1, while shape 102 is indexed on grid level 2, where it is in only two grid cells.

Spatial queries and the spatial index

Spatial queries, such as finding all the lakes within a state boundary, use the spatial index. The spatial index is used unless the search order has been set to SE_ATTRIBUTE_FIRST in the SE_stream_set_spatial_constraints function. When the search order is set to SE_ATTRIBUTE_FIRST, ArcSDE ignores the spatial index, and the criteria of the attribute where clause determines which records of the feature class the query returns.

Whenever the spatial index is used, the ArcSDE service generally uses the following decision process to perform the query:

1. Define the envelope. The envelope could be defined directly by the application such as the extent defined by the ArcMap zoom in tool. Alternatively, the envelope may be defined as the envelope of another feature.
2. Join the spatial index table with the feature table and return all features whose grid cells intersect the envelope.
3. Join the feature table with the business table and apply the criteria of the attribute where clause to further refine the features returned.

Grid cell size impacts the size of the spatial index table. Setting up the spatial index means balancing the cell sizes—smaller cell sizes mean more cells per shape, which requires more entries in the spatial index table.

Guidelines for tuning the spatial index

Because client applications and spatial data profiles vary from one system to another, no single solution fits all. Experienced users of ArcSDE often experiment with the spatial index, trying different cell sizes and different grid level configurations.

The sdelayer command has several operations that can help you optimize the spatial index by changing the grid cell sizes and adding new grid levels with the ‘alter’ operation. The ‘stats’ and ‘si_stats’ operations profile your spatial data and current spatial index.

The following guidelines can help improve the performance of spatial queries.

- Consider how many grid levels are needed and remember the ArcSDE server scans the spatial index table once per grid level. Often a single grid level is the best solution for a feature class, despite the notion of distributing geometries evenly across many grid levels to minimize the spatial index entries.

- Use one grid level for pure point type feature class and consider making the cell sizes large. Spatial queries generally process point geometries faster than other geometry types.

- Monitor the spatial index. Tuning a spatial index is difficult if the data changes frequently. Tuning depends on the structure of the spatial data. Periodically assess the spatial index as your spatial data changes.

- Base the spatial index on the application. Match the spatial index grid cell sizes to the extent of the application window. By doing so, the application is probably viewing exact entries in the spatial index table. This helps to size the spatial index table suitably and reduces the amount of processing because fewer candidate feature IDs must be evaluated against the feature table (see 'Spatial queries and the spatial index' above).

- For unknown or variable application windows, start by defining one grid level with a cell size three times the average feature extent size. Query the feature table to obtain the average feature size with the following SQL statement:

  ```
  select (avg(emaxx - eminx) + avg(emaxy - eminy)) / 2
  from f<N>;
  ```

  ```
  (where <N> is the layer number of the feature class)
  ```

  Such spatial index configuration minimizes the number of rows in the spatial index table while maintaining the proficiency of the index because the majority of the features can be referenced by less than one or two grid cells.

- Design the feature class around spatial data categories such as type, geometry size, and distribution. Sometimes a carefully designed feature class, using these categories, can substantially boost the performance of spatial queries.

Displaying spatial index statistics

The sdelayer command's spatial index statistics operation, 'si_stats', can help you determine optimum spatial index grid sizes. Optimum grid cell sizes depend on the spatial extent of all feature geometries, the variation in feature geometry spatial extent, and the types of searches to be performed on the map feature class. Below is a sample output generated by si_stats:

```
$ sdelayer -o si_stats -l victoria,parcels -u av -p mo -i sde81
ArcSDE   8.1          Wed Jan 17 22:43:09 PST 2000
Layer    Administration Utility
-------------------------------------------------------
Layer 1 Spatial Index Statistics:
Level 1,   Grid Size 200
|-------------------------------------------------------|
| Grid Records: 978341                                  |
| Feature Records: 627392                               |
| Grids/Feature Ratio: 1.56                             |
| Avg. Features per Grid: 18.26                         |
| Max. Features per Grid: 166                           |
| % of Features Wholly Inside 1 Grid: 59.71             |
|-------------------------------------------------------|
|            Spatial Index Record Count By Group        |
| Grids:     <=4    >4  >10  >25  >50  >100  >250  >500 |
```

```
|---------- ------ --- ---- ---- ---- ----- ----- ----- |
| Shapes:   627392   0    0    0    0     0     0     0 |
| % Total:     100%  0%   0%   0%   0%    0%    0%    0%|
|-------------------------------------------------------|
Level 2,   Grid Size 1600 (Meters)
|-------------------------------------------------------|
| Grid Records: 70532                                   |
| Feature Records: 36434                                |
| Grids/Feature Ratio: 1.94                             |
| Avg. Features per Grid: 18.21                         |
| Max. Features per Grid: 82                            |
| % of Features Wholly Inside 1 Grid: 45.35             |
|-------------------------------------------------------|
|             Spatial Index Record Count By Group       |
| Grids:     <=4    >4  >10  >25  >50  >100  >250  >500 |
|---------- ------ --- ---- ---- ---- ----- ----- ----- |
| Shapes:   35682  752   87   17    3     0     0     0 |
| % Total:     97%   2%   0%   0%   0%    0%    0%    0%|
|-------------------------------------------------------|
```

As the output shows, for each defined spatial index level, the following values and statistics are printed:

- Grid level and cell size.
- Total spatial index records for the current grid level.
- Total geometries stored for the current grid level.
- Ratio of spatial index records per geometry.
- Geometry counts and percentages by group that indicate how geometries are grouped within the spatial index at this grid level. The column headings have the following meaning (where ‘N’ is the number of grid cells):

<=N Number of geometries and percentage of total geometries that fall within <= N grid cells

>N Number of geometries and percentage of total geometries that fall within > N grid cells

Notice that the ‘>’ groupings include count values from the next group. For instance, the ‘>4’ group count represents the number of geometries that require more than four grid records as well as more than 10, and so on.

- Average number of geometries per grid.
- Maximum number of geometries per grid. This is the maximum number of geometries indexed into a single grid.
- Percentage of geometries wholly inside one grid. This is the percentage of all geometries wholly contained by one grid record.

The output sample shows spatial index statistics for a map feature class that uses two grid levels: one that specifies a grid size of 200 meters, the other a grid size of 1,600 meters. When a geometry requires more than four spatial index records, it is automatically promoted to the next grid level, if one is defined. A geometry will not generate more than four records if a higher grid level is available.

In the example above, 627,392 features are indexed through grid level 1. Because the system automatically promotes geometries that need more than four spatial index records to the next defined grid level, all 627,392 geometries for grid level 1 are indexed with four grid records or less. Grid level 2 is the last defined grid level, so geometries indexed at this level are allowed to be indexed with more than four grid records. At grid level 2, there are a total of 36,434 geometries and 70,532 spatial index records. There are 35,682 geometries indexed with four grid records or fewer, 752 geometries indexed with more than four grid records, 87 geometries indexed with more than 10, 17 geometries with more than 25, and three geometries with more than 50 grid records. Percentage values below each column show how the geometries are dispersed through the eight groups.

Creating tables with compressed binary schema

The geometry storage format for ArcSDE feature classes defaults to LONG RAW compressed binary. If you always store your geometry in this format, you do not need to adjust the geometry storage format.

If you wish to have a mix of geometry types in your schema, add configuration keywords to the DBTUNE table with the desired geometry storage format and assign the configuration keywords to the feature classes.

The DBTUNE table GEOMETRY_STORAGE storage parameter defines a feature class's geometry storage format. The GEOMETRY_STORAGE value for the default, LONG RAW compressed binary, is SDEBINARY. In the following example, a dbtune file has a PARCELS configuration keyword that contains the value SDEBINARY.

```
##PARCELS
GEOMETRY_STORAGE            SDEBINARY
<other parameters>
END
```

Additional storage parameters precisely define the storage configuration of the parcel's feature class.

```
##PARCELS

GEOMETRY_STORAGE    "SDEBINARY"
B_STORAGE           "TABLESPACE btabsp STORAGE (FREELISTS 4 INITIAL 500M
                    NEXT 100M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
B_INDEX_ROWID       "TABLESPACE bindex_tsp STORAGE (FREELISTS 4 INITIAL 100M
                    NEXT 25M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
```

```
B_INDEX_SHAPE       "TABLESPACE bindex_tsp STORAGE (FREELISTS 4 INITIAL 100M
                    NEXT 25M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
A_STORAGE           "TABLESPACE atabsp STORAGE (FREELISTS 4 INITIAL 100M
                    NEXT 25M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
A_INDEX_ROWID       "TABLESPACE aindex_tsp STORAGE (FREELISTS 4 INITIAL 50M
                    NEXT 10M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
A_INDEX_SHAPE       "TABLESPACE aindex_tsp STORAGE (FREELISTS 4 INITIAL 50M
                    NEXT 10M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
A_INDEX_STATEID     "TABLESPACE aindex_tsp STORAGE (FREELISTS 4 INITIAL 50M
                    NEXT 10M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
D_STORAGE           "TABLESPACE atabsp STORAGE (FREELISTS 4 INITIAL 50M
                    NEXT 10M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
D_INDEX_STATE_ROWID "TABLESPACE dindex_tsp STORAGE (FREELISTS 4 INITIAL 50M
                    NEXT 10M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
D_INDEX_DELETED_AT  "TABLESPACE dindex_tsp STORAGE (FREELISTS 4 INITIAL 50M
                    NEXT 10M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
F_STORAGE           "TABLESPACE ftabsp STORAGE (FREELISTS 4 INITIAL 500M
                    NEXT 100M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
F_INDEX_FID         "TABLESPACE findex_tsp STORAGE (FREELISTS 4 INITIAL 50M
                    NEXT 10M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
F_INDEX_AREA        "TABLESPACE findex_tsp STORAGE (FREELISTS 4 INITIAL 50M
                    NEXT 10M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
F_INDEX_LEN         "TABLESPACE findex_tsp STORAGE (FREELISTS 4 INITIAL 50M
                    NEXT 10M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
S_STORAGE           "TABLESPACE stabsp STORAGE (FREELISTS 4 INITIAL 300M
                    NEXT 50M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
S_INDEX_ALL         "TABLESPACE sindex_tsp STORAGE (FREELISTS 4 INITIAL 100M
                    NEXT 50M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
S_INDEX_SP_FID      "TABLESPACE sindex_tsp STORAGE (FREELISTS 4 INITIAL 100M
                    NEXT 50M MINEXTENTS 1 MAXEXTENTS 50 PCTINCREASE 0)"
END
```

In this example, the storage schema is compressed binary; it defines the storage and location for the business table, adds table, deletes table, feature table, and spatial index table. Chapter 3, ‘Configuring DBTUNE storage parameters’, describes these storage parameters as well as many others.

Referential integrity

Maintaining the referential integrity between the business and feature table is important. You should not edit the records of either the feature table or the spatial index table. Several indexes and constraints have been added to the business, feature, and spatial index table to ensure referential integrity is maintained. However, these indexes and constraints are removed when the feature class is converted to the load-only I/O mode, a state that allows for rapid insertion of data into the feature class.

When the feature class is placed back into normal I/O mode, the state that allows users to query the feature class through an ArcSDE client, the indexes are created and the constraints are enabled. The conversion to normal I/O mode will fail if the unique indexes cannot be built on the business table’s spatial column or the feature table’s FID column. It will also fail if a value exists in the business table’s spatial column that is not in the feature table’s FID column. In this

case a reference to the offending business table record is loaded into the SDE_EXCEPTIONS table.

APPENDIX D

Oracle Spatial geometry type

ArcSDE for Oracle8*i* supports Oracle Spatial's Object Relational Model as a method to store spatial data. Oracle Spatial's Object Relational Model was introduced in Oracle8*i* as an alternative to the Oracle Spatial normalized schema. The Oracle Spatial Object Relational Model uses object-relational types and methods to define, index, and perform spatial analysis on spatial data. ArcSDE supports Oracle Spatial 8.1.6 and higher. For additional information on Oracle Spatial, please see *Oracle Spatial Users Guide and Reference*.

What is Oracle Spatial?

Oracle Spatial is a product that extends the Oracle database with the addition of spatial data management functions. Oracle Spatial provides a SQL geometry type, spatial metadata schema, spatial indexing methods, spatial functions, and implementation rules.

The Oracle Spatial product is available for the Oracle8*i* Enterprise Edition and must be licensed separately. Oracle Spatial is not available for Oracle Workgroup or Personal Oracle products.

Geometry type

The Oracle Spatial geometry type is named SDO_GEOMETRY and is implemented using Oracle's extensible object-relational type system. The SDO_GEOMETRY type stores information about a geometry value including its shape type, spatial reference ID, interpolation instructions, and coordinate values.

The SDO_GEOMETRY type supports single and multipart point, line, and area geometry. Geometries may be defined as having linear interpolation between coordinates as defined by

the OpenGIS Simple Feature Specification. Geometries may also be constructed from circular curves or a combination of both interpolation methods.

Applications are responsible for properly inserting, updating, and fetching the contents of the SDO_GEOMETRY type using Oracle's object-relational SQL interface. Applications are also responsible for ensuring that the contents of the SDO_GEOMETRY type adhere to the rules defined in the Oracle Spatial documentation.

Consult your *Oracle Spatial Users Guide and Reference* for information on the definition and use of the SDO_GEOMETRY type.

Metadata schema

The Oracle Spatial metadata schema provides storage for information about the geometry data. It is the responsibility of an application to record in the metadata schema each SDO_GEOMETRY column it creates or modifies. Applications can record such information as the SDO_GEOMETRY schema, spatial reference ID, coordinate dimension, and spatial indexing instructions.

Consult your *Oracle Spatial Users Guide and Reference* for information on the Oracle Spatial metadata schema.

Spatial index

Oracle Spatial provides spatial indexing methods for the SDO_GEOMETRY type. Spatial indexes provide fast access to records based on the location of geometry values.

Oracle Spatial provides three different spatial indexing methods: Fixed Quadtree, Hybrid Quadtree, and Rtree indexes. Oracle Spatial provides the Oracle Spatial index advisor utility to assist in defining spatial index parameters.

Consult your *Oracle Spatial Users Guide and Reference* for information on supported Spatial index types.

Spatial functions

Oracle Spatial extends SQL with search functions that provide primary and secondary spatial filtering. Including the SDO_FILTER function in a SQL query performs a primary spatial search that uses the spatial index of tables with SDO_GEOMETRY columns. Spatial predicates, such as SDO_RELATE and SDO_CONTAINS, return secondary relationships between pairs of SDO_GEOMETRY.

Oracle Spatial provides spatial transformation functions that change the form of an SDO_GEOMETRY value. For example, the SDO_BUFFER function computes the

coordinates of a new SDO_GEOMETRY object as a distance surrounding the original geometry. Other spatial transformation functions include SDO_DIFFERENCE and SDO_INTERSECTION.

Consult your *Oracle Spatial Users Guide and Reference* for information on supported spatial search functions and transformations.

Coordinate reference

Oracle Spatial provides a number of coordinate reference systems using predefined spatial reference ID (SRID) values. The predefined SRID value is stored in the SDO_GEOMETRY object. The SDO_TRANSFORM function uses the spatial reference ID to establish coordinate reference transformations.

Consult your *Oracle Spatial Users Guide and Reference* for information on supported coordinate references.

How does ArcSDE use Oracle Spatial?

ArcSDE supports Oracle Spatial for managing geometry in an Oracle8*i* Enterprise Edition database.

Making Oracle Spatial your default geometry schema

When you install ArcSDE, the SDE compressed binary geometry schema is the default. The SDE compressed binary schema is supported on Oracle Workgroup and Enterprise Servers at release 8 and 8*i*. The default settings for ArcSDE are defined in the DBTUNE table—one of these settings controls the GEOMETRY_STORAGE method. As installed, the GEOMETRY_STORAGE setting looks like this:

```
##DEFAULTS
GEOMETRY_STORAGE            SDEBINARY
<other parameters>
END
```

Changing the default ArcSDE geometry storage to use Oracle Spatial is easy. Simply changing the GEOMETRY_STORAGE setting from SDEBINARY to SDO_GEOMETRY makes Oracle Spatial the ArcSDE default geometry storage schema:

```
##DEFAULTS
GEOMETRY_STORAGE            SDO_GEOMETRY
<other parameters>
END
```

After the default GEOMETRY_STORAGE setting has been changed to SDO_GEOMETRY, ArcSDE, by default, creates feature classes with SDO_GEOMETRY columns.

ArcSDE for Oracle supports a number of different geometry storage schemas—these different schemas can all exist in the same database. While there can only be one default geometry schema, individual tables can be created using different geometry schemas. See Chapter 3, 'Configuring DBTUNE storage parameters', for instructions on using DBTUNE to define different geometry schemas.

SDO_GEOMETRY columns

ArcSDE creates a feature class by adding a geometry column to the specified business table. When the GEOMETRY_STORAGE storage parameter is set to SDO_GEOMETRY, ArcSDE adds an SDO_GEOMETRY column to the business table. In this example, a business table named 'COUNTRIES' has name and population properties—after adding a geometry column, it also has an SDO_GEOMETRY column named 'BORDERS'.

NAME	DATA TYPE	NULL?
NAME	VARCHAR2(32)	
POPULATION	NUMBER(11)	
BORDERS	MDSYS.SDO_GEOMETRY	
OBJECTID	NUMBER(38)	NOT NULL

'COUNTRIES' business table schema

A geometry column can be added to the business table using ArcCatalog, the sdelayer administration utility, or the ArcSDE C and Java API.

When ArcSDE adds the SDO_GEOMETRY column, an additional OBJECTID column is also defined. ArcSDE uses the OBJECTID for log file queries, single row operations, and multiversioned database operations. An existing column can be used for the OBJECTID as long as it is indexed and declared as NUMBER(38) with a NOT NULL and UNIQUE constraint.

Spatial index

When an SDO_GEOMETRY column is added to a business table, a spatial index on that geometry column is also defined. By default, ArcSDE creates an RTREE index on an SDO_GEOMETRY column. ArcSDE includes support for the creation of Oracle Spatial Fixed and Hybrid indexes. ArcSDE can also create feature classes with no spatial index; however, spatial constraints cannot be supported until a spatial index is constructed.

The spatial index can be defined using ArcCatalog, the sdelayer administration utility, DBTUNE configurations, or the ArcSDE C and Java API.

ArcSDE automatically drops and re-creates Oracle Spatial indexes that ArcSDE has created whenever the feature class is switched between LOAD_ONLY_IO and NORMAL_IO mode.

Spatial indexes defined by the Oracle Spatial Index Advisor application are not dropped when ArcSDE switches the feature class to LOAD_ONLY_IO mode.

Coordinate dimension

You can create ArcSDE geometry as 2D, 2D with measures, 3D, and 3D with measures. ArcSDE defines the Oracle Spatial dimension information (DIMINFO) as:

- The X ordinate is the first dimension.
- The Y ordinate is the second dimension.
- The Z ordinate is the third dimension if the feature class is defined as having elevations.
- The M ordinate is the last dimension if the feature class is defined as having measures.

The dimension extents for X range, Y range, Z range, and M range can be calculated from the actual data or based on fixed values in the DBTUNE table. See Chapter 3, 'Configuring DBTUNE storage parameters', for DBTUNE storage parameters to establish predefined Oracle Spatial dimension properties and to change the name of any dimension.

Coordinate reference

Oracle Spatial coordinate references are predefined and cannot be modified. To set an SDO_GEOMETRY column's Spatial Reference ID (SRID), identify the appropriate Oracle Spatial coordinate reference description and set the feature class's SDO_SRID DBTUNE storage parameter to that value. If the SDO_SRID storage parameter is not set, the SRID of each SDO_GEOMETRY value is set to NULL, and so is the corresponding SRID of the metadata record in the USER_SDO_GEOM_METADATA view.

ArcSDE does not require the Oracle Spatial coordinate reference ID to be set. ArcSDE maintains the coordinate reference information for each feature class in its own SPATIAL_REFERENCES table independent of Oracle Spatial.

Consult your *Oracle Spatial Users Guide and Reference* for information on supported coordinate references.

Oracle Spatial metadata

When ArcSDE adds an SDO_GEOMETRY column to a business table, it also adds the required Oracle Spatial metadata record to the USER_SDO_GEOM_METADATA view. This metadata includes the table name, SDO_GEOMETRY column name, spatial reference ID, and coordinate dimension information.

SDO_GEOMETRY values

ArcSDE populates the SDO_GEOMETRY value from the SE_SHAPE object. The ArcSDE SE_SHAPE object can contain simple and complex geometry that may include elevations, measures, CAD data, annotation, and surface patches. The SDO_GEOMETRY value supports a subset of these geometric properties.

When generating the SDO_GEOMETRY coordinate information, follow these rules:

- Define the SDO_GTYPE parameter based on the Oracle 8.1.6 release.
- The SDO_SRID is NULL if no Oracle Spatial coordinate reference is defined.
- Coordinate values are written in the appropriate coordinate reference system.
- Coordinates are written as X, Y, <Z>, and <M>, where the elevation and measure ordinates are only defined if present in the source SE_SHAPE object.
- If elevations and/or measures are present in the source SE_SHAPE object, all coordinates are stored with an elevation and/or measure ordinate.
- Elevations and measures may be NAN if specific coordinates in the geometry contain undefined elevation or measure values.
- Measures are not restricted to ascending or descending order.
- Measures may be present on any geometry type, not just linestrings.
- Circular curves are written to the SDO_GEOMETRY type; other nonlinear interpolated shapes (cubic spline, bezier, etc.) are converted to linestrings.
- All ArcSDE-generated SDO_GEOMETRY values are generated from SE_SHAPE objects that have passed the ArcSDE rigorous geometry validation.
- Single point layers use the SDO_POINT property in the SDO_GEOMETRY object.
- ArcSDE does not support heterogeneous geometry collection in the SDO_GEOMETRY object.
- ArcSDE does not encode SDO_ETYPE 0 elements in the SDO_GEOMETRY object. SDO_ETYPE 0 elements are application specific - see *Interoperability Considerations* below for more information.

CAD and annotation properties

The SDO_GEOMETRY type cannot store all of the CAD or annotation data that ArcSDE supports. To store CAD or annotation data, ArcSDE adds a BLOB column called SE_CAD to the business table whenever a feature class defined with CAD or annotation properties is created with an SDO_GEOMETRY spatial column.

NAME	DATA TYPE	NULL?
NAME	VARCHAR2(32)	
POPULATION	NUMBER(11)	
BORDERS	MDSYS.SDO_GEOMETRY	
SE_CAD	BLOB	
OBJECTID	NUMBER(38)	NOT NULL

'COUNTRIES' business table schema with the addition of CAD data

Whenever ArcSDE detects that the data source has CAD data, ArcSDE writes a simple geometric representation of the CAD data into the SDO_GEOMETRY value and then writes the unmodified CAD data into the SE_CAD value. If the data source does not have CAD data, ArcSDE sets the SE_CAD value to NULL.

The SE_CAD property contains data from numerous ArcGIS components:

- AutoCAD or MicroStation data from ArcSDE CAD Client
- Parametric objects such as cubic splines and bezier curves from ArcMap
- Surface patches from ArcMap Spatial Analyst
- Annotation from ArcInfo Workstation

Spatial queries

ArcSDE uses the Oracle Spatial SDO_FILTER function to perform the primary spatial query. ArcSDE performs secondary filtering of the SDO_GEOMETRY based on the spatial relationship requested by the application.

Applications may also include Oracle Spatial primary and secondary filter functions in the SQL where clause supplied to ArcSDE. Using spatial filters in the where clause, applications can distribute the spatial query between the database server, the ArcSDE application server, and the application itself.

How does ArcSDE use existing Oracle Spatial tables?

Tables with SDO_GEOMETRY columns can be created by other applications. ArcSDE has been designed to use tables containing SDO_GEOMETRY columns that were created by other applications.

Automatic discovery of tables with SDO_GEOMETRY columns

Whenever an ArcSDE client list the feature classes stored in the database, ArcSDE automatically searches the Oracle Spatial metadata views for new tables with SDO_GEOMETRY columns. When a new table is discovered, it is registered with ArcSDE and made available to applications.

ArcSDE uses the first record in a newly discovered table to establish the ArcSDE geometry type. If the table contains multiple geometry types, the sdelayer administration utility can be used to alter the geometry type definition.

ArcSDE searches for a column in the table to use as an OBJECTID column. To qualify, the column must be defined as NUMBER (38), NOT NULL, and UNIQUE constraints. If such a column is found, it is recorded in the ArcSDE table registry along with the table. If an OBJECTID column is not found, the table is registered, but operations requiring an OBJECTID are unavailable.

For SDO_GEOMETRY columns that have an Oracle Spatial coordinate reference ID (SRID), ArcSDE stores the information in the ArcSDE SPATIAL_REFERENCES table. ArcSDE sets its spatial reference AUTH_NAME field to ORACLE and the AUTH_SRID field to the SRID value. ArcSDE tests the coordinate reference description and, if it is valid, sets the SRTEXT field to the Oracle Spatial coordinate reference description.

Accessing SDO_GEOMETRY values

ArcSDE does not support heterogeneous geometry collections in an SDO_GEOMETRY object.

ArcSDE automatically validates SDO_GEOMETRY values as they are fetched from the database. This validation ensures that geometric objects are properly formed and adhere to feature class constraints. Geometry values that do not pass validation are skipped.

Interoperability considerations

There is a common misconception that applications can interoperate simply because they support the same underlying geometry type. The geometry type is only one aspect of the

interoperability picture—a common understanding of rules, constraints, schema, and implementation is also required.

Multiple SDO_GEOMETRY columns in a table

ArcSDE and ArcGIS do not support multiple geometry columns in a table. Tables with multiple SDO_GEOMETRY columns should be accessed through views that contain only one SDO_GEOMETRY column.

Use the sdetable create_view operation to create views of business tables.

Single geometry type in an SDO_GEOMETRY column

While ArcSDE supports multiple geometry types in a geometry column, many applications do not. For example, ArcGIS requires that a geometry column be restricted to a single geometry type.

Oracle Spatial does not enforce geometry type constraints on an SDO_GEOMETRY column. While one application may want to enforce a single geometry type constraint on an SDO_GEOMETRY column, another application could insert different geometry types. You can create an insert–update trigger that checks the SDO_GEOMETRY GTYPE property to enforce geometry types.

Geometry validation

Oracle Spatial does not automatically enforce geometry validation on insert or update of an SDO_GEOMETRY value. You can create an insert–update trigger to fire the SDO_VALIDATE function to enforce validation of SDO_GEOMETRY types.

To reduce the occurrences of problems from illegal or poorly formed geometry values, ArcSDE automatically validates any SDO_GEOMETRY value from a table that was created by other applications.

SDO_ETYPE 0 elements in an SDO_GEOMETRY object

Oracle Spatial allows applications to insert application specific data into an SDO_GEOMETRY object. Applications do this by embedding their data using an SDO_ETYPE value of 0. The nature of the application specific data is known only to the application that generated the SDO_GEOMETRY object. Such application specific data cannot be reliably supported in an interoperable environment. Applications reading SDO_GEOMETRY objects do not know how to interpret SDO_ETYPE 0 data. Applications updating SDO_GEOMETRY objects do not know how to edit or preserve the SDO_ETYPE 0 data.

When reading SDO_GEOMETRY objects containing SDO_ETYPE 0 elements, ArcSDE will ignore the SDO_ETYPE 0 data, and will return the geometry component to the application.

When updating SDO_GEOMETRY objects containing SDO_ETYPE 0 elements, ArcSDE will not preserve the SDO_ETYPE 0 data. Applications that need to ensure that SDO_ETYPE 0 data is preserved should make sure that users do not have UPDATE access to the table.

Coordinate reference

ArcSDE requires that all SDO_GEOMETRY values in a column be in the same coordinate reference system. If the coordinate reference is undefined, the SRID value should be NULL as defined in the *Oracle Spatial Users Guide and Reference.*

Oracle Spatial does not automatically enforce spatial reference ID validation on insert or update of an SDO_GEOMETRY value. You can create an insert–update trigger to fire the SDO_VALIDATE function to enforce validation of SDO_GEOMETRY types.

Identification of elevations and measures

Oracle Spatial and ArcSDE assume that the first and second dimensions of the SDO_GEOMETRY are X and Y.

If an SDO_GEOMETRY object has three dimensions, ArcSDE assumes the third dimension is a measure if the dimension name starts with an “M”; otherwise, the third dimension is assumed to be an elevation. You can control how ArcSDE interprets the third dimension by setting the feature class’s entity flag to have either elevations or measures.

In this example, sdelayer sets the entity type of a feature class to store linestrings and elevations.

```
sdelayer -o add -e l3
```

In this example, sdelayer sets the entity type of a feature class to store linestrings and measures.

```
sdelayer -o add -e lM
```

If the SDO_GEOMETRY object has four dimensions, measures are expected to be the last ordinate.

Measures and linear reference

Oracle Spatial provides functions for linear reference calculations using measure values. The Oracle Spatial linear reference functions require that all measure values in an

SDO_GEOMETRY object be monotonically ascending or descending without NAN values. Oracle Spatial linear reference also restricts measure values to linestrings.

ArcSDE allows measures and linear reference calculations on all geometric types, with support for arbitrarily ordered measure values and NAN values.

If you use Oracle Spatial linear reference functions, design your application and database to operate within the Oracle Spatial linear reference constraints.

Object identification

ArcSDE provides limited support for Oracle Spatial tables without an OBJECTID column—no logfile operations, no single row operations, and no versioned database support. An OBJECTID column can easily be added using the sdetable administration command or the ArcCatalog application.

Many applications, such as ArcGIS Desktop, require an OBJECTID column in a table. Each application has its own requirements and limitations. ArcGIS Desktop can draw and query feature classes created with SDO_GEOMETRY columns but without an OBJECTID column; however, ArcGIS Desktop can't select, edit, or add these feature classes to a feature dataset.

Multiversioned database

ArcGIS Desktop uses a multiversioned database implemented through ArcSDE for all editing operations. The multiversioned database provides long transaction support for multiple simultaneous design alternatives.

Multiversioned views are available for SQL access to the multiversioned database. See the *ArcSDE Developers Guide* for more information.

Networks and topology feature classes

ArcGIS Desktop can create and maintain networks and integrated topological feature classes from simple feature classes that use the SDO_GEOMETRY type. ArcGIS Desktop manages the relationships and maintains the topological integrity of the data—modifications to the underlying features through ArcGIS Desktop are reflected in these integrated networks.

Modification of Oracle Spatial feature classes participating in these networks should be restricted to ArcGIS Desktop applications. Other applications can freely read the data, but any modifications they make are not reflected in the networks.

Relationships and constraints

ArcGIS Desktop enforces relationships and constraints across lots of different data sources. Feature classes containing an SDO_GEOMETRY type may be included in relationships and may have constraints defined on them.

Modification of Oracle Spatial feature classes participating in relationships and constraints should be restricted to ArcGIS Desktop applications. Other applications can freely read the data, but their edits are not properly handled.

Oracle Spatial software patches

Keep the Oracle Spatial software current by applying the patches as they become available.

APPENDIX E

Oracle normalized geometry schema

The Oracle Normalized Geometry Schema uses well-known SQL numeric types to store the coordinates of a geometry as a collection of rows in a table. The ArcSDE implementation of the Normalized Geometry Schema is based on the OpenGIS Simple Features Specification for SQL, revision 1.1.

ArcSDE utilizes Oracle Spatial indexing and primary search functions to implement the Normalized Geometry Schema. The Oracle product is known as the Spatial Data Option in Oracle 7, the Spatial Cartridge in Oracle 8, and Oracle Spatial (Normalized Schema) in Oracle8*i*.

Normalized geometry schema

In the normalized geometry schema, the coordinate values for a shape are stored as individual Oracle numeric data types in a separate Geometry Table. Access from a business table to a shape is through a foreign key—the Geometry ID, or GID.

The Geometry Table has at least six columns: GID, ETYPE, ESEQ, SEQ, and two coordinate values. The geometry type (point, line string, or polygon) is stored as an ETYPE value. The ETYPE is either 1 (point), 2 (line string), or 3 (polygon). A normalized representation may not be able to store all of a geometry's coordinates in a single row in the geometry table. To accommodate geometries with a large number of values, the geometry is represented by multiple rows. The element sequence value, ESEQ, identifies multiple parts within a geometry. Rows that represent a single part are listed by a sequence (SEQ) value so that rows are returned in the proper order.

The tables below illustrate the relationship between a business table and its Geometry Table in the normalized geometry representation. Any number of coordinate pairs are allowed for a given table. In this example, two coordinate pairs are stored for each row in the Geometry Table.

Feature-ID	Column 1	Column 2	Geometry ID
101			1
102			2
103			3
...			...

A business table with GIDs

GID	ETYPE	ESEQ	SEQ	X1	Y1	X2	Y2
1	3	1	1	10.00	10.00	10.00	15.00
1	3	1	2	10.00	15.00	15.00	15.00
1	3	1	3	15.00	15.00	15.00	10.00
1	3	1	4	15.00	10.00	10.00	10.00
2	3	1	1	100.00	100.00	100.00	150.00
2	3	1	2	100.00	150.00	150.00	150.00
2	3	1	3	150.00	150.00	150.00	100.00
2	3	1	4	150.00	100.00	100.00	100.00
2	3	2	1	70.00	90.00	75.00	90.00
...	...	...	...	...	...	...	...

A Geometry Table with two shapes. The second shape has more than one part.

GID	Index Key
1	22
2	23
3	22
...	...

A spatial index table

If a part is represented by multiple rows, the last coordinate pair is the first coordinate values in the next row. A polygon must close—the first and last coordinates must be the same. Any coordinate pairs that aren't used are set to null. Null shapes are stored in the geometry table as a point with no coordinate values.

Normalized feature class metadata tables

Four Oracle tables store and index the spatial data of a spatially enabled business table. Collectively, these tables compose a normalized geometry schema.

layer tables

Table Name	Description
<business_table_name>_SDOLAYER	Contains the application metadata for the layer in a single row.
<business_table_name>_SDODIM	Defines the dimension and tolerance of each coordinate value.
<business_table_name>_SDOGEOM	Contains the geometric data for the object.
<business_table_name>_SDOINDEX	Stores index information about the geometric features in the layer.

<business_table_name>_SDOLAYER:

- SDO_ORDCNT: The total number of values per row. This is the total number of values, not the total number of coordinate pairs.
- SDO_LEVEL: The number of tessellation levels created during indexing.
- VERIFY_GEOMETRY: TRUE/FALSE. If TRUE, features are verified by the ArcSDE software.

<business_table_name>_SDODIM:

- SDO_DIMNUM: The dimension number of the row. Dimensions start at one and increase.
- SDO_LB: The lower bound of the dimension.
- SDO_UB: The upper bound of the dimension.
- SDO_TOLERANCE: The distance that two points can be separated and still considered at the same location due to rounding errors. The value must be greater than 0. Generally, you will use a small value such as 0.000005, where the number of zeroes to the right of the decimal point matches your data's precision.
- SDO_DIMNAME: The common name applied to the dimension such as longitude, latitude, easting, or northing.

<business_table_name>_SDOGEOM:

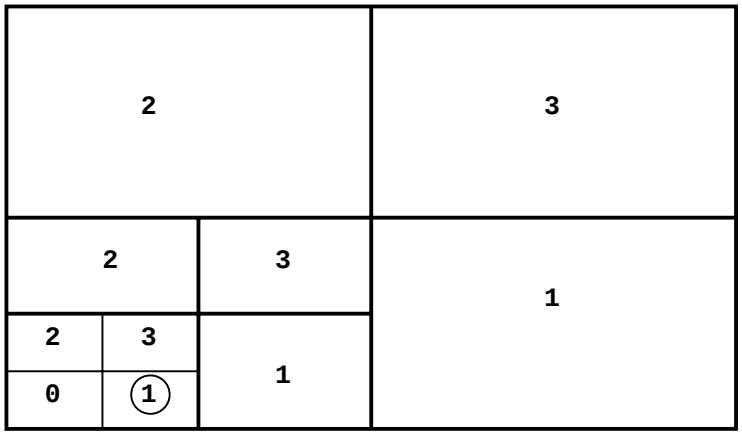
- SDO_GID: The unique identifier for the geometric feature. Each feature in the layer must have a unique ID.
- SDO_ETYPE: The valid Spatial Data Option values for geometry type are point, line string, or polygon (ETYPE values 1, 2, or 3). These correspond to the ArcSDE entity types: ‘p’ point, ‘l’ simple line, ‘s’ line (spaghetti), and ‘a’ area (polygon).
- SDO_ESEQ: A geometry is composed of one or more primitive types called elements or parts. This column enumerates each element in the geometry.
- SDO_SEQ: An internal sequence number for element rows.
- SDO_X1: The x-value of the first coordinate.
- SDO_Y1: The y-value of the first coordinate.
- SDO_Xn: The x-value of the nth coordinate.
- SDO_Yn: The y-value of the nth coordinate.

<business_table_name>_SDOINDEX:

- SDO_GID: The unique geographic identifier for each feature in the layer.
- SDO_CODE: The index tile value for the extent of the feature.

Spatial index

The Normalized Geometry Schema uses the Oracle Spatial linear quadtree to index spatial data. Using the bounding values from <business_table_name>_SDODIM and the number of levels specified in <business_table_name>_SDOLAYER, the normalized layer is recursively tessellated. The two-dimensional layer is divided into four equal areas, or quadrants, labeled 0, 1, 2, and 3, to create the first tessellation level. To create the next level, each of the four areas is again split into four pieces. Refer to the Oracle Spatial documentation for more information on optimizing the spatial index.



A recursively tessellated normalized layer with three levels

The figure above has four levels. A tile is identified by concatenating the appropriate digit for each layer. The feature represented by the circle would have an ID of 0 at level one, 00 at level two, and 001 at level three. By adding more levels, you can subdivide your data as finely as you like. The length of the tile ID is a direct reflection of its surface area. The smaller the tile ID, the larger the area it represents.

Making the Normalized Geometry Schema the default

The GEOMETRY_STORAGE parameter in the DBTUNE table defines the geometry storage method to be used. By setting the GEOMETRY_STORAGE storage parameter in the DEFAULTS configuration keyword to NORMALIZED, you can make the Normalized Geometry Schema your default storage method. Here is an example of how the GEOMETRY_STORAGE storage parameter would be set within the DEFAULTS configuration keyword in a dbtune file. This file would be imported into the DBTUNE table with the sdedbtune administration command. Refer to Chapter 3 ‘Configuring DBTUNE storage parameters’, for more information about the DBTUNE table, configuration keywords, and storage parameters.

```
## DEFAULTS
GEOMETRY_STORAGE    NORMALIZED
<other parameters>
END
```

You can choose not to make the Normalized Geometry Schema your default geometry storage method and still define a Normalized layer. To create a layer using the Normalized Geometry Schema, you can use the NORMALIZED dbtune keyword, which is defined as:

```
## NORMALIZED
GEOMETRY_STORAGE        NORMALIZED
END
```

Or you can create a specific keyword that specifies the GEOMETRY_STORAGE parameter as NORMALIZED. In this example, a configuration named WELLS_NORMALIZED is defined with explicit storage, extent, and indexing parameters.

```
##WELLS_NORMALIZED
GEOMETRY_STORAGE    NORMALIZED
SDO_ORDCNT          2       # Ordinate count
SDO_LEVEL           8       # Layer Tessellation
SDO_VERIFY          TRUE    # SDE will verify the geometry
SDO_LB_1            -180.0  # SDODIM Lower X
SDO_UB_1            180.0   # SDODIM Upper X
SDO_TOLERANCE_1     0.00005 # SDODIM Tolerance
SDO_LB_2            -90.0   # SDODIM Lower Y
SDO_UB_2            90      # SDODIM Upper Y
SDO_TOLERANCE_2     0.00005 # SDODIM Tolerance
END
```

As shown in the example above, the Normalized Geometry Storage Method allows you to define the dimension values, index levels, ordinate counts, etc., for the Normalized feature class. These parameters are defined in Chapter 3 of this document.

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