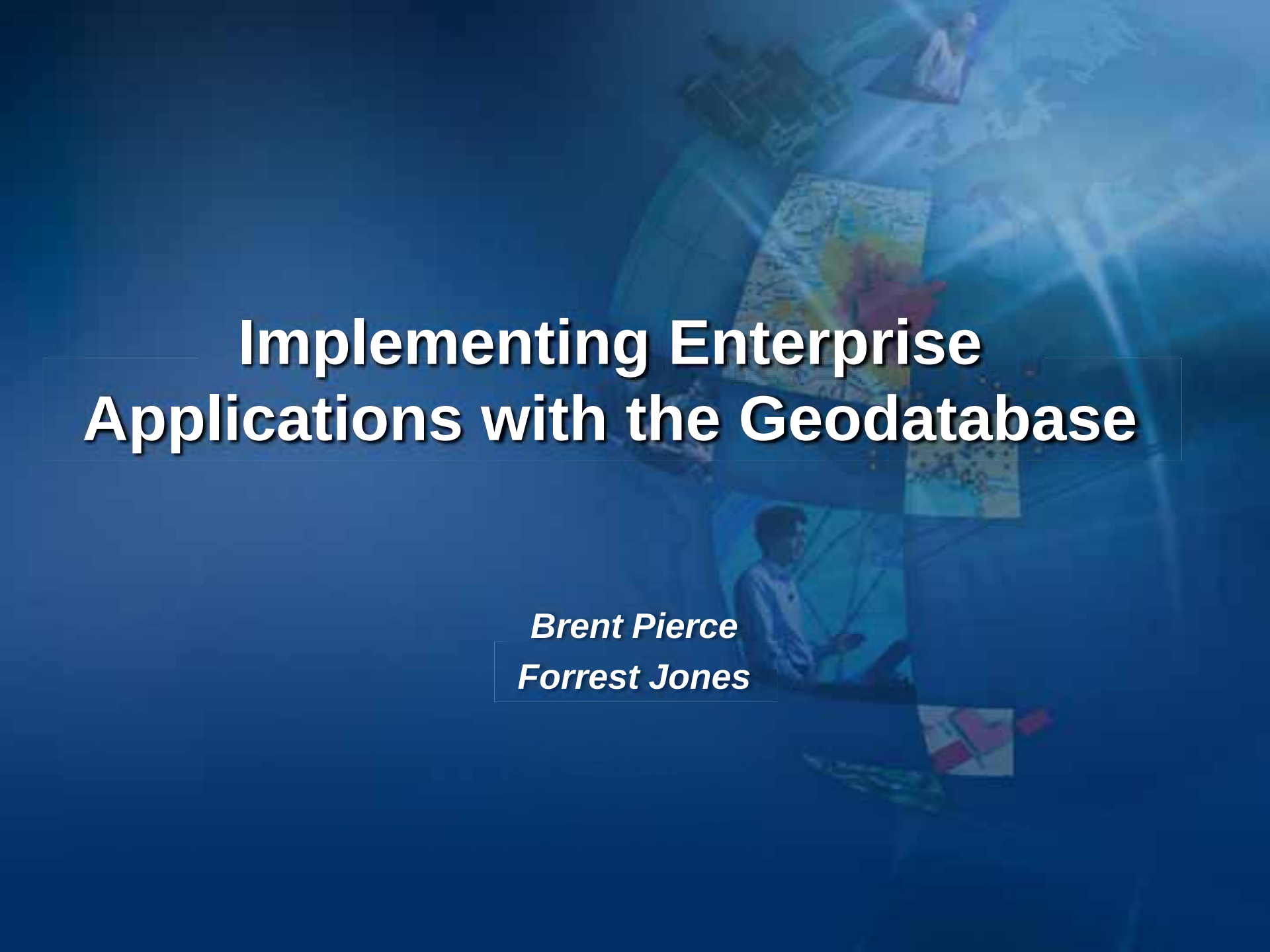
Implementing Enterprise Applications with the Geodatabase



Brent Pierce

Forrest Jones

Assumptions

- Good working knowledge of the Geodatabase
- Experience in programming against the GDB API
- Code examples will use C#.NET
  - Readily translatable to VB, VB.NET, VC++, etc.
  - Code samples available with the slides on EDN after the Summit
  - Code samples in the presentation might not compile
    - (shortened to improve readability)
- Lots of content, little time
  - Please hold all questions to the end
    - We'll be at the Tech Talk and Server Island Area for questions

What is covered in this session

- Connecting to the Geodatabase
- Working with Schemas
- Geodatabase cursor model
- Querying Data
  - Spatial / Non-Spatial
  - Views and Joins
- Transactions and Editing
  - Transactions
  - Versioned / Non-Versioned
  - Reconcile and Post
- Difference Cursors
- Archiving
- Version Events
- Code Instrumentation and Tracing

Workspaces

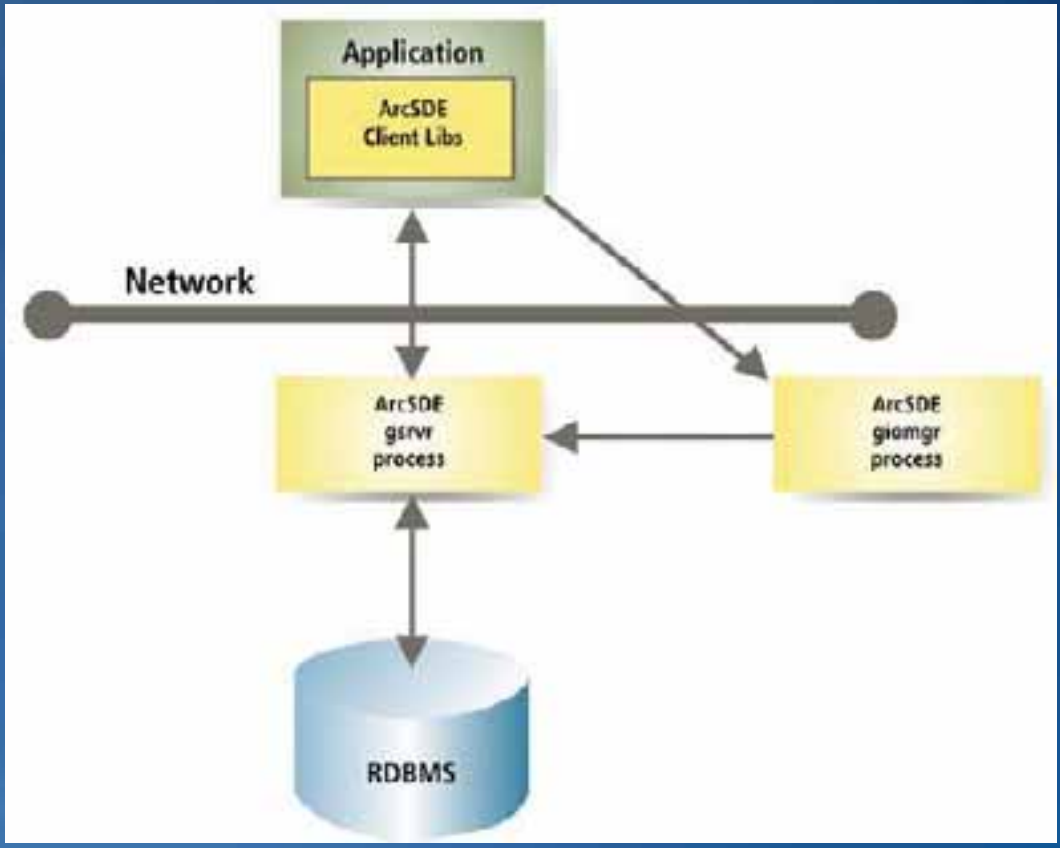
Connections and workspaces (Enterprise)

- The workspace is the DBMS connection and gives access to the data
- Each connection/workspace creates an ArcSDE and DBMS process.
  - Type of connection controls server/client load
- ArcGIS maintains a workspace/connection pool to save resources
  - Workspaces are uniquely instanced
- Opening too many connections consumes server and DBMS resources

Database Connection

Application Server

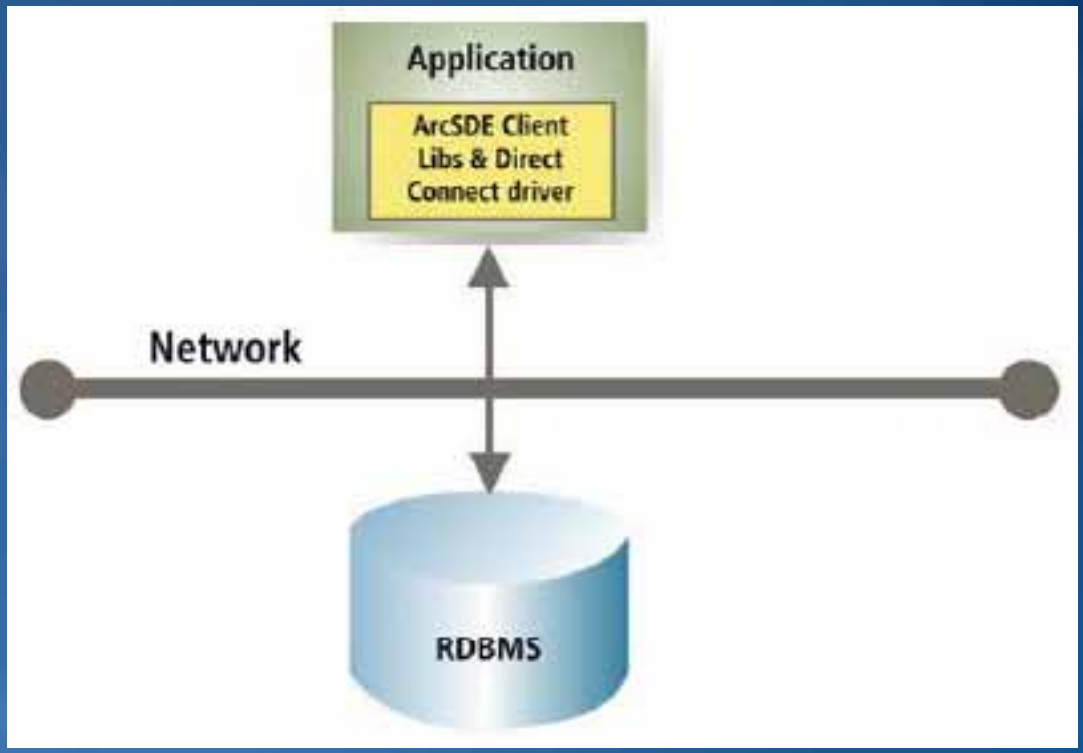
- **Server machine must run ArcSDE service**
  - **giomgr/gsrvr processes**
  - **Can decrease client load by increasing server load**



Database Connection

Direct Connect

- Connect directly to database
- No ArcSDE service required
  - No giomgr/gsrvr processes
  - Can decrease server load by increasing client load



Making a connection

- Connecting using a property set

```
IWorkspaceFactory sdeWkspFact = new SdeWorkspaceFactoryClass();
IPropertySet propset = new PropertySetClass();

propset.SetProperty("SERVER",“crimsontide");
propset.SetProperty("INSTANCE","5151");
propset.SetProperty("USER","brent");
propset.SetProperty("PASSWORD","brent");
propset.SetProperty("DATABASE","null");
propset.SetProperty("VERSION","SDE.DEFAULT");
propset.SetProperty("AUTHENTICATION_MODE","DBMS");

IWorkspace workspace = sdeWkspFact.Open(propset, 0);
```

- Connecting using a connection file

```
string nameOfFile = "D:\\data\\redarrow.sde”;
IWorkspace workspace = workspaceFactory.OpenFromFile(nameOfFile, 0);
```

ArcSDE for SQL Server Express Geodatabases

- **Detailed API**
  - Analyze statistics
  - Create a geodatabase

```
IDataServerManager DSManager = new DataServerManagerClass();
DSManager.ServerName = “crimsontide\\sqlexpress”;
DSManager.Connect();
IDataServerManagerAdmin DSMAdmin = (IDataServerManagerAdmin)DSManager;

DSMAdmin.CreateGeodatabase(“MyGDB",“C:\\MyGDB.mdf",100,“C:\\MyGDB.ldf“,100);
```

  - Detatch/Attach geodatabases

```
DSMAdmin.DetatchGeodatabase("MyGDB");

DSMAdmin.AttachGeodatabase(“MyGDB“,“C:\\MyGDB.mdf",“C:\\MyGDB.ldf“);
```

Once Connected…

Information about the connected workspace

- IDatabaseConnectionInfo2
  - GeodatabaseServerClass
    - esriServerClassEnterprise
    - esriServerClassWorkgroup
    - esriServerClassPersonal
  - ConnectionDBMS
    - esriDBMS_DB2
    - esriDBMS_Informix
    - esriDBMS_Oracle
    - esriDBMS_SQLServer
    - esriDBMS_PostgreSQL
  - ConnectionCurrentDateTime
  - ConnectedUser
  - ConnectedDatabase
- IFeatureClassStorage

Working With Schemas

Schema Cache

What is the schema cache?

- A cached snapshot of the GDB schema
  - Used by ArcGIS (opening Map Documents, Reconcile)
  - Requires a static data model
    - GDB schema changes will not be reflected in the cache
- Can improve performance when opening datasets
  - Reduces database round trips by using the cached information
- APIs to access the schema cache
  - `IWorkspaceFactorySchemaCache`
    - `EnableSchemaCache`
    - `EnableSchemaCaching`
    - `RefreshSchemaCache`
    - `DisableSchemaCache`

Schema Cache

When to use a schema cache?

- **Beneficial when working with large static data models**
  - **Tables, fields, domains, sub-types and relationships are well defined and will not change**
- **If the application opens and uses many classes**
  - **These should be opened at the start of the application and references maintained throughout the lifetime of the application**

Schema Cache

How to leverage in enterprise applications

- Enable schema cache before tables are opened
  - Calls to `OpenFeatureClass, OpenTable, IName.Open` will be optimized
  - Can enable schema caching at the factory level
- Cache needs to be “fresh”
  - If in dynamic environments schema changes will not be visible until cache is refreshed.

```
//Spatial Cache Refresh if stale
if(sCache.IsSchemaCacheStale(workspace))
{
   sCache.RefreshSchemaCache(workspace);
}
```

- your responsibility to disable the cache
  - Must be disabled before releasing the workspace object that is cached

Using Schema Caching

1. Cast to `IWorkspaceFactorySchemaCache` from the workspace factory and open the workspace

```
IWorkspaceFactorySchemaCache sCache =
(IWorkspaceFactorySchemaCache)workspaceFactory;

IWorkspace workspace = workspaceFactory.Open(propset, 0);

sCache.EnableSchemaCache(workspace);

IFeatureWorkspace featureWorkspace = (IFeatureWorkspace)workspace;
IFeatureClass parcel = featureWorkspace.OpenFeatureClass("ParcelClass");
//...open all feature classes used in application

sCache.DisableSchemaCache(workspace);
```

Using Schema Caching

❷ **Enable the schema cache on the workspace**

Alternatively `EnableSchemaCaching` will enable caching on all workspace passed out by the factory

```
IWorkspaceFactorySchemaCache sCache =
(IWorkspaceFactorySchemaCache)workspaceFactory;

IWorkspace workspace = workspaceFactory.Open(propset, 0);

sCache.EnableSchemaCache(workspace);

IFeatureWorkspace featureWorkspace = (IFeatureWorkspace)workspace;
IFeatureClass parcel = featureWorkspace.OpenFeatureClass("ParcelClass");
//...open all feature classes used in application

sCache.DisableSchemaCache(workspace);
```

Using Schema Caching

❸ **Open all feature classes used in application**

Largest benefit for stand alone feature classes and tables

```
IWorkspaceFactorySchemaCache sCache =
(IWorkspaceFactorySchemaCache)workspaceFactory;

IWorkspace workspace = workspaceFactory.Open(propset, 0);

sCache.EnableSchemaCache(workspace);

IFeatureWorkspace featureWorkspace = (IFeatureWorkspace)workspace;
IFeatureClass parcel = featureWorkspace.OpenFeatureClass("ParcelClass");
//...open all feature classes used in application

sCache.DisableSchemaCache(workspace);
```

Using Schema Caching

4. Disable the schema cache after the classes have been opened

```
IWorkspaceFactorySchemaCache sCache =
(IWorkspaceFactorySchemaCache)workspaceFactory;

IWorkspace workspace = workspaceFactory.Open(propset, 0);

sCache.EnableSchemaCache(workspace);

IFeatureWorkspace featureWorkspace = (IFeatureWorkspace)workspace;
IFeatureClass parcel = featureWorkspace.OpenFeatureClass("ParcelClass");
//...open the all feature classes used in application

sCache.DisableSchemaCache(workspace);
```

Using Schema Caching

- Gotchas
  - If the GDB schema changes cache will have to be refreshed
    - Geodatabase schema changes will not be visible until cache is refreshed

```
IWorkspaceFactorySchemaCache sCache =
(IWorkspaceFactorySchemaCache)workspaceFactory;

IWorkspace workspace = workspaceFactory.Open(propset, 0);

sCache.EnableSchemaCache(workspace);

IFeatureWorkspace featureWorkspace = (IFeatureWorkspace)workspace;
IFeatureClass parcel = featureWorkspace.OpenFeatureClass("ParcelClass");
//...open all feature classes used in application

sCache.DisableSchemaCache(workspace);
```

Cursors

Cursors

What are they?

- A geodatabase object used for the iteration of records returned from a query

- 3 Class Cursors
  - Search (general query cursor)
  - Update (positioned update cursor)
  - Insert (bulk inserts)

- 1 QueryDef Cursor
  - Defined query (e.g. IQueryDef.Evaluate)

- What's the difference?
  - Rows created by Class cursors are bound to the class which created the cursor, rows created by a QueryDef cursor are not bound to a class

Class Cursors

Types

- **Search cursors**
  - Returns rows specified by a Query or Spatial Filter
- **Update cursors**
  - Update and delete rows specified by the filter
  - Specify the ObjectID field
- **Insert cursors**
  - Used for inserting rows into a table
- **Accessed by**
  - Corresponding methods on table or feature class

Class Cursors: Recycling Property

What is Recycling?

- A recycling cursor is a cursor that hands out the same row object on each call to **`NextRow`**
  - Internal data structures and objects will be reused

```
//example of a recycling cursor
IFeatureCursor searchCursor = featureClass.Search(queryFilter, true)
```

- A non-recycling cursor is a cursor that hands out a new row object on each call to **`NextRow`**
  - New internal data structures and objects will be created for each row

```
//example of a non-recycling cursor
IFeatureCursor searchCursor = featureClass.Search(queryFilter, false)
```

Class Cursors: Recycling

When to use a recycling cursor

- Use recycling cursors when references to the current row and its values **do not need** to be kept beyond the next call to `NextRow/NextFeature`
- do not pass the references around as some other method may decide to hold it

Class Cursors: Non-Recycling

When to use a non-recycling cursor

- Use non-recycling cursors when references to the current row and its values are needed beyond the next call to `NextRow/NextFeature`
- Commonly used to cache sets of rows (long lived references)
- Some Geodatabase APIs require sets of rows – should be retrieved as non-recycled rows

QueryDef Cursors

- Query based on one or more tables
  - Analogous to an SQL Query
  - Get a cursor back
  - Not bound to a class
- Tables must be in database
  - Do not have to be registered with the geodatabase
- Can result in a feature layer
  - Need to use TableQueryName::IQueryName2 if no ObjectIDs in input tables
- Are also used to establish joins

Example: QueryDef Cursors

- Simple Query (One Table)

```
//Create the query definition
IQueryDef queryDef = featureWorkspace.CreateQueryDef();

//Provide a list of tables to join
queryDef.Tables = "PoleFeature";

//Retrieve the fields from all tables
queryDef.SubFields = "bob.PoleFeature.TAG, bob.PoleFeature.SHAPE";

//Set up the join based on the owner_name attribute
queryDef.WhereClause = "PoleFeature.TAG > 1000";

ICursor cursor = queryDef.Evaluate();

IRow row = cursor.NextRow();
```

Example: QueryDef Joins

- Simple 1:M table join

```
//Create the query definition
IQueryDef queryDef = featureWorkspace.CreateQueryDef();

//Provide a list of tables to join
queryDef.Tables = "PoleFeature, TransformerFeature";

//Retrieve the fields from all tables
queryDef.SubFields = "bob.PoleFeature.TAG, bob.PoleFeature.SHAPE,
bob.TransformerFeature.Tag_Val";

//Set up the join based on the owner_name attribute
queryDef.WhereClause = "PoleFeature.TAG = TransformerFeature.Tag_Val";

ICursor cursor = queryDef.Evaluate();
IRow row = cursor.NextRow();
```

Example: QueryDef Joins

- Complex 1:M table Join

```
IQueryDef queryDef = featureWorkspace.CreateQueryDef();
queryDef.Tables = "ElectricStation, CircuitSource, CableJunction";

queryDef.SubFields = "ElectricStation.StationName,
  ElectricStation.StationAbbreviation,
  CableJunction.ObjectID";
queryDef.WhereClause = "((ElectricStation.CircuitID LIKE 'A-235%' " +
    "AND SUBSTR(ElectricStation.CircuitID,5+1,1) not between '0' and '9')" +
    "OR (ElectricStation.CircuitID = 'A-235'))" +
    "AND ElectricStation.StationTypeCode = 'GEN'" +
    "AND CircuitSource.ObjectID = ElectricStation.CircuitSourceObjectID" +
    "AND ElectricStation.ObjectID = CircuitSource.ElectricStationObjectID" +
    "AND CableJunction.DeviceObjectID = ElectricStation.ObjectID" +
    "AND CableJunction.DeviceType = 'ENG'" +
    "OR  INSTR(UPPER(CircuitSource.PhaseDesignation),'123') > 0)";

ICursor cursor = queryDef.Evaluate();
IRow row = cursor.NextRow();
```

Querying and Joining Data

Querying and Joining Data

- Defining the query
  - Query Filters
  - Spatial Filters
- Optimizing queries
  - Spatial Caching
- Persisted Views
  - ArcSDE Views (Multi Versioned Views)
- On-The-Fly Joins
  - QueryTables
  - RelQueryTables

Defining the query

IQueryFilter

- Used when querying a single class
- `IQueryFilterDefinition::PostFixClause`
  - Supports order by

```
IQueryFilter queryFilter = new QueryFilterClass();
queryFilter.SubFields = "OBJECTID,FULLNAME,ParcelID";
queryFilter.WhereClause = “FULLNAME like ‘D%’";

IQueryFilterDefinition queryFilterDef =
(IQueryFilterDefinition)queryFilter;
queryFilterDef.PostfixClause = "ORDER BY FULLNAME";

IFeatureCursor featureCursor = featureClass.Search(queryFilter, true);
```

Defining the query

ISpatialFilter

- Used to query spatial aspects of a feature class
  - Inherits from `IQueryFilter`
- Will be satisfied by spatial cache if within cache extent

```
ISpatialFilter spatialFilter = new SpatialFilterClass();

spatialFilter.SubFields = "OBJECTID,FULLNAME,ParcelID,SHAPE";
spatialFilter.Geometry = searchShape;
spatialFilter.SpatialRel = within;
spatialFilter.WhereClause = "FULLNAME like 'D%'";

IFeatureCursor featureCursor = featureClass.Search(spatialFilter, true);
```

Defining the query

ISpatialFilter

- Used to query spatial aspects of a feature class
  - Inherits from `IQueryFilter`
- Will be satisfied by spatial cache if within cache extent

```
ISpatialFilter spatialFilter = new SpatialFilterClass();

spatialFilter.SubFields = "OBJECTID,FULLNAME,ParcelID,SHAPE";
spatialFilter.Geometry = searchShape;
spatialFilter.SpatialRel = within;
spatialFilter.WhereClause = "FULLNAME like 'D%'";

IFeatureCursor featureCursor = featureClass.Search(spatialFilter, true);
```

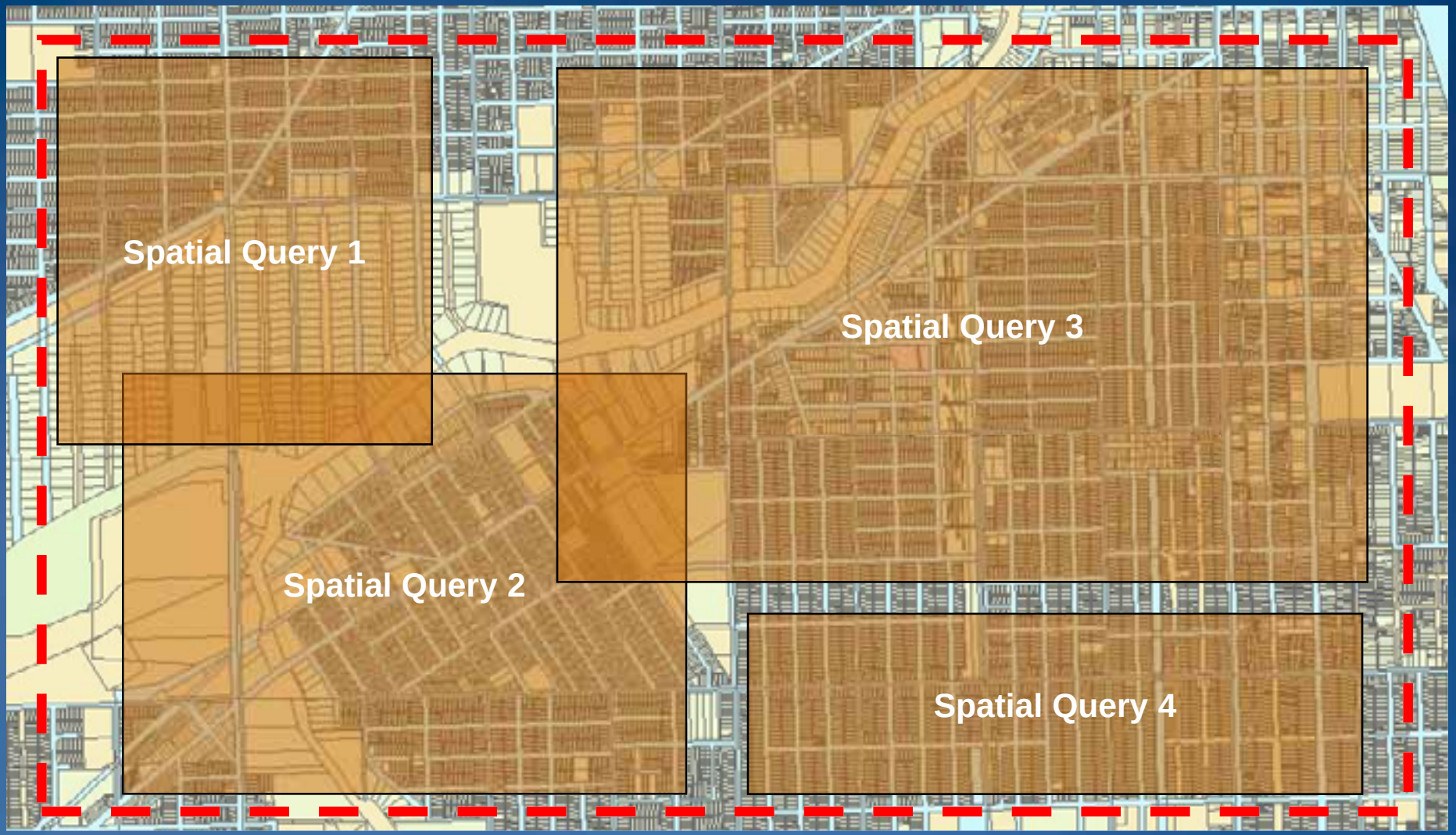
Spatial Caching

What is it?

- Client side caching of feature values over a given spatial extent (MapCache in ArcMap)
- Can speed up queries
  - Reduces roundtrips to the database
- `ISpatialCacheManager2`
  - `FillCache \ EmptyCache`
  - `CacheExtent`
- When to use?
  - If making many spatial queries within a common extent

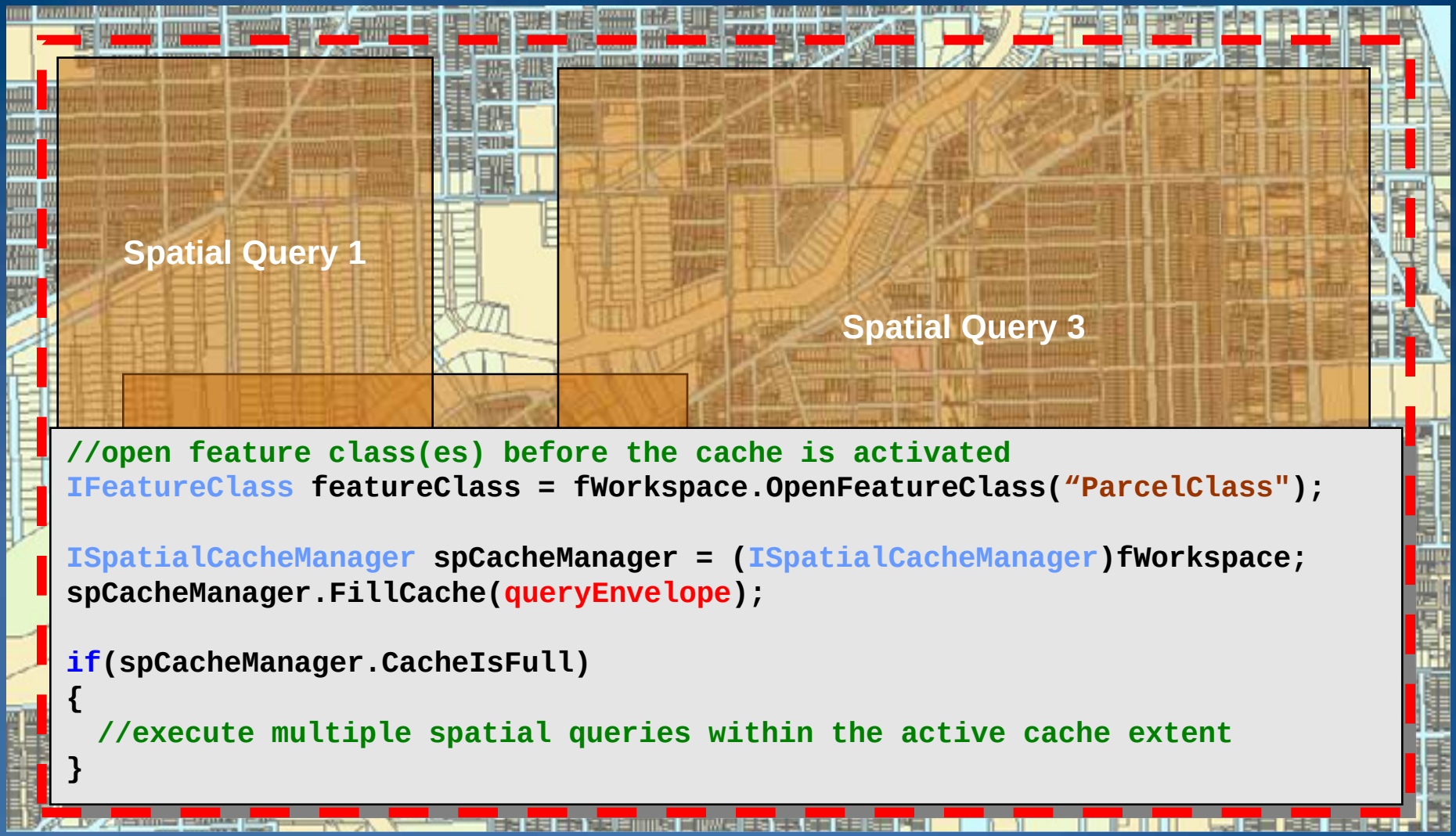
Spatial Caching

How to leverage spatial caching in enterprise applications



Spatial Caching

How to leverage spatial caching in enterprise applications



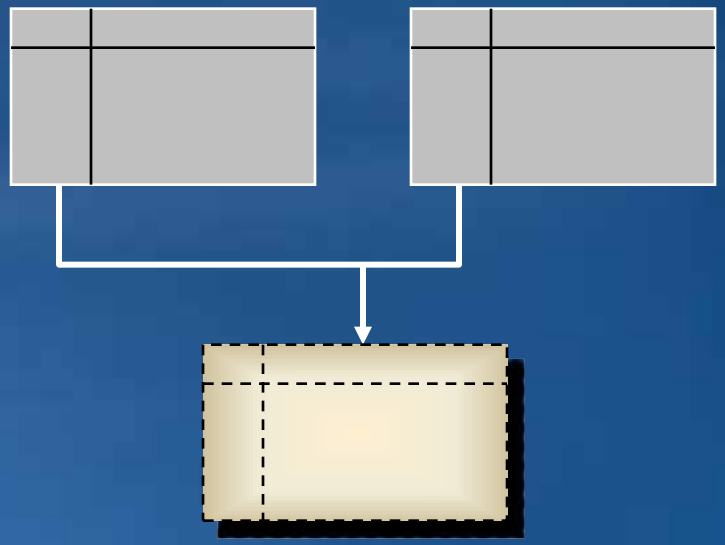

```
//open feature class(es) before the cache is activated
IFeatureClass featureClass = fWorkspace.OpenFeatureClass("ParcelClass");

ISpatialCacheManager spCacheManager = (ISpatialCacheManager)fWorkspace;
spCacheManager.FillCache(queryEnvelope);

if(spCacheManager.CacheIsFull)
{
  //execute multiple spatial queries within the active cache extent
}
```

Views, Table Joins and Complex Queries

- Persisted
  - ArcSDE Views (MultiVersion Views)
- On-The-Fly
  - QueryTables
    - Same Database
      - Spatial and Non-Spatial
  - RelQueryTables
    - Cross Database
      - Spatial and Non-Spatial



Persisted Views

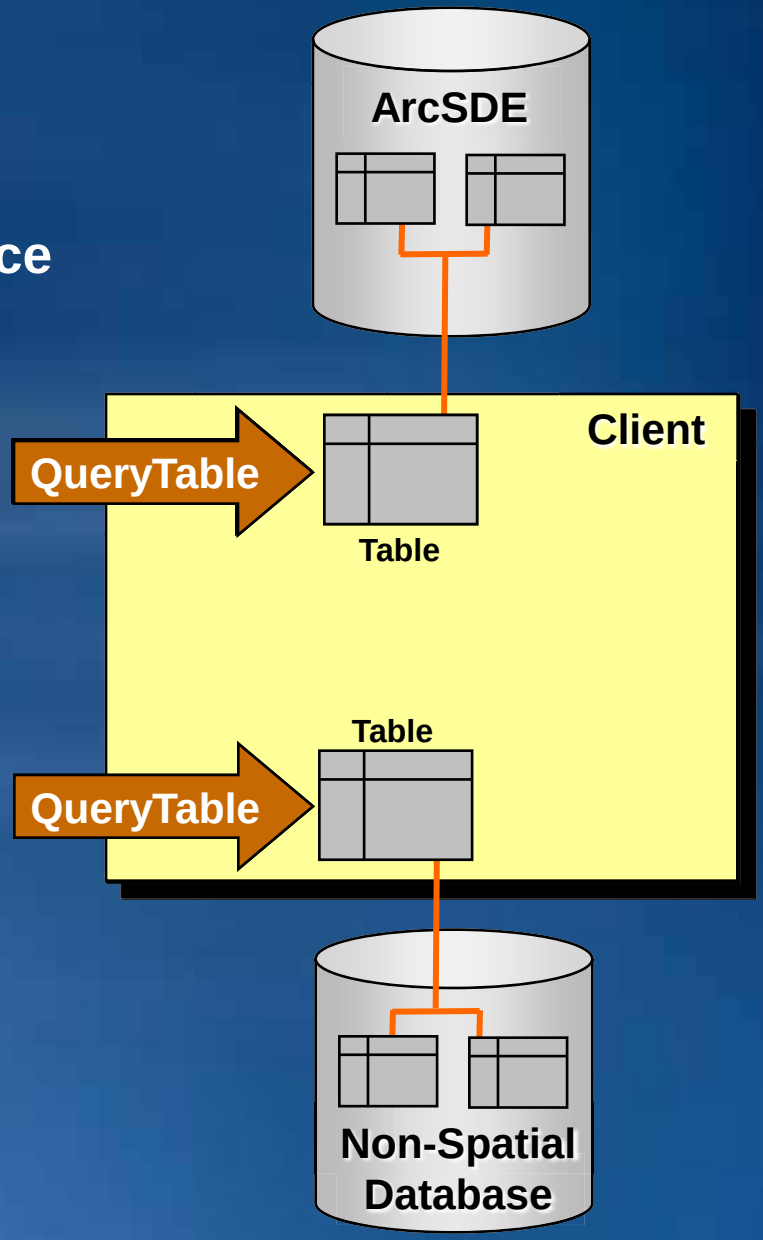
- Open views as tables (read only)

```
//open view through API as (read only) table
ITable myJoinedTable = fWorkspace.OpenTable(“databaseView");
```

- Must satisfy geodatabase rules for a valid table or feature class
  - Only one spatial column
  - Supported data types in returned fields

On-The-Fly Joins

- QueryTables (`TableQueryName`)
  - Tables must be within same datasource
  - Matches all candidates
  - Uses QueryDef object
  - Can be used with non-spatial tables



Example: QueryTables (TableQueryName)

- Steps to create a join via IQueryName2
  1. Create a new TableQueryName object
  2. Set the QueryDef and PrimaryKey property
  3. Cast to IDatasetName setting WorkspaceName and Name
  4. Open the name object as a table

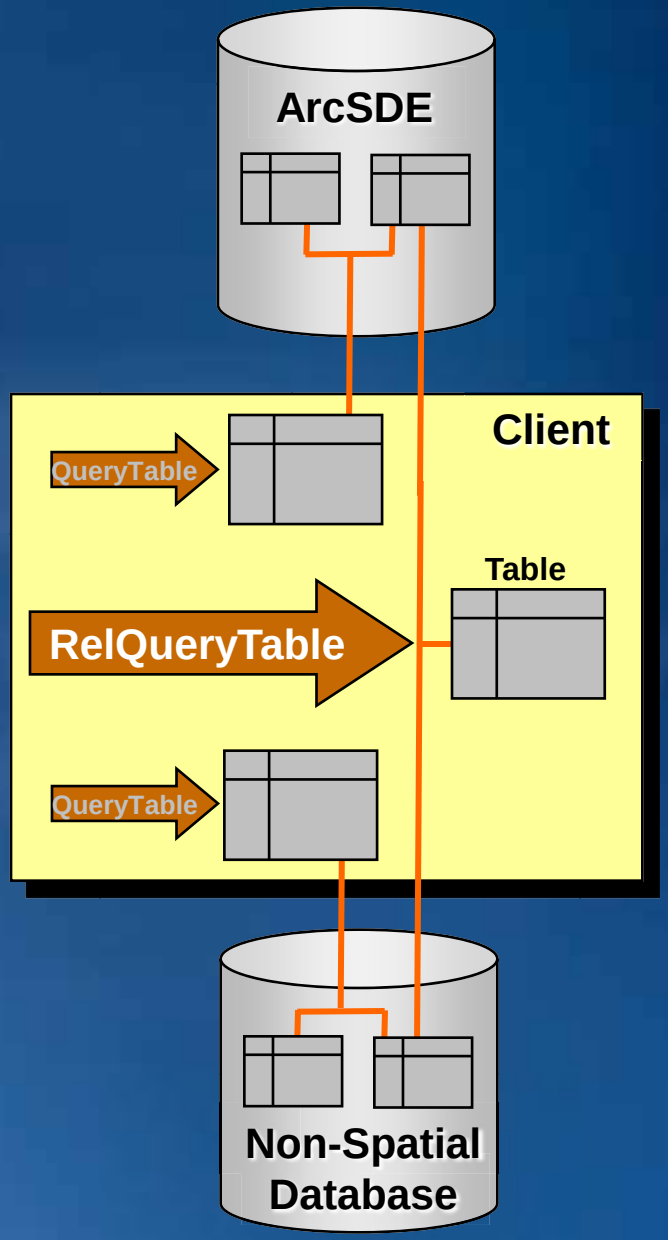
```
// Make the new TableQueryName
IQueryName2 qn2 = (IQueryName2)new TableQueryName();
qn2.QueryDef = qdef;
qn2.PrimaryKey = "ObjectID";
qn2.CopyLocally = false;

// Set the workspace and name of the new QueryTable
IDatasetName pDSName = (IDatasetName)qn2;
pDSName.WorkspaceName = WSName;
pDSName.Name = TableName;

// Open and return the table
IName name = (IName)qn2;
ITable table = (ITable)name.Open();
```

On-The-Fly Joins

- QueryTables (`TableQueryName`)
  - Tables must be within same datasource
  - Matches all candidates
  - Uses QueryDef object
  - Can be used with non-spatial tables
- RelQueryTables (`IRelQueryTable`)
  - Tables can be in different datasources
  - Matches only first candidate on 1:M join
  - Uses in-memory or relationship classes



Example: RelQueryTables (IRelQueryTable)

- Steps to create a join via IRelQueryTable
  1. Create a new memory RelationshipClass
     - Passing in the ObjectClasses that need to be joined
     - An existing relationship class can be used
  2. Call open on RelQueryTableFactory casting to ITable
     - Passing in the relationship class

```
// build a memoryrelationshipclass
IMemoryRelationshipClassFactory mRCfactory = new
MemoryRelationshipClassFactoryClass();

// open the memoryrelationshipclass
1 IRelationshipClass memRC = mRCfactory.Open("memrc", targetObjectClass,
fromField, joinObjectClass, toField, "forward", "backward",
esriRelCardinality.esriRelCardinalityOneToOne);

// Open the relquerytable as a table
IRelQueryTableFactory rqtfactory = new RelQueryTableFactoryClass();

2 ITable rqTable = (ITable)rqtfactory.Open(memRC, true, null, null, "",
false, true);
```

Editing and Transactions

Geodatabase & DBMS Transactions

Transaction Models

- **Non-versioned**
  - Utilizes database transactions
  - Transaction scope controlled through `StartEditing` and `StopEditing` calls
- **Versioned**
  - Utilizes database transactions (extended as long transaction)
  - Provides read consistency and isolation
  - Geodatabase transaction is defined by the scope of the edit session
  - Changes are only viewable by the editor until the edit session is explicitly saved
  - Provides undo and redo
  - Transaction scope controlled through `StartEditOperation` and `StopEditOperation` calls

Geodatabase & DBMS Transactions

Outside of an Edit Session (i.e. Updating)

- **`ITransactions` interface – `StartTransaction`, `CommitTransaction`, `AbortTransaction`, `InTransaction`**
- **`ITransactionsOptions` interface – `AutoCommitInterval`**
  - Number of modifications before a commit is automatically executed
  - Default is 1000 (server config)
  - 0 == no automatic commits (developers should set to 0 if server is configured with appropriate rollback resources)
- **DBMS rules apply – DDL may commit DML**

Geodatabase & DBMS Transactions

Within a Non-Versioned Edit Session (i.e. Editing)

- The logical transaction
  - `StartMultiuserEditing(NVES) == StartTransaction`
  - `StopEditing(true)  == CommitTransaction`
  - `StopEditing(false) == AbortTransaction`
- `StartMultiUserEditing` turns off auto commit (set to 0)

```
muWEdit.StartMultiuserEditing(esriMultiuserEditSessionMode.esriMESMNonVersioned);
```

- Editing errors need to be handled around the API committing the transaction – if error need to call `StopEditing(false)`
- Don't mix use of `ITransaction` and `IMultiUserWorkspaceEdit`

Geodatabase & DBMS Transactions

Within a Versioned Edit Session (i.e. Editing)

- The logical transaction
  - `StartEditOperation == StartTransaction`
  - `StopEditOperation == CommitTransaction`
  - `AbortEditOperation == AbortTransaction`
- `StartMultiUserEditing` turns off auto commit (set to 0)

```
muWEdit.StartMultiuserEditing(esriMultiuserEditSessionMode.esriMESMVersioned);
```

- Editing errors need to be handled around the API committing the transaction – if error need to call `AbortEditOperation`

Geodatabase & DBMS Transactions

Developer Considerations

- **Geodatabase "DDL" and other objects which invoke it may cause a commit**
  - CreateFeatureClass
  - Geoprocessing Tools
  - Selection in Map over 100 features (may call create table)
  - Etc…
- **Transactions are per "connection" not per Version**

Geodatabase & DBMS Transactions

Transaction Scope

- **Non-Versioned Edit Session**
  - Make many calls to `StopEditing(true)`
  - Edit Operations are no ops

```
muWEdit.StartMultiuserEditing(esriMESMNonVersioned);
          // Edit Code
workspaceEdit.StopEditing(true);
```

} Database Transaction

- **Versioned Edit Session**
  - Avoid excessive calls to `StopEditing(True)`

```
muWEdit.StartMultiuserEditing(esriMESMVersioned);
  workspaceEdit.StartEditOperation();
          // Edit Code
  workspaceEdit.StopEditOperation();
          //…
  workspaceEdit.StartEditOperation();
          // Edit Code
  workspaceEdit.StopEditOperation();
workspaceEdit.StopEditing(true);
```

} Database Transaction

} Database Transaction

Example: Editing a Versioned Geodatabase

- Steps to making a version edit
  1. Get a reference to the `version\workspace` that is to be edited
  2. Use `IMultiUserWorkspaceEdit` to start the appropriate edit session
  3. Use `IWorkspaceEdit.StartOperation` to start an edit operation
  4. Make edit
  5. Stop operation and stop edit session saving edits

Versioned Editing

1. Get a reference to the `Version` that is to be edited

   Open the `FeautreClass` to be edited from this version

```
IFeatureWorkspace fWorkspace =
(IFeatureWorkspace)versionedWorkspace.FindVersion("SDE.DEFAULT");

IFeatureClass parcelClass = fWorkspace.OpenFeatureClass(“ParcelClass");

IWorkspaceEdit workspaceEdit = (IWorkspaceEdit)featureWorkspace;
IMultiuserWorkspaceEdit muWEdit =  (IMultiuserWorkspaceEdit)featureWorkspace;

if(muWEdit.SupportsMultiuserEditSessionMode(esriMESMVersioned))
{
muWEdit.StartMultiuserEditing(esriMESMVersioned);
      workspaceEdit.StartEditOperation();
          IFeature feature = parcelClass.GetFeature(2);
          feature.set_Value(8, "TEG");
          feature.Store();
       workspaceEdit.StopEditOperation();
workspaceEdit.StopEditing(true);
}
```

Versioned Editing

- ❷ Use `IMultiUserWorkspaceEdit` to start the appropriate edit session

```
IFeatureWorkspace fWorkspace =
(IFeatureWorkspace)versionedWorkspace.FindVersion("SDE.DEFAULT");

IFeatureClass parcelClass = fWorkspace.OpenFeatureClass(“ParcelClass");

IWorkspaceEdit workspaceEdit = (IWorkspaceEdit)featureWorkspace;
IMultiuserWorkspaceEdit muWEdit =  (IMultiuserWorkspaceEdit)featureWorkspace;

if(muWEdit.SupportsMultiuserEditSessionMode(esriMESMVersioned))
{
muWEdit.StartMultiuserEditing(esriMESMVersioned);
      workspaceEdit.StartEditOperation();
          IFeature feature = parcelClass.GetFeature(2);
          feature.set_Value(8, "TEG");
          feature.Store();
       workspaceEdit.StopEditOperation();
workspaceEdit.StopEditing(true);
}
```

Versioned Editing

❸ Use `IWorkspaceEdit.StartOperation` to start an edit operation

```
IFeatureWorkspace fWorkspace =
(IFeatureWorkspace)versionedWorkspace.FindVersion("SDE.DEFAULT");

IFeatureClass parcelClass = fWorkspace.OpenFeatureClass(“ParcelClass");

IWorkspaceEdit workspaceEdit = (IWorkspaceEdit)featureWorkspace;
IMultiuserWorkspaceEdit muWEdit =  (IMultiuserWorkspaceEdit)featureWorkspace;

if(muWEdit.SupportsMultiuserEditSessionMode(esriMESMVersioned))
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muWEdit.StartMultiuserEditing(esriMESMVersioned);
      workspaceEdit.StartEditOperation();
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          feature.set_Value(8, "TEG");
          feature.Store();
       workspaceEdit.StopEditOperation();
workspaceEdit.StopEditing(true);
}
```

Versioned Editing

4. Make edit(s) to the open feature class

```
IFeatureWorkspace fWorkspace =
(IFeatureWorkspace)versionedWorkspace.FindVersion("SDE.DEFAULT");

IFeatureClass parcelClass = fWorkspace.OpenFeatureClass(“ParcelClass");

IWorkspaceEdit workspaceEdit = (IWorkspaceEdit)featureWorkspace;
IMultiuserWorkspaceEdit muWEdit =  (IMultiuserWorkspaceEdit)featureWorkspace;

if(muWEdit.SupportsMultiuserEditSessionMode(esriMESMVersioned))
{
muWEdit.StartMultiuserEditing(esriMESMVersioned);
      workspaceEdit.StartEditOperation();
          IFeature feature = parcelClass.GetFeature(2);
          feature.set_Value(8, "TEG");
          feature.Store();
       workspaceEdit.StopEditOperation();
workspaceEdit.StopEditing(true);
}
```

Versioned Editing

- ❺ Stop operation and stop edit session saving edits

```
IFeatureWorkspace fWorkspace =
(IFeatureWorkspace)versionedWorkspace.FindVersion("SDE.DEFAULT");

IFeatureClass parcelClass = fWorkspace.OpenFeatureClass(“ParcelClass");

IWorkspaceEdit workspaceEdit = (IWorkspaceEdit)featureWorkspace;
IMultiuserWorkspaceEdit muWEdit =  (IMultiuserWorkspaceEdit)featureWorkspace;

if(muWEdit.SupportsMultiuserEditSessionMode(esriMESMVersioned))
{
muWEdit.StartMultiuserEditing(esriMESMVersioned);
      workspaceEdit.StartEditOperation();
          IFeature feature = parcelClass.GetFeature(2);
          feature.set_Value(8, "TEG");
          feature.Store();
       workspaceEdit.StopEditOperation();
workspaceEdit.StopEditing(true);
}
```

Versioned Editing

- Gotchas
  - Feature class needs to be open in the version before edit session is started

```
IFeatureWorkspace fWorkspace =
(IFeatureWorkspace)versionedWorkspace.FindVersion("SDE.DEFAULT");

IFeatureClass parcelClass = fWorkspace.OpenFeatureClass("ParcelClass");

IWorkspaceEdit workspaceEdit = (IWorkspaceEdit)featureWorkspace;
IMultiuserWorkspaceEdit muWEdit =  (IMultiuserWorkspaceEdit)featureWorkspace;

if(muWEdit.SupportsMultiuserEditSessionMode(esriMESMVersioned))
{
muWEdit.StartMultiuserEditing(esriMESMVersioned);
      workspaceEdit.StartEditOperation();
          IFeature feature = parcelClass.GetFeature(2);
          feature.set_Value(8, "TEG");
          feature.Store();
       workspaceEdit.StopEditOperation();
workspaceEdit.StopEditing(true);
}
```

Versioned Editing

Reconcile and Post

- **Ability to merge changes from one version to another**

```
// To reconcile and post the changes, we need to start a
// new edit session.
muWorkspaceEdit.StartMultiuserEditing(esriMultiuserEditSessionMode.esriMESMVersioned);

// Cast the workspace to the IVersionEdit4 interface and reconcile the changes
// with the QA version.
IVersionEdit4 versionEdit4 = (IVersionEdit4)workspace;
Boolean conflictsDetected = versionEdit4.Reconcile4("QA", true, true, false, true);

// CanPost indicates that posting can occur, post the changes to the QA version.
if (versionEdit4.CanPost())
{
      versionEdit4.Post("QA");
      workspaceEdit.StopEditing(true);
}
else
{
      // Stop the edit session, without saving any edits.
      workspaceEdit.StopEditing(false);
}
```

Archiving

Archiving with the Geodatabase

- The ability to archive edits made to versioned feature classes
- The archives will support historical queries
  - Display the data at a particular time or over a time span
- Historical Version another type of version
  - Classes can be opened from a historical version
- Queries go against the archive table
  - May be faster than querying Default

Archiving API

- Querying a class open in a historical version

```
IHistoricalWorkspace hWorkspace = (IHistoricalWorkspace)pWksp;
IHistoricalVersion hVersion = hWorkspace.FindHistoricalVersionByTimeStamp(date);

IFeatureWorkspace featureWorkspace = (IFeatureWorkspace)hVersion;
IFeatureClass parcel = featureWorkspace.OpenFeatureClass("ParcelClass");
```

- Querying the archive class directly

```
IArchivableClass parcel =
(IArchivableClass)featureWorkspace.OpenFeatureClass("ParcelClass");
ITable parcelArchive = parcel.Archive;

IQueryFilter queryFilter = new QueryFilterClass();
queryFilter.SubFields = “APN";
queryFilter.WhereClause = “APN = 12336 AND GDB_FROM_DATE > '2007-03-10
20:01:48.000'";
```

Difference Cursors

Difference Cursors

What are they?

- A cursor of object differences between versions
- Common APIs which create difference cursors
  - `IVersionTable.Differences`
- Returns a `IDifferenceCursor` Object
- Can be used for Historical or Transactional versions
- Difference type must be specified

Difference Cursors

Transactional Versions

- Returns differences between any two versioned tables
  - **`IRow`** object not returned for **`DeleteNoChange`** difference case
  - To get deleted row use **`IVersion2.GetCommonAncestor`**

```
// get delete no change differences between the two versions
IDifferenceCursor differenceCursor = childTable.Differences(parentTable,
                                                esriDifferenceTypeDeleteNoChange,
                                                null);

differenceCursor.Next(out oid, out differenceRow);
featureWorkspace =
(IFeatureWorkspace)childVersion.GetCommonAncestor(parentVersion);
caFeatureClass = featureWorkspace.OpenFeatureClass("parcelClass");

while (oid != -1)
{
      differenceRow = caFeatureClass.GetFeature(oid);
      Console.WriteLine("The difference row has an OID of {0}", oid);

      differenceCursor.Next(out oid, out differenceRow);
}
```

Difference Cursors

Historical Versions

- Does not support all differences
  - Supported for **`Insert, UpdateNoChange, DeleteNoChange`**
  - **`IRow`** object not returned for **`DeleteNoChange`** difference case

```
// get insert differences between the two historical versions
IDifferenceCursor differenceCursor = hvYearEnd2006.Differences(hvQ12007,
                                                               esriDifferenceTypeInsert,
                                                               null);

differenceCursor.Next(out oid, out differenceRow);

while (oid != -1)
{
    Console.WriteLine("The difference row has an OID of {0}", oid);
    differenceCursor.Next(out oid, out differenceRow);
}
```

Differences Within An Edit Session

EditDataChanges

- Ability to determine what's changed
  - Within a Edit Session or Edit Operation
  - Returns difference cursor
- Works on all types of geodatabases

```
// get insert differences in the edit session

IDataChangesEx editDataChanges;
editDataChanges = workspaceEdit2.get_EditDataChanges(WithinSession);

ESRI.ArcGIS.esriSystem.IEnumBSTR enumBSTR = editDataChanges.ModifiedClasses;
string changedClass = enumBSTR.Next();

IDifferenceCursorEx differenceCursor;
differenceCursor = editDataChanges.ExtractEx(changedClass, TypeInsert);
```

Events

Version Events

- **IVersionEvents / IVersionEvents2**
  - Used for executing specific code blocks when events fire
  - Reconcile, Post, Version Redefine, Archive Update events

```
//event handler method
private void versionEvent_OnReconcile(string targetVersionName, bool
  HasConflicts)
{
        //filter false conflicts from conflict classes
}

//event handler method
private void versionEvent_OnArchiveUpdated(string targetVersionName, bool
  HasConflicts)
{
        //modify user maintained date fields in the archive
}
```

Code Instrumentation and Tracing

Code instrumentation and tracing

What is it?

- **Code Instrumentation[1]**
  - **Adding code to an application for debug**
  - **Time certain operations in your application**
- **Tracing**
  - **More information about what applications are doing**
  - **Using existing tools to trace**
  - **Instrument code to produce own trace files**
- **Allows a look at how an application is performing**

1- Tom Kyte blog post http://tkyte.blogspot.com/2005/06/instrumentation.html

Code instrumentation and tracing

- Why do you need it?
  - Check how efficient the application works with the database
    - e.g. number of calls and the performance of individual operations
  - Info about deployed applications
  - Determine application transaction times
  - Identify bottlenecks
  - Testing overall performance

- Symptoms to look out for
  - Repeated calls to the database
  - Slow running operations

Code instrumentation and tracing

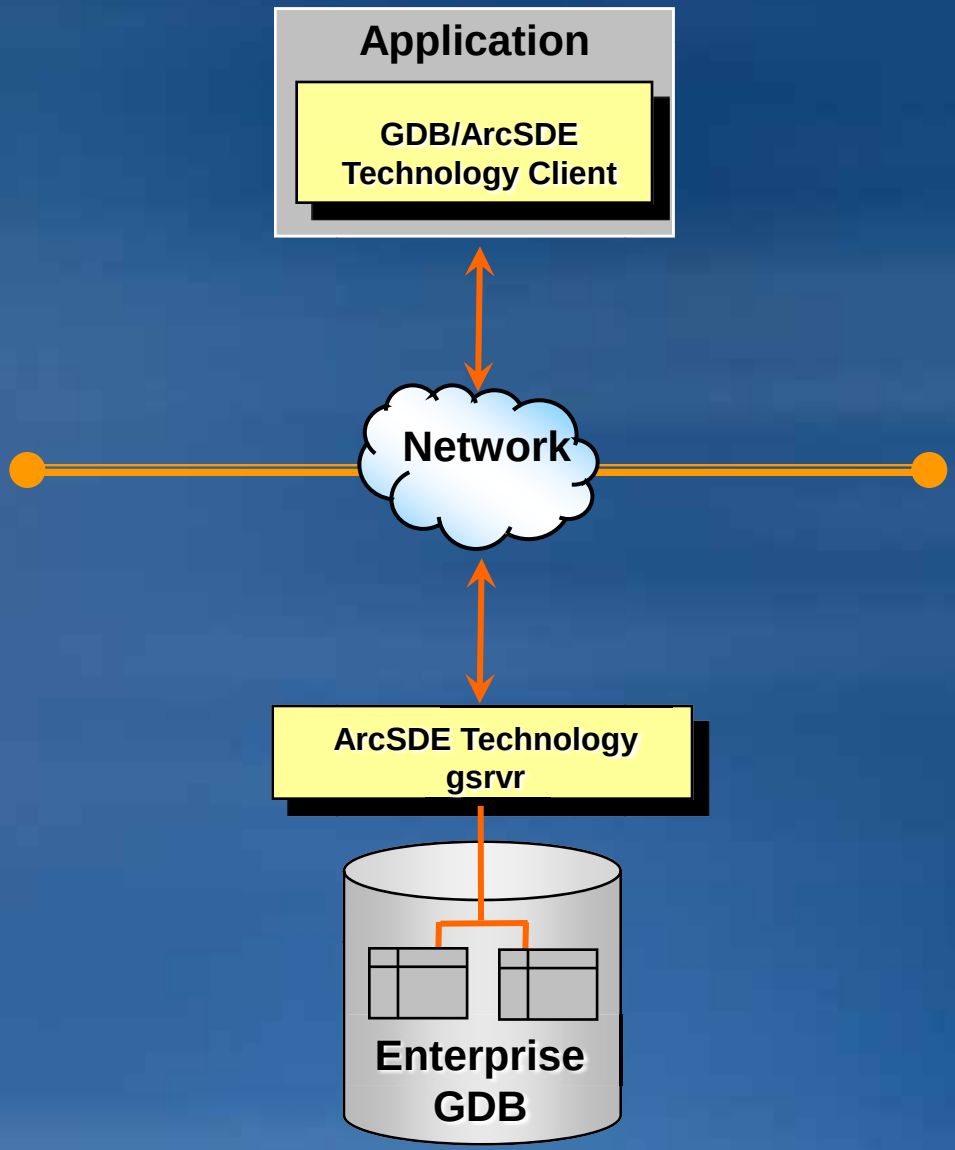
Ways to accomplish

- **Custom applications**
  - **Add code to time critical operations**
    - **Timers around particular functions or business logic**
    - **Data fetching**
  - **Enable DBMS tracing from app**
- **Built-in and already available**
  - **DBMS trace files**
  - **ArcSDE intercept**
  - **ArcSDE/ArcIMS/ArcGIS Server logs**

Code instrumentation and tracing

Client

Server



Example: Fire Danger Application

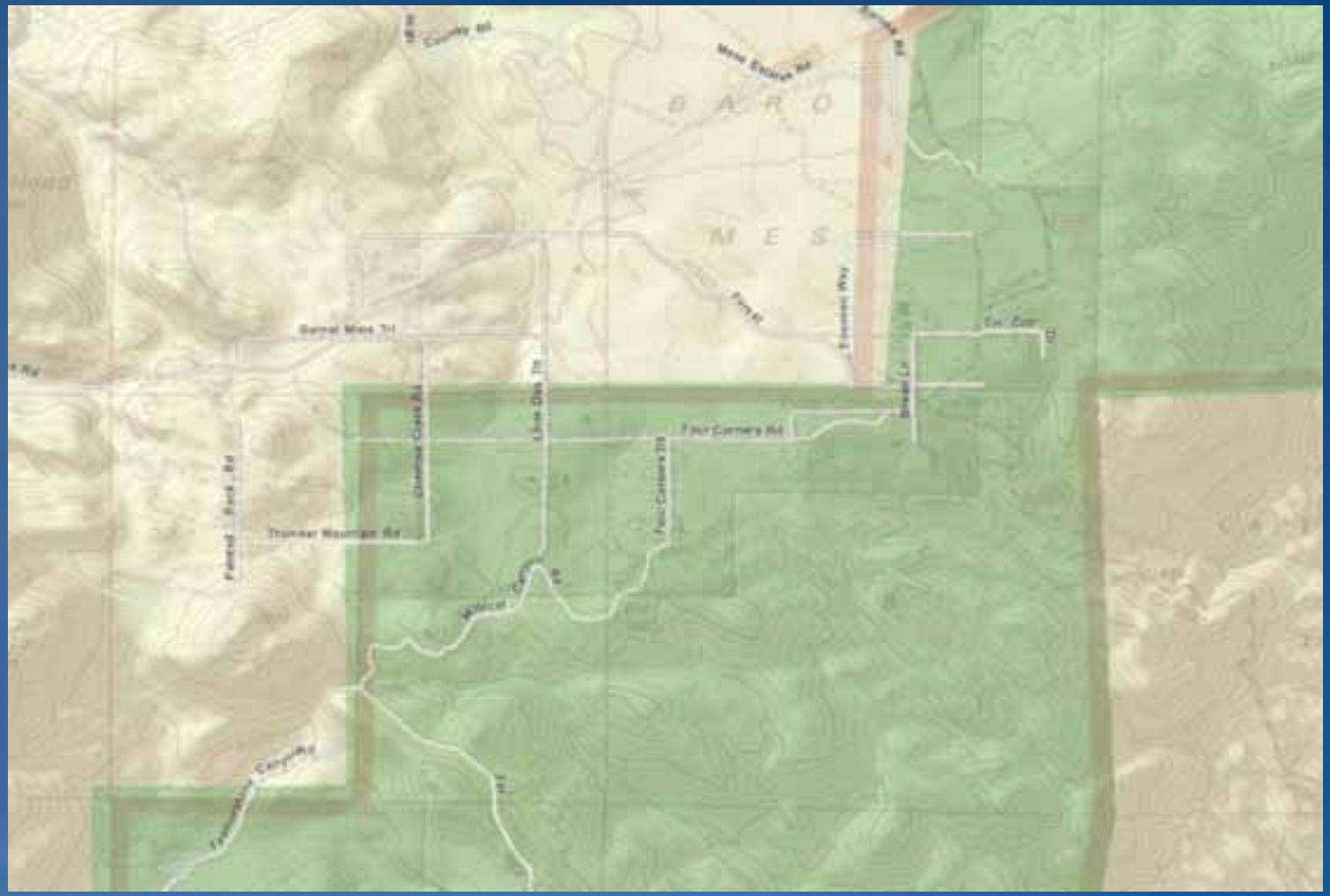
- Application receives a boundary of fire
- Then determines what parcels are in danger
- Reports affected parcels on map

Example: Fire Danger Application

- Business logic
  - Fire boundary imported
  - Algorithm to determine buffer distance
  - Buffer performed
  - Intersection of buffer with parcels

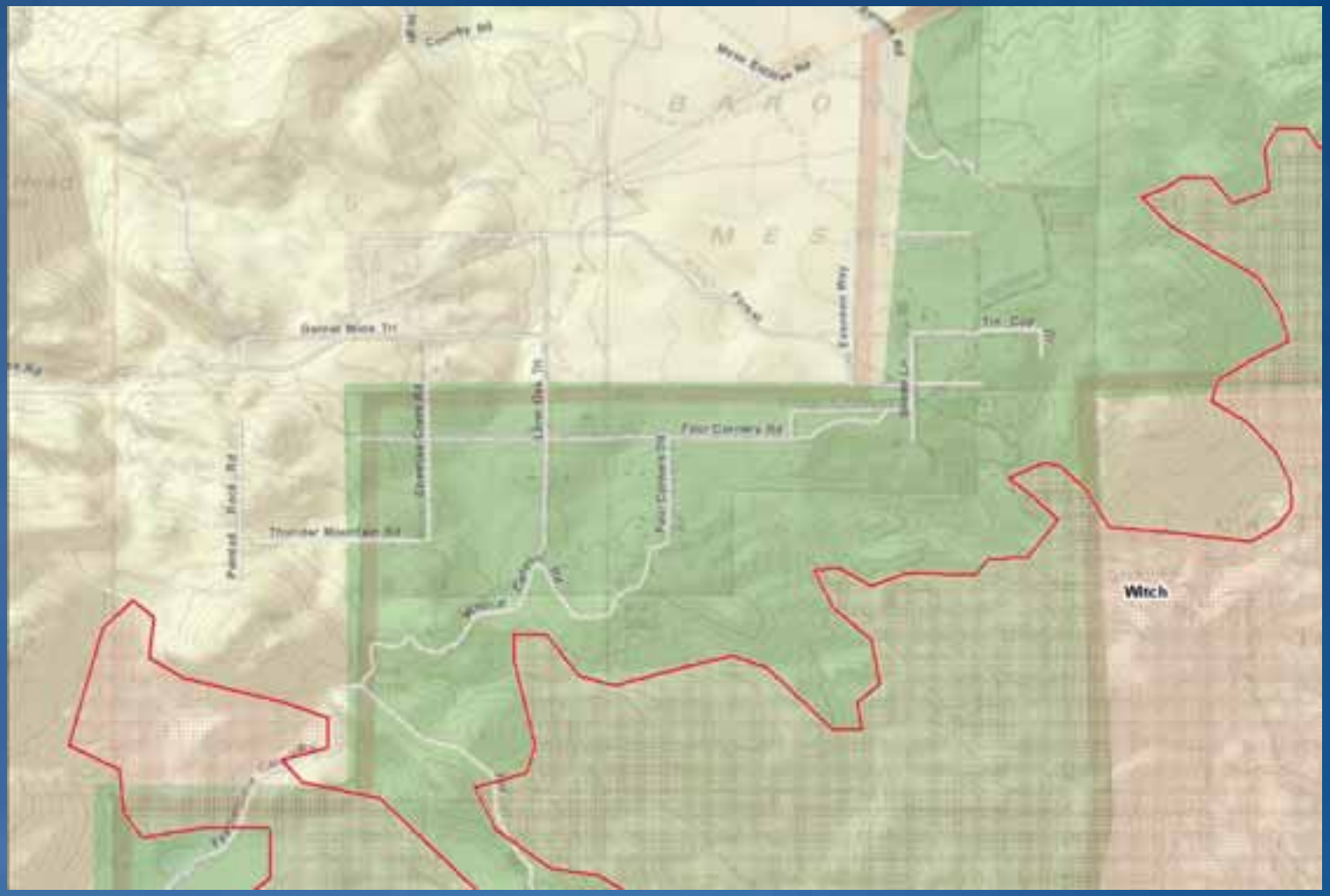
Example: Fire Danger Application

- **Business logic: coded function()**
  - **Fire boundary imported: impFireShp(inFC)**



Example: Fire Danger Application

- **Business logic: coded function()**
  - **Fire boundary imported: impFireShp(inFC)**



Example: Fire Danger Application

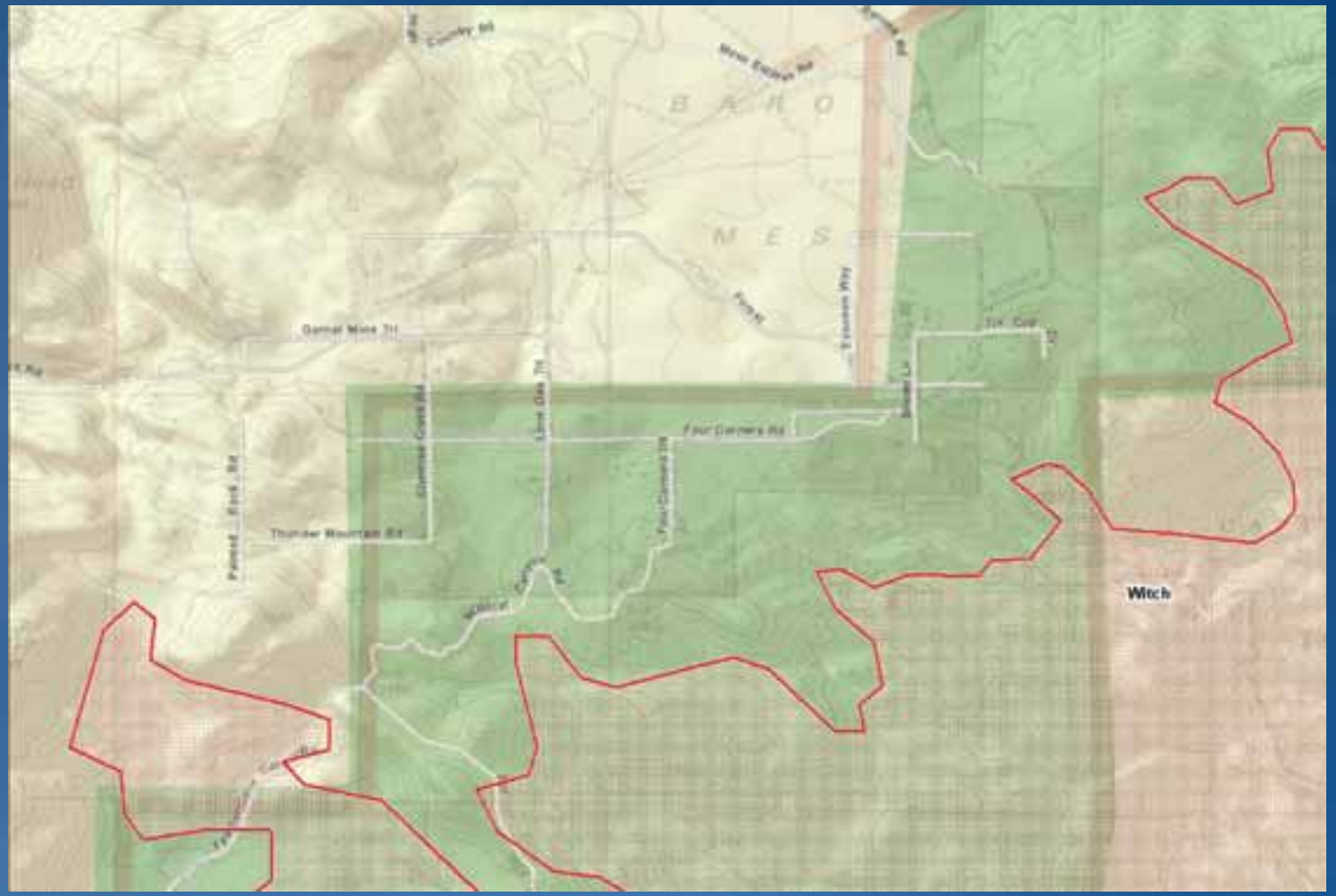
- **Business logic: coded function()**
  - **Algorithm to determine buffer distance, uses a model:**

    calcBuffer(inVeg, inBound, inWeather, inTopo, …)

http://www.fs.fed.us/psw/topics/fire_science/craft/craft/Resources/BBN_templates.htm

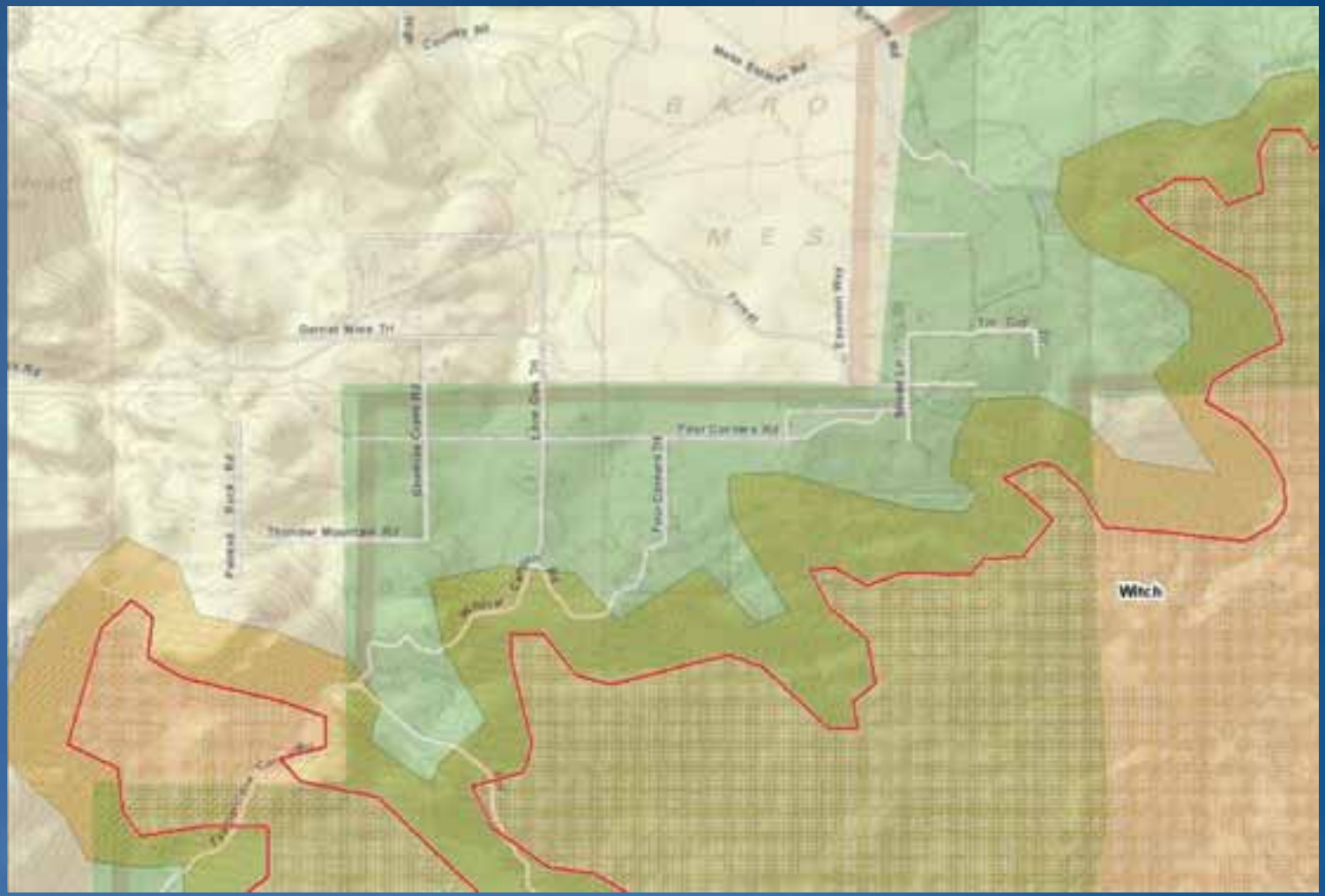
Example: Fire Danger Application

- Business logic: coded function()
  - Buffer performed: runBuffer(inFC, inDistance)



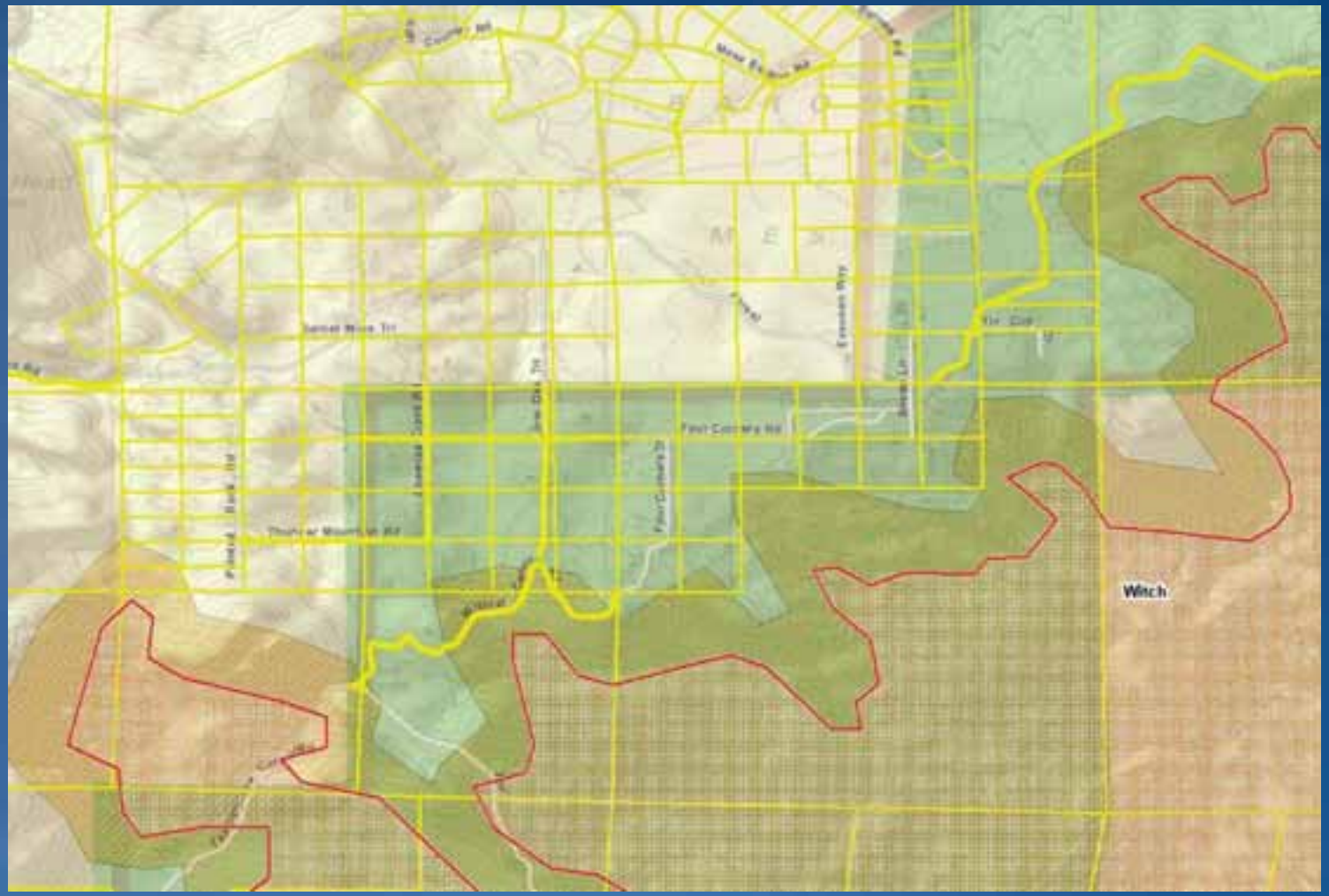
Example: Fire Danger Application

- **Business logic: coded function()**
  - **Buffer performed: runBuffer(inFC, inDistance)**



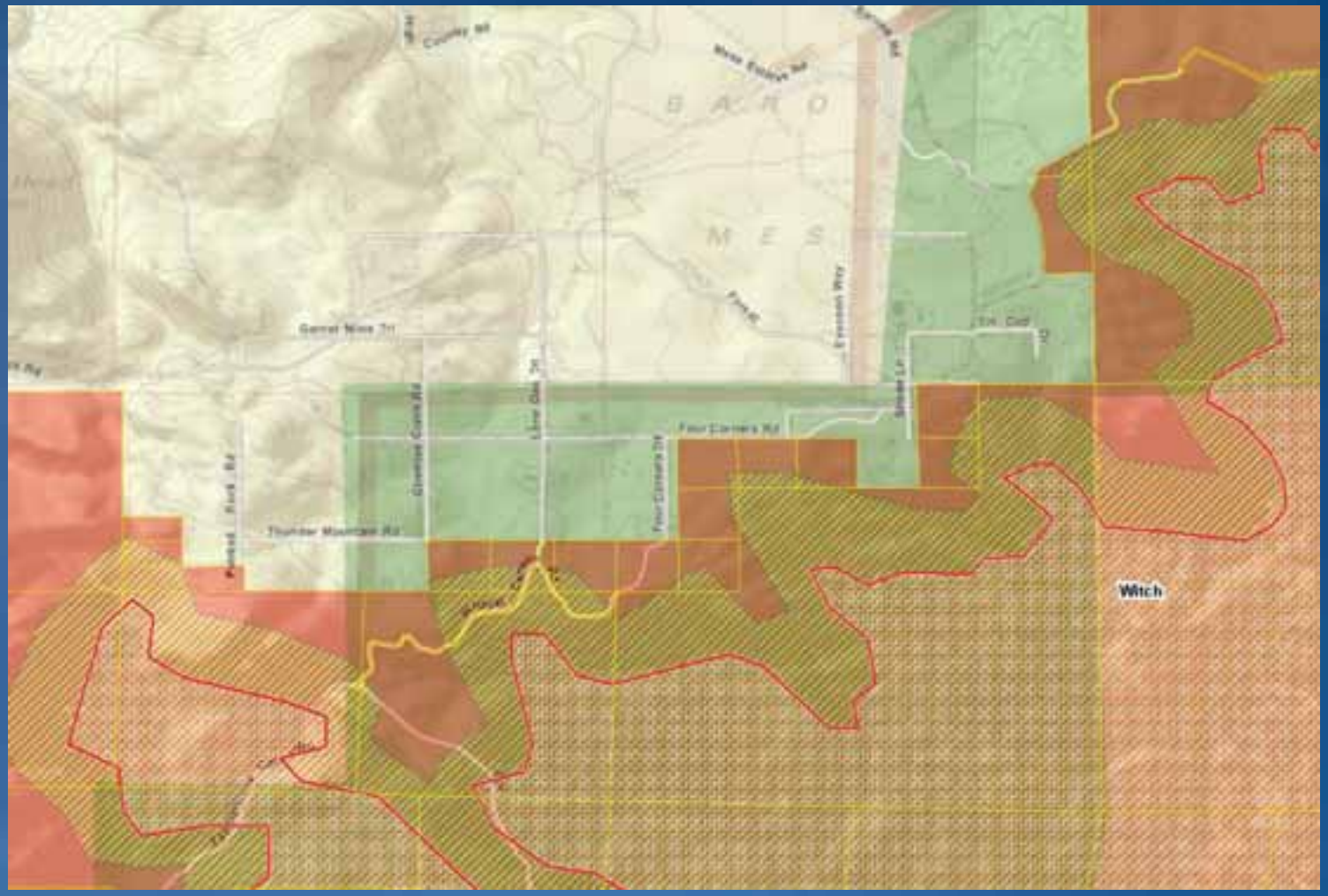
Example: Fire Danger Application

- Business logic: coded function()
  - Intersection of buffer with parcels: findParcels(inBufShp, inParcelFC)



Example: Fire Danger Application

- Business logic: coded function()
  - Intersection of buffer with parcels: findParcels(inBufShp, inParcelFC)



Example: Fire Danger Application

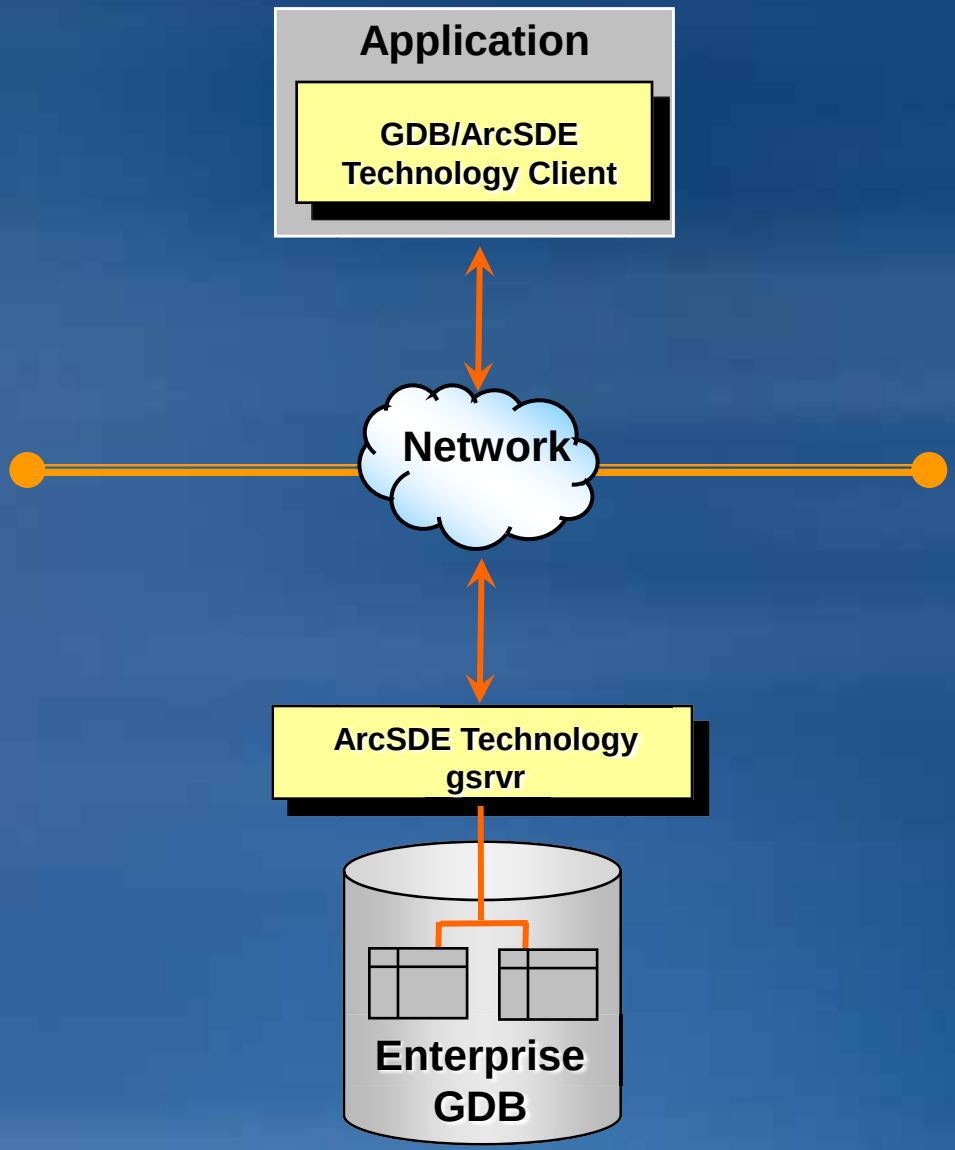
- Business logic
  - Fire boundary imported
  - Algorithm to determine buffer distance
  - Buffer performed
  - Intersection of buffer with parcels

- Application is performing slow

Code instrumentation and tracing

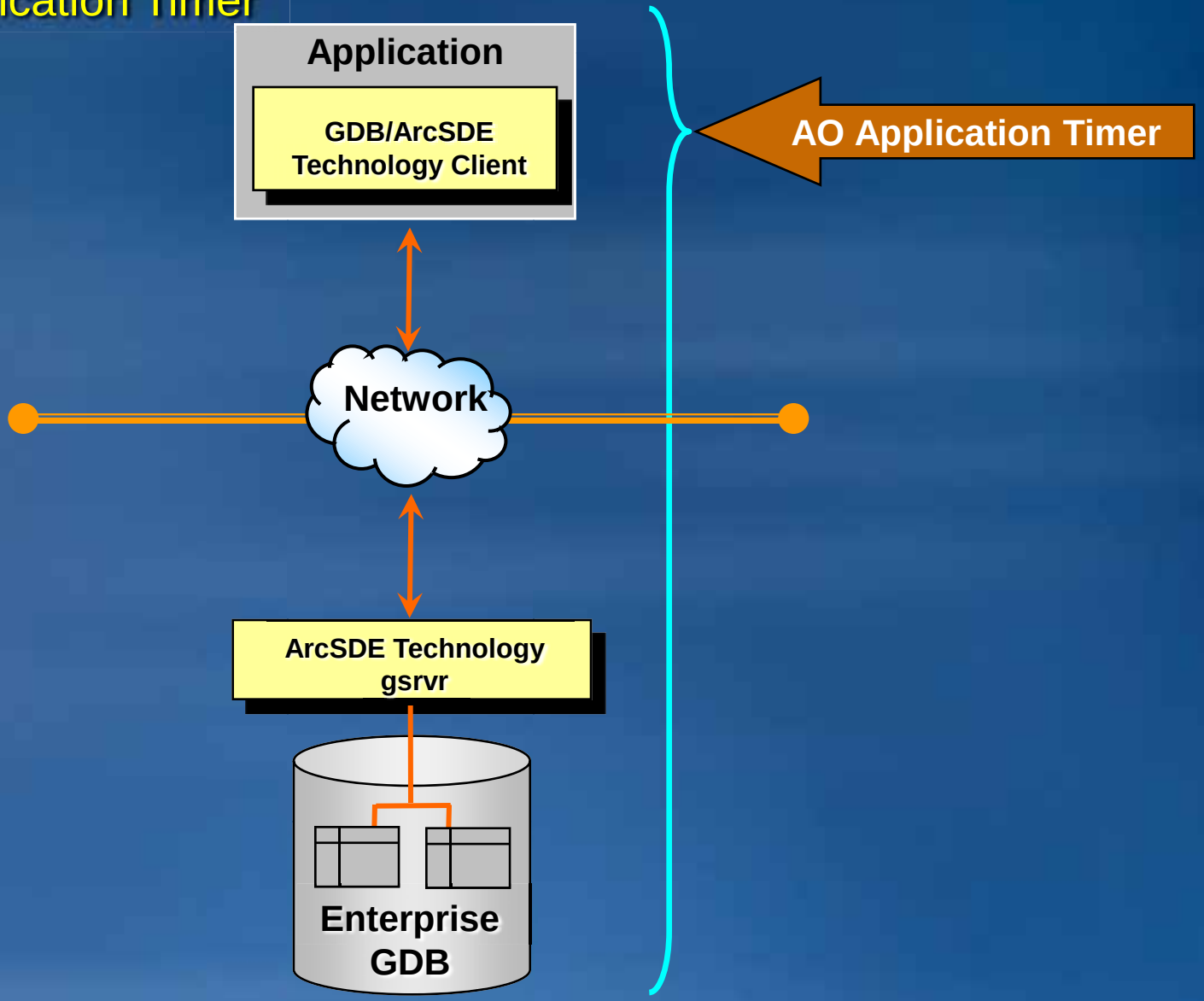
Client

Server



Code instrumentation and tracing

ArcObjects Application Timer



Example: Fire Danger Application

ArcObjects Application Timer

- Using .NET Stopwatch
- Wrap a timer around the coded functions

```
using System.Diagnostics;
//Create a stopwatch
Stopwatch stopWatch = new Stopwatch();
```

1

http://msdn.microsoft.com/en-us/library/system.diagnostics.stopwatch.aspx

Example: Fire Danger Application

ArcObjects Application Timer

- Using .NET Stopwatch
- Wrap a timer around the coded functions

```
using System.Diagnostics;
//Create a stopwatch
1 Stopwatch stopWatch = new Stopwatch();

stopWatch.Start();
2     IFeatureClass parcelsInDangerFC = findParcels(inBufShp,inParcelFC);
stopWatch.Stop();
```

http://msdn.microsoft.com/en-us/library/system.diagnostics.stopwatch.aspx

Example: Fire Danger Application

ArcObjects Application Timer

- Using .NET Stopwatch
- Wrap a timer around the coded functions

```
using System.Diagnostics;
//Create a stopwatch
Stopwatch stopWatch = new Stopwatch();

stopWatch.Start();
     IFeatureClass parcelsInDangerFC = findParcels(inBufShp,inParcelFC);
stopWatch.Stop();

// Get the elapsed time as a TimeSpan value.
TimeSpan ts = stopWatch.Elapsed;

// Format and display the TimeSpan value.
string elapsedTime = String.Format("{0:00}:{1:00}:{2:00}.{3:00}",
ts.Hours, ts.Minutes, ts.Seconds,
ts.Milliseconds / 10);

Console.WriteLine(elapsedTime, "RunTime");
```

1
2
3

http://msdn.microsoft.com/en-us/library/system.diagnostics.stopwatch.aspx

Example: Fire Danger Application

ArcObjects Application Timer

- Using .NET Stopwatch
- Wrap a timer around the coded functions

```
using System.Diagnostics;
//Create a stopwatch
1 Stopwatch stopWatch = new Stopwatch();

stopWatch.Start();
2     IFeatureClass parcelsInDangerFC = findParcels(inBufShp,inParcelFC);
stopWatch.Stop();

// Get the elapsed time as a TimeSpan value.
TimeSpan ts = stopWatch.Elapsed;

3 // Format and display the TimeSpan value.
string elapsedTime = String.Format("{0:00}:{1:00}:{2:00}.{3:00}",
ts.Hours, ts.Minutes, ts.Seconds,
ts.Milliseconds / 10);

Console.WriteLine(elapsedTime, "RunTime");

4 //Repeat for other functions
```

http://msdn.microsoft.com/en-us/library/system.diagnostics.stopwatch.aspx

Example: Fire Danger Application

ArcObjects Application Timer

- **Business logic**

Operation	Elapsed Time (HH:MM:SS.MS)
Fire boundary imported	00:00:03.56
Algorithm to determine buffer distance	00:00:01.19
Buffer performed	00:00:07.63
Intersection of buffer with parcels (findParcels)	00:00:30.72

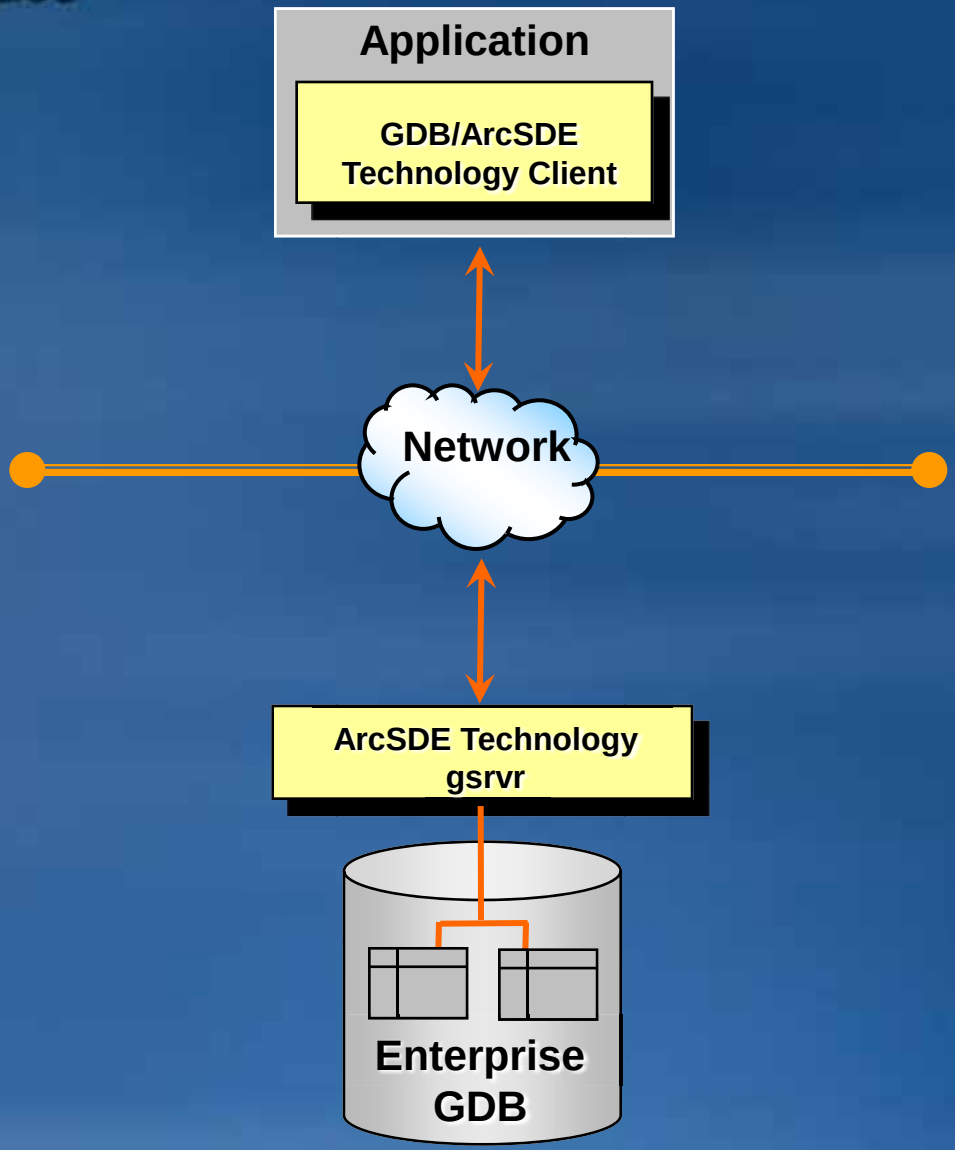
- **Use timers to determine where the bottleneck is**

Code instrumentation and tracing

Database Trace

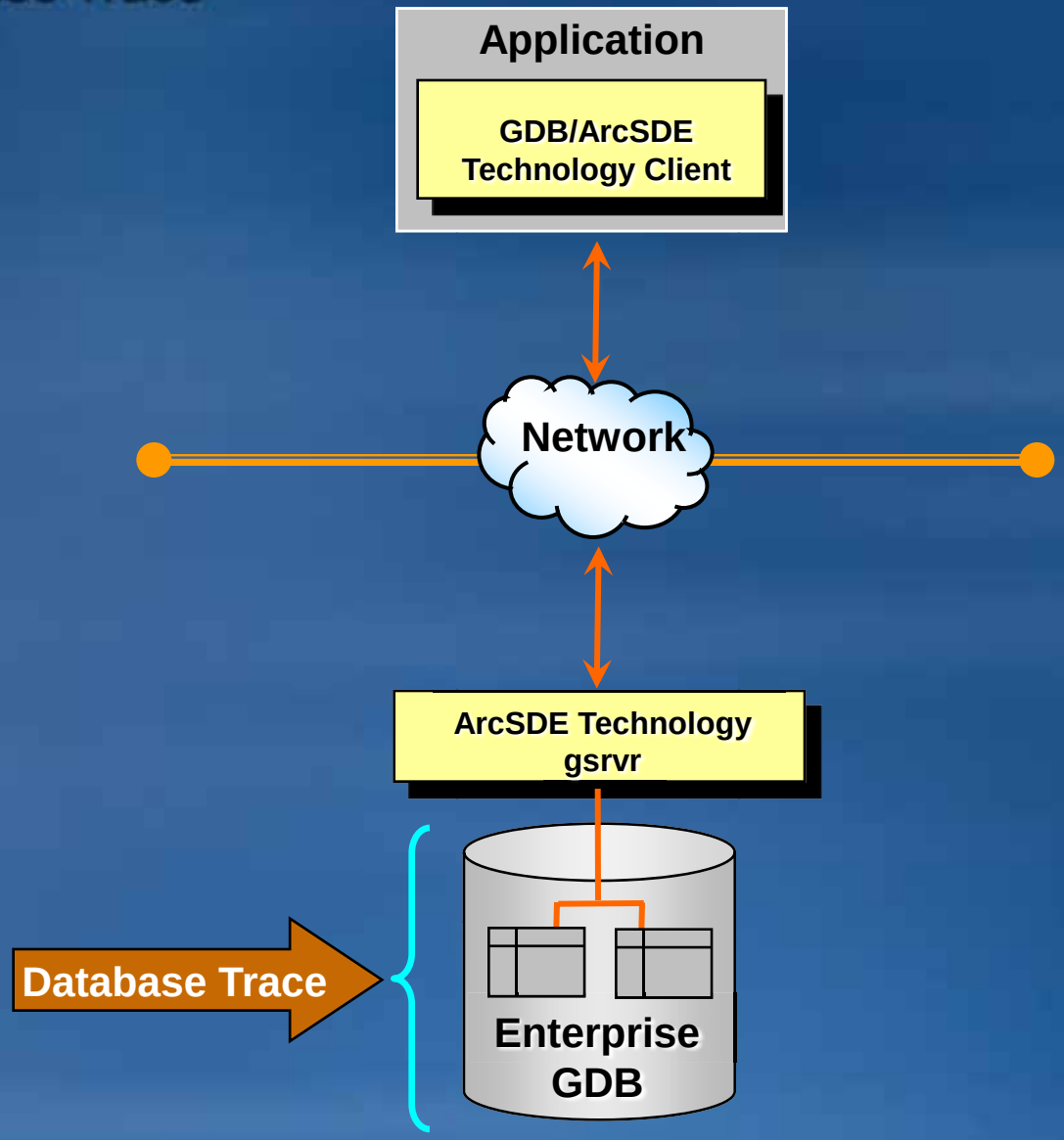
Client

Server



Code instrumentation and tracing

Database Trace



Code instrumentation and tracing

Database Trace

- Allows you to figure out how much time is being spent inside the DBMS and how individual SQL statements perform, e.g. Definition Queries
- What does an Oracle trace look like?
- Coding the application to perform DBMS traces
  - enables operations to be profiled in the database

Example: DBMS trace output on Oracle

Database Trace: Contents

- **TKPROF output contains SQL execution paths, row counts, wait events, and more.**
  - **For sql statements and overall trace session information**

```
OVERALL TOTALS FOR ALL NON-RECURSIVE STATEMENTS

call     count       cpu    elapsed       disk      query    current        rows
------- ------  -------- ---------- ---------- ---------- ----------  ----------
Parse        0      0.00       0.00          0          0          0           0
Execute     16      0.17       0.19          0          0          0           0
Fetch      189      2.96       3.53          0       1605          0       17820
------- ------  -------- ---------- ---------- ---------- ----------  ----------
total      205      3.14       3.72          0       1605          0       17820

Misses in library cache during parse: 0

Elapsed times include waiting on following events:
  Event waited on                             Times   Max. Wait  Total Waited
  ----------------------------------------   Waited  ----------  ------------
  SQL*Net message to client                      200        0.00          0.00
  SQL*Net message from client                    199        0.52          2.50
  SQL*Net more data to client                    923        0.00          0.09
  direct path read                                44        0.05          0.15
  log file sync                                   12        0.00          0.00
```

Example: DBMS trace output on Oracle

Database Trace: Contents

- TKPROF output contains SQL execution paths, row counts, wait events, and more.
  - For sql statements and overall trace session information

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OVERALL TOTALS FOR ALL NON-RECURSIVE STATEMENTS

call     count       cpu    elapsed       disk      query    current        rows
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Execute     16      0.17       0.19          0          0          0           0
Fetch      189      2.96       3.53          0       1605          0       17820
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  Event waited on                             Times   Max. Wait  Total Waited
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  direct path read                                44        0.05          0.15
  log file sync                                   12        0.00          0.00
```

Example: DBMS trace output on Oracle

Database Trace: Contents

- **TKPROF output contains SQL execution paths, row counts, wait events, and more.**

Column heading values are described at the beginning of the TKPROF output

```
********************************************************************************
count    = number of times OCI procedure was executed
cpu      = cpu time in seconds executing
elapsed  = elapsed time in seconds executing
disk     = number of physical reads of buffers from disk
query    = number of buffers gotten for consistent read
current  = number of buffers gotten in current mode (usually for update)
rows     = number of rows processed by the fetch or execute call
********************************************************************************
```

- **Good reference book:**
  - **"Expert One-on-One Oracle" by Thomas Kyte**

Example: DBMS trace output on Oracle

Database Trace: e.g. findParcels function

Operation	Elapsed Time (HH:MM:SS.MS)
Fire boundary imported	00:00:03.56
Algorithm to determine buffer distance	00:00:01.19
Buffer performed	00:00:07.63
Intersection of buffer with parcels (findParcels)	00:00:30.72

- Profile the findParcels function in DBMS

Example: enable DBMS trace

Database Trace: Programmatically

- Determine DBMS flavor with IDatabaseConnectionInfo2.ConnectionDBMS
- Use the IWorkspace.ExecuteSQL to alter the database session to begin tracing

```
//Find the dbms flavor you are connected to construct a SQL Trace Statement
String sqlStatement;
```

NOTE: Permissions may need to be granted for the connected user to start a trace from your application.

Example: enable DBMS trace

Database Trace: Programmatically

- Determine DBMS flavor with IDatabaseConnectionInfo2.ConnectionDBMS
- Use the IWorkspace.ExecuteSQL to alter the database session to begin tracing

```
//Find the dbms flavor you are connected to construct a SQL Trace Statement
String sqlStatement;

if (dbmsInfo.ConnectionDBMS == esriConnectionDBMS.esriDBMS_Oracle)
 sqlStatement = "alter session set events '10046 trace name context
  forever,  level 12'";

else if (dbmsInfo.ConnectionDBMS == esriConnectionDBMS.esriDBMS_SQLServer)
 sqlStatement = "master..sp_trace_setstatus 1";

else if (dbmsInfo.ConnectionDBMS == esriConnectionDBMS.esriDBMS_Informix)
 sqlStatement = "set explain on";

else return;
```

1

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Example: enable DBMS trace

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- Determine DBMS flavor with IDatabaseConnectionInfo2.ConnectionDBMS
- Use the IWorkspace.ExecuteSQL to alter the database session to begin tracing

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else if (dbmsInfo.ConnectionDBMS == esriConnectionDBMS.esriDBMS_SQLServer)
 sqlStatement = "master..sp_trace_setstatus 1";

else if (dbmsInfo.ConnectionDBMS == esriConnectionDBMS.esriDBMS_Informix)
 sqlStatement = "set explain on";

else return;

//Execute the SQL statement on the Workspace
workspace.ExecuteSQL(sqlStatement);
```

1

2

NOTE: Permissions may need to be granted for the connected user to start a trace from your application.

Example: enable DBMS trace

Database Trace: Programmatically

- Determine DBMS flavor with IDatabaseConnectionInfo2.ConnectionDBMS
- Use the IWorkspace.ExecuteSQL to alter the database session to begin tracing

```
//Create a stopwatch
Stopwatch stopWatch = new Stopwatch();

//Perform operation to profile
stopWatch.Start();
    IFeatureClass parcelsInDangerFC = findParcels(inBufShp,inParcelFC);
stopWatch.Stop();
```

❸

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```
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Stopwatch stopWatch = new Stopwatch();

//Perform operation to profile
stopWatch.Start();
     IFeatureClass parcelsInDangerFC = findParcels(inBufShp,inParcelFC);
stopWatch.Stop();

//Perform logic to determine how to turn trace off
if (dbmsInfo.ConnectionDBMS == esriConnectionDBMS.esriDBMS_Oracle)
 sqlStatement = "alter session set events '10046 trace name context forever,
  level 0'";
```

❸

❹

NOTE: Permissions may need to be granted for the connected user to start a trace from your application.

Example: enable DBMS trace

Database Trace: Programmatically

- Determine DBMS flavor with IDatabaseConnectionInfo2.ConnectionDBMS
- Use the IWorkspace.ExecuteSQL to alter the database session to begin tracing

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stopWatch.Stop();

//Perform logic to determine how to turn trace off
if (dbmsInfo.ConnectionDBMS == esriConnectionDBMS.esriDBMS_Oracle)
 sqlStatement = "alter session set events '10046 trace name context forever,
  level 0'";


//Execute the SQL statement on the Workspace
workspace.ExecuteSQL(sqlStatement);
```

3

4

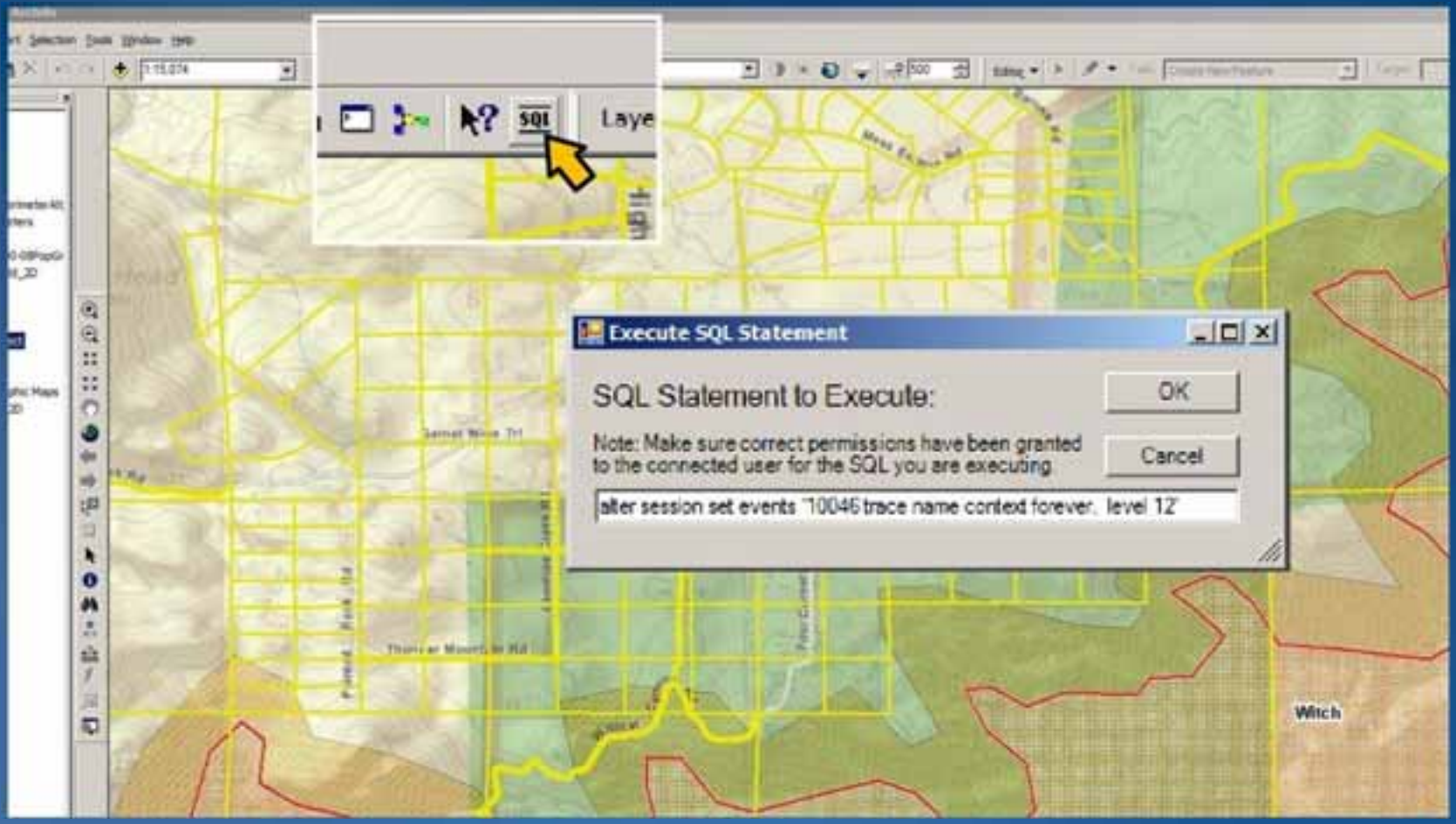
5

NOTE: Permissions may need to be granted for the connected user to start a trace from your application.

Example: enable DBMS trace

Database Trace: from ArcMap

- IWorkspace.ExecuteSQL GUI tool (Custom add-in command for ArcGIS)
  - Available at http://resources.esri.com in the ArcGIS Desktop DotNet Code Gallery
  - Search for "ExecuteSQL Command for ArcMap"



NOTE: Permissions may need to be granted for the connected user to start a trace from your application.

Example: DBMS trace output on Oracle

Database Trace: e.g. findParcels function

```
//ST_EnvIntersects Query with the longest time
```

Example: DBMS trace output on Oracle

Database Trace: e.g. findParcels function

```
//ST_EnvIntersects Query with the longest time

SQL ID: b8xarztp3ncmb
Plan Hash: 4281564849
SELECT  1 SHAPE, PARCEL.OBJECTID_1,  PARCEL.SHAPE.points,PARCEL.SHAPE.numpts,
  PARCEL.SHAPE.entity,PARCEL.SHAPE.minx,PARCEL.SHAPE.miny,PARCEL.SHAPE.maxx,
  PARCEL.SHAPE.maxy,PARCEL.rowid
FROM
  GDB.PARCEL PARCEL WHERE SDE.ST_EnvIntersects(PARCEL.SHAPE,:1,:2,:3,:4) = 1



call     count       cpu    elapsed       disk      query    current        rows
------- ------  -------- ---------- ---------- ---------- ----------  ----------
Parse        1      0.14       0.33          2       1004          0           0
Execute      1      0.00       0.00          0          0          0           0
Fetch       23     22.46      24.65      46014      48237          0        2268
------- ------  -------- ---------- ---------- ---------- ----------  ----------
total       25     22.60      24.98      46016      49241          0        2268

Misses in library cache during parse: 1
Optimizer mode: ALL_ROWS
Parsing user id: 100

Rows     Row Source Operation
-------  ---------------------------------------------------
   2268  TABLE ACCESS FULL PARCEL (cr=48632 pr=46016 pw=0 time=0 us cost=12677
  size=18358624 card=7859)
```

Example: DBMS trace output on Oracle

Database Trace: e.g. findParcels function

```
//ST_EnvIntersects Query with the longest time

SQL ID: b8xarztp3ncmb
Plan Hash: 4281564849
SELECT  1 SHAPE, PARCEL.OBJECTID_1,  PARCEL.SHAPE.points,PARCEL.SHAPE.numpts,
  PARCEL.SHAPE.entity,PARCEL.SHAPE.minx,PARCEL.SHAPE.miny,PARCEL.SHAPE.maxx,
  PARCEL.SHAPE.maxy,PARCEL.rowid
FROM
  GDB.PARCEL PARCEL WHERE SDE.ST_EnvIntersects(PARCEL.SHAPE,:1,:2,:3,:4) = 1



call     count       cpu    elapsed       disk      query    current        rows
------- ------  -------- ---------- ---------- ---------- ----------  ----------
Parse        1      0.14       0.33          2       1004          0           0
Execute      1      0.00       0.00          0          0          0           0
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```

Example: DBMS trace output on Oracle

Database Trace: e.g. findParcels function

- Full table scan, no spatial index
- Need to add spatial index
- ST Domain Index
  - Index used for ST_Geometry in Oracle
  - Contains statistics about the spatial index
- If index exists, but no statistics present:
  - `DOMAIN INDEX (Sel: Default - No Stats)`

Example: DBMS trace output on Oracle

Database Trace: e.g. findParcels function

- Add Spatial Index
  - ArcGIS or ArcObjects IClass.AddIndex Method
  - sdelayer -o normal_io command

- Gather statistics

```
SQL> exec dbms_stats.gather_table_stats(user,'PARCEL');
                PL/SQL procedure successfully completed.
```

- Check if statistics are present for ST Domain Index

```
SQL> select
BLEVEL,LEAF_BLOCKS,CLUSTERING_FACTOR,DENSITY,NUM_ROWS,LAST_ANALYZED from
SDE.ST_GEOMETRY_INDEX where table_name='PARCEL';

BLEVEL LEAF_BLOCKS CLUSTERING_FACTOR DENSITY  NUM_ROWS LAST_ANALYZED
------------ ---------------------- -------------------------------- ------------- ------------------- ------------------------
         2              15098                    622400      22.68        783159         25-MAR-09
```

Example: DBMS trace output on Oracle

Database Trace: e.g. findParcels function

```
//ST_EnvIntersects Query AFTER Spatial Index added AND Stats Gathered
```

Example: DBMS trace output on Oracle

Database Trace: e.g. findParcels function

```
//ST_EnvIntersects Query AFTER Spatial Index added AND Stats Gathered

SQL ID: b8xarztp3ncmb
Plan Hash: 1656122025
SELECT  1 SHAPE, PARCEL.OBJECTID_1,  PARCEL.SHAPE.points,PARCEL.SHAPE.numpts,
  PARCEL.SHAPE.entity,PARCEL.SHAPE.minx,PARCEL.SHAPE.miny,PARCEL.SHAPE.maxx,
  PARCEL.SHAPE.maxy,PARCEL.rowid
FROM
  GDB.PARCEL PARCEL WHERE SDE.ST_EnvIntersects(PARCEL.SHAPE,:1,:2,:3,:4) = 1


call     count       cpu    elapsed       disk      query    current        rows
------- ------  -------- ---------- ---------- ---------- ----------  ----------
Parse        1      0.00       0.00          0          0          0           0
Execute      1      0.00       0.00          0          0          0           0
Fetch       23      0.18       0.14          0       2851          0        2268
------- ------  -------- ---------- ---------- ---------- ----------  ----------
total       25      0.18       0.15          0       2851          0        2268

Misses in library cache during parse: 0
Optimizer mode: ALL_ROWS
Parsing user id: 100

Rows     Row Source Operation
-------  ---------------------------------------------------
   2268  TABLE ACCESS BY INDEX ROWID PARCEL (cr=3112 pr=0 pw=0 time=0 us cost=9198
  size=5655532 card=11266)
   2268   DOMAIN INDEX (Sel: 1.4385563) A4_IX1 (cr=261 pr=0 pw=0 time=0 us cost=9198
  size=0 card=0)
```

Example: DBMS trace output on Oracle

Database Trace: e.g. findParcels function

```
//ST_EnvIntersects Query AFTER Spatial Index added AND Stats Gathered

SQL ID: b8xarztp3ncmb
Plan Hash: 1656122025
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  PARCEL.SHAPE.entity,PARCEL.SHAPE.minx,PARCEL.SHAPE.miny,PARCEL.SHAPE.maxx,
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Example: DBMS trace output on Oracle

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  PARCEL.SHAPE.entity,PARCEL.SHAPE.minx,PARCEL.SHAPE.miny,PARCEL.SHAPE.maxx,
  PARCEL.SHAPE.maxy,PARCEL.rowid
FROM
  GDB.PARCEL PARCEL WHERE SDE.ST_EnvIntersects(PARCEL.SHAPE,:1,:2,:3,:4) = 1


call     count       cpu    elapsed       disk      query    current        rows
------- ------  -------- ---------- ---------- ---------- ----------  ----------
Parse        1      0.00       0.00          0          0          0           0
Execute      1      0.00       0.00          0          0          0           0
Fetch       23      0.18       0.14          0       2851          0        2268
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   2268   DOMAIN INDEX (Sel: 1.4385563) A4_IX1 (cr=261 pr=0 pw=0 time=0 us cost=9198
  size=0 card=0)
```

Example: DBMS trace output on Oracle

Database Trace: ST Domain index statistics summary

ST_EnvIntersects Query	NO Spatial Index	Domain Index WITH Stats
Total count	2271	2271
Total cpu	22.60	0.18
Total elapsed time	24.98	0.15
Total disk	46016	0
Total query	49241	2851
Total current	0	0
Total rows	2268	2268

Example: DBMS trace output on Oracle

Database Trace: Performance Issue

- One step further
  - Big improvement
  - HOWEVER, is it possible to improve?
- Go back to application or examine trace more
  - Profile again if needed.

Example: Summary

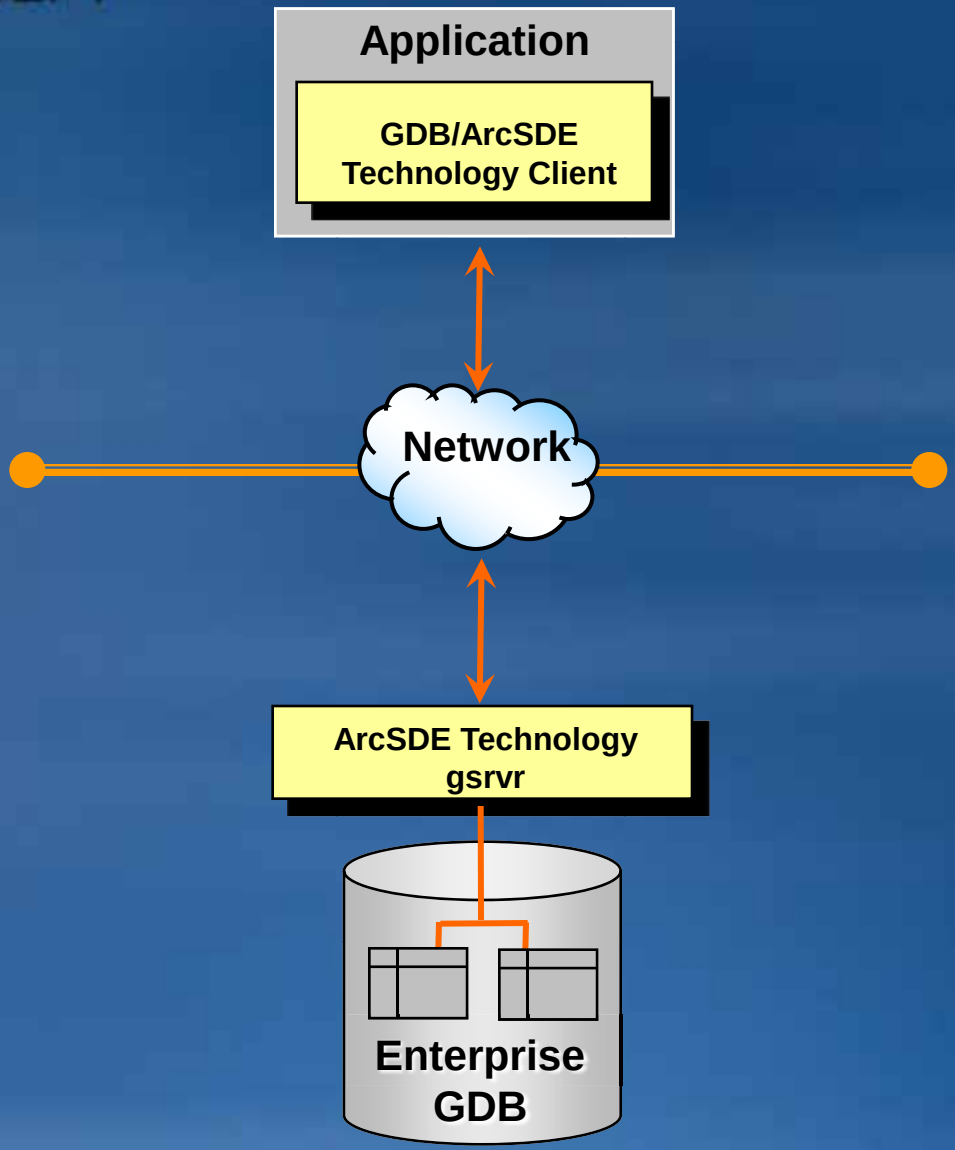
- Using application timer information
  - Determine what to trace in DBMS
- Fix issues
- Repeat
  - This is an iterative process
- Look at the entire application/system
  - Determine where bottlenecks are

Code instrumentation and tracing

SDEINTERCEPT

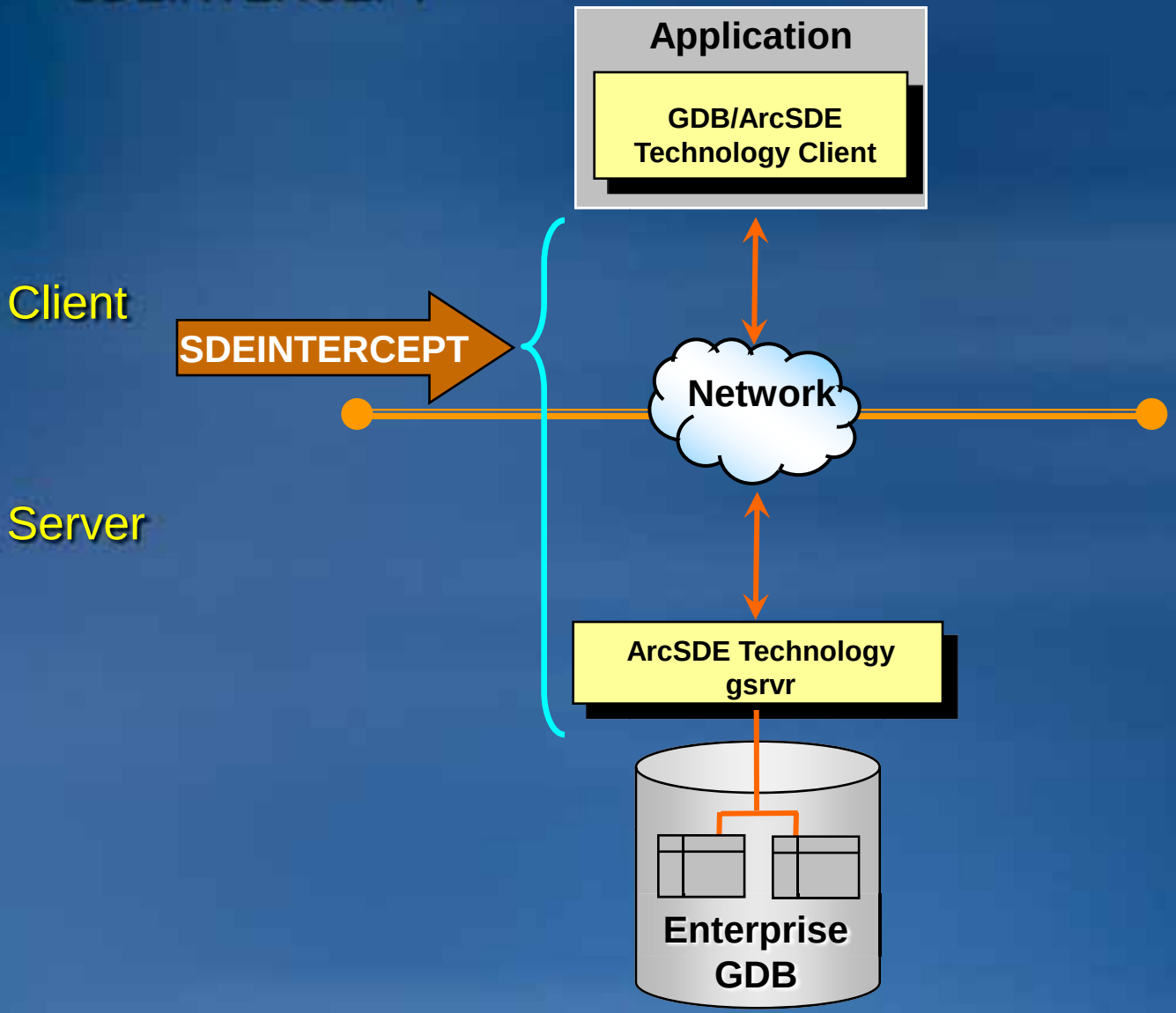
Client

Server



Code instrumentation and tracing

SDEINTERCEPT



Code instrumentation and tracing

SDEINTERCEPT

- Built-in ArcSDE functionality
- Logs the ArcSDE client calls to the ArcSDE server
- Useful to profile how many and what type of calls are made

Code instrumentation and tracing

SDEINTERCEPT

- Client side - only client session
- Server side - all sessions
- Based on connection to the SDE geodatabase

Code instrumentation and tracing

SDEINTERCEPT

- Client side - only client session
- Server side - all sessions
- Based on connection to the SDE geodatabase

- set SDEINTERCEPTLOC=<file location>
- set SDEINTERCEPT=<flags>

Code instrumentation and tracing

SDEINTERCEPT

- **Intercept flags**
  - **set SDEINTERCEPT=<flags>**
  - **Flags to intercept network broadcasts**
  - **Sets type and amount of information written to intercept file**
  - **SDEINTERCEPT flags not set, defaults to “crwf”**

Flag	Description
c	Intercept the API command name
r	Intercept the Channel broadcasts read-only
w	Intercept the Channel broadcasts write-only
t	Intercept log time (minute:second)
T	Intercept log time (hour:minute:second)
f	Intercept flush immediate

Example: SDEINTERCEPT setup

SDEINTERCEPT

- set SDEINTERCEPTLOC
- set SDEINTERCEPT
- Start application

1

```
REM enabling SDEINTERCEPT
REM Batch File to enable SDEINTERCEPT and Start ArcMap

set SDEINTERCEPTLOC=c:\temp\client_sdeintercept
```

Example: SDEINTERCEPT setup

SDEINTERCEPT

- set SDEINTERCEPTLOC
- set SDEINTERCEPT
- Start application

```
REM enabling SDEINTERCEPT
REM Batch File to enable SDEINTERCEPT and Start ArcMap

1 set SDEINTERCEPTLOC=c:\temp\client_sdeintercept
2 set SDEINTERCEPT=cwrfT
```

Example: SDEINTERCEPT setup

SDEINTERCEPT

- set SDEINTERCEPTLOC
- set SDEINTERCEPT
- Start application

```
REM enabling SDEINTERCEPT
REM Batch File to enable SDEINTERCEPT and Start ArcMap

set SDEINTERCEPTLOC=c:\temp\client_sdeintercept
set SDEINTERCEPT=cwrfT
C:\arcgis\bin\arcmap.exe
```

Example: SDEINTERCEPT Output

SDEINTERCEPT

```
========================================
[W 18:26:20.312] Command:      QueryWithInfo
[W 18:26:20.312] Long:         1
[W 18:26:20.312] Query Info:
  Num Columns:   1
  Columns:       "*"
  SQL_Construct: [1]
  Tables:        "GDB.TEST_NUM2"
  WhereClause:   "OBJECTID in (1)"
  Query Type:    4
  ByClause:      <null>
  Num Hints:     0
  Num Parameter markers: 0
  Logfile:       <null>
[R 18:26:20.312] Long:         0
[R 18:26:20.312] Col_Defines:  [2]
  Name                              Type     Width nDec  NULL?    RowID
  ------------------------------ ---------- ----- ---- -------- -----
  CALCU                          SE_INT32        10    0      NULL
  OBJECTID                       SE_INT32        10    0  NOT NULL  SDE
  ------------------------------ ---------- ----- ---- -------- -----
========================================
```

Example: SDEINTERCEPT Output

SDEINTERCEPT

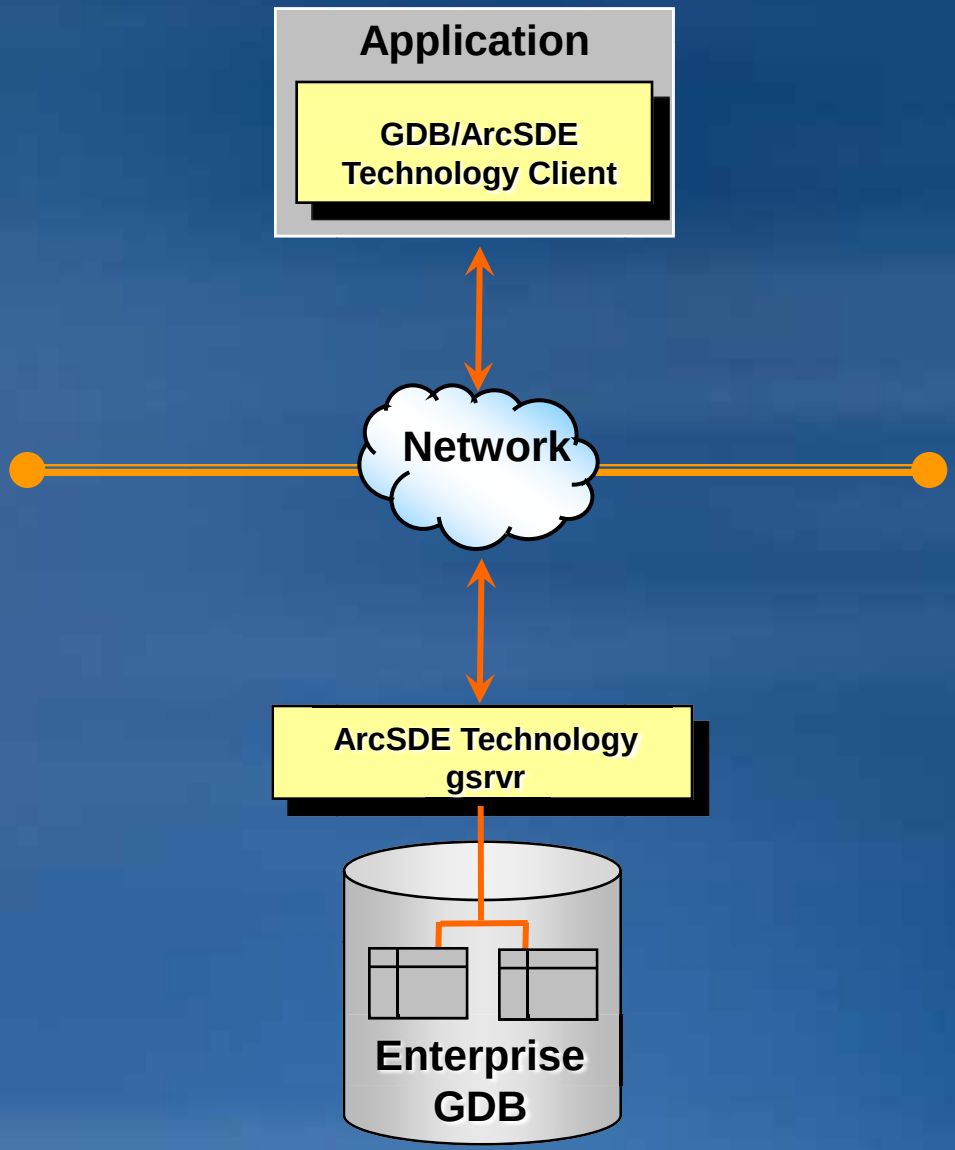
```
========================================
[W 18:26:20.312] Command:      ExecuteSpatialQuery
[W 18:26:20.312] Long:         1
[R 18:26:20.312] Long:         0
========================================
[W 18:26:20.312] Command:      NextBuffer
[W 18:26:20.328] Long:         1
[R 18:26:20.328] Long:         -51
========================================
[W 18:26:20.328] Command:      GetstreamError
[W 18:26:20.328] Long:         1
[R 18:26:20.328] Long:         -51
[R 18:26:20.328] Long:         1455
[R 18:26:20.328] NString:      "ORA-01455: converting column overflows
  integer datatype
"
[R 18:26:20.328] NString:      ""
========================================
[W 18:26:28.140] Command:      CloseStream
[W 18:26:28.140] Long:         1
[W 18:26:28.140] Long:         1
[R 18:26:28.140] Long:         0
========================================
```

Code instrumentation and tracing

Summary

Client

Server

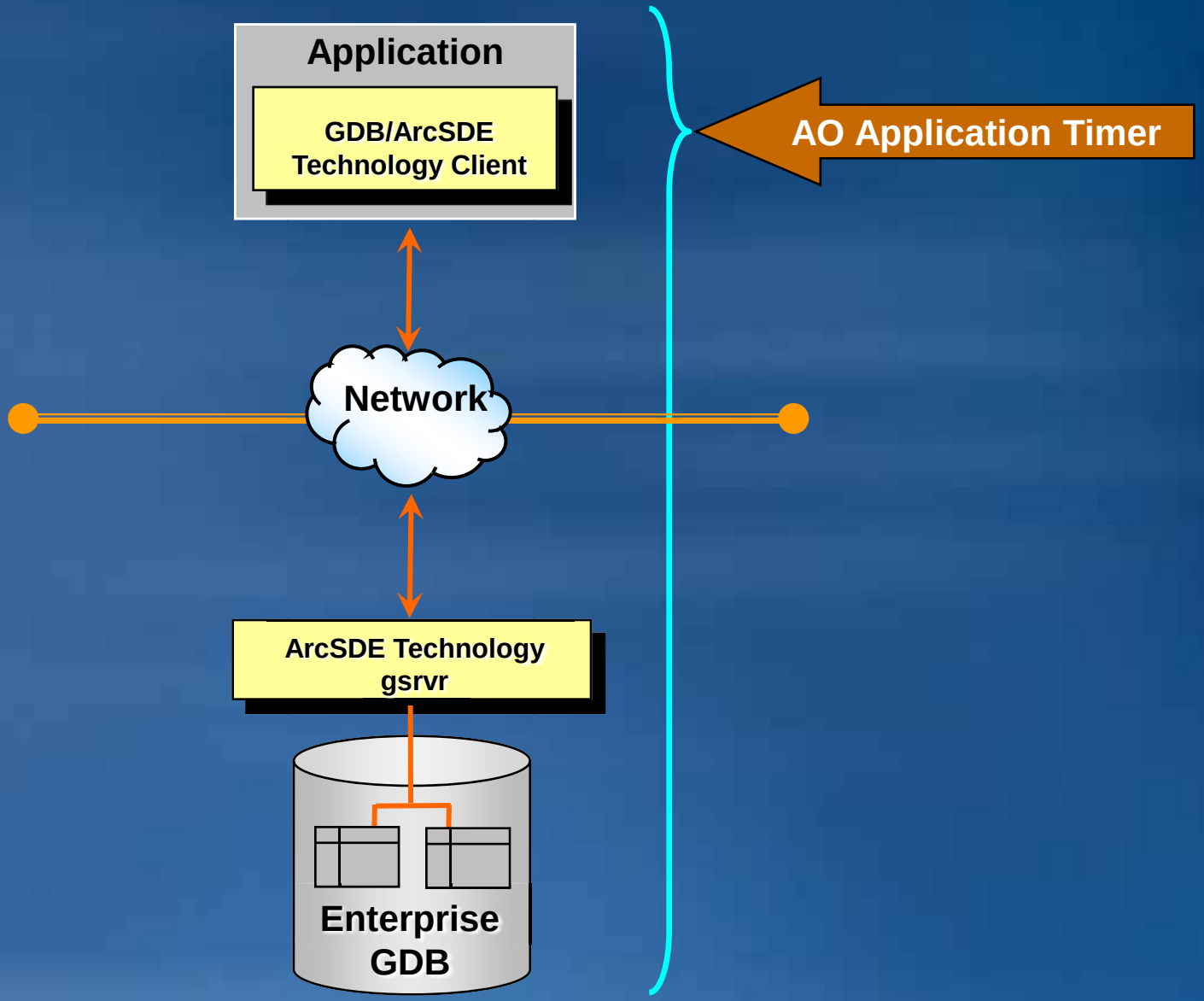


Code instrumentation and tracing

Summary

Client

Server



Code instrumentation and tracing

Summary

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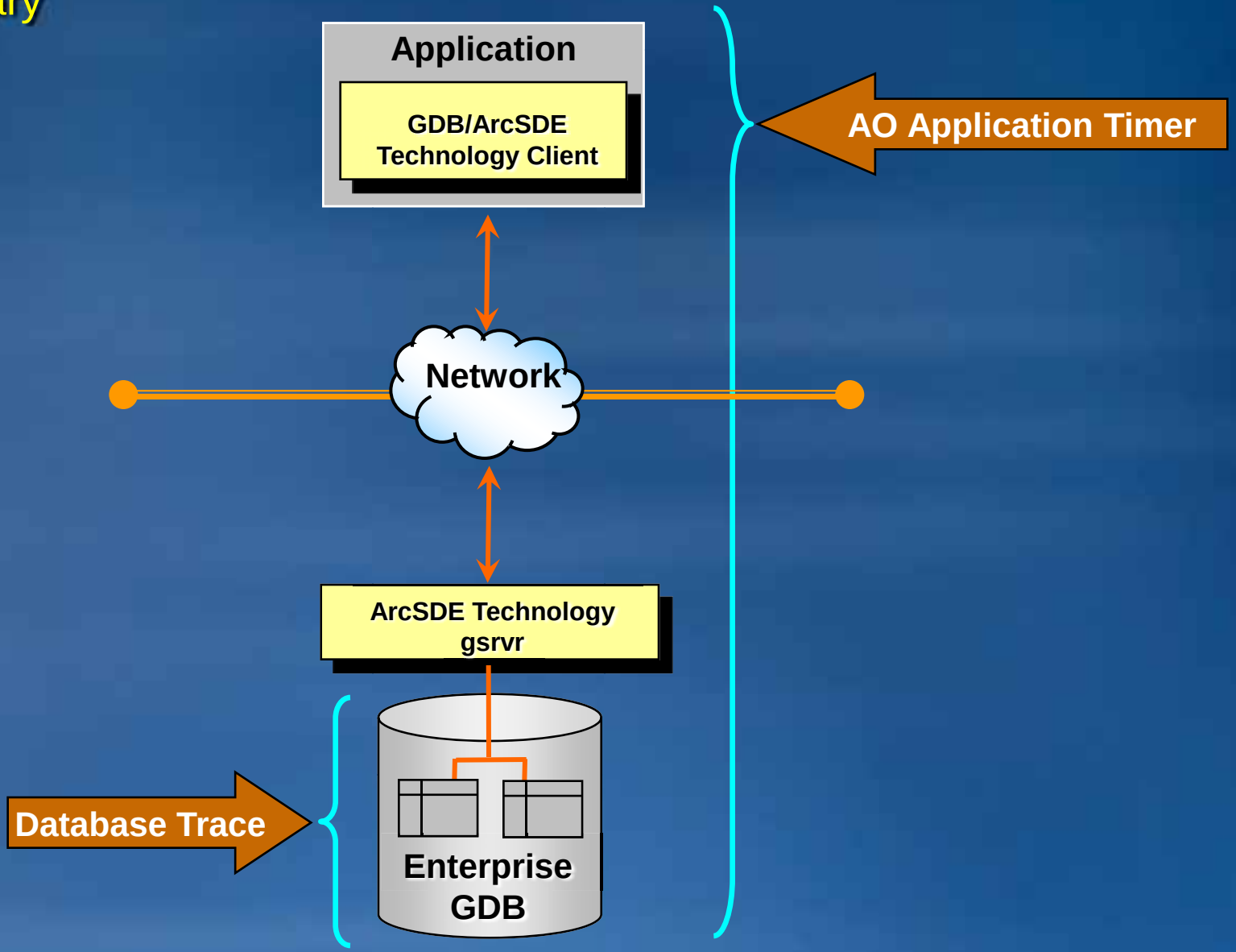
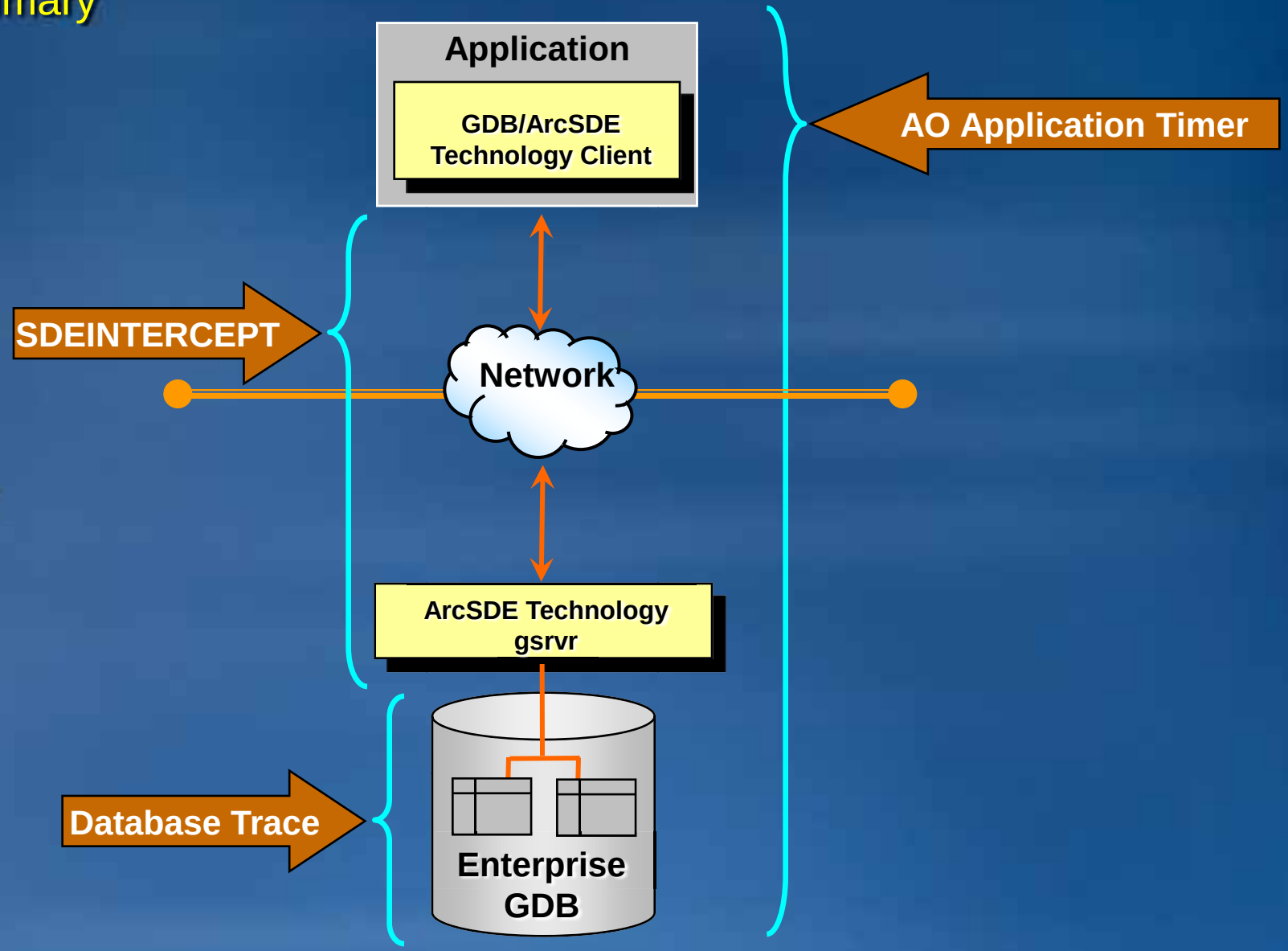
Server



Code instrumentation and tracing

Summary



Code instrumentation and tracing

Summary

- Several instrumentation and tracing methods
- Look at entire application stack
- Application performance
  - Iterative process throughout development and release
  - Tools to determine where performance problems are
  - Determine where to look next
  - i.e. start at application level, or maybe the initial information is a DBMS trace, use built-in tools
- Build tracing and logging into app

Other Recommended Sessions

- Working with the Geodatabase Effectively using SQL
  - Thursday 8:30 – 9:45

In Conclusion…

- All sessions are recorded and will be available on EDN
  - Slides and code will also be available
- Please fill out session surveys!
- Still have questions?
  1. Tech talk, Demo Theatres, Meet the Team
  2. "Ask a Developer" link on web page
     - www.esri.com/devsummit/techquestions
- Instructor-Led Training
  - Managing Editing Workflows in a Multiuser Geodatabase
- Free Web Training Seminar
  - Introduction to Geodatabase Replication