OpenGIS의 OLE/COM 구현기술

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홍 봉 희
부 산 대 학 교

Open GIS의 OLE/COM 구현 기술

부산대학교 컴퓨터공학과
홍 봉희

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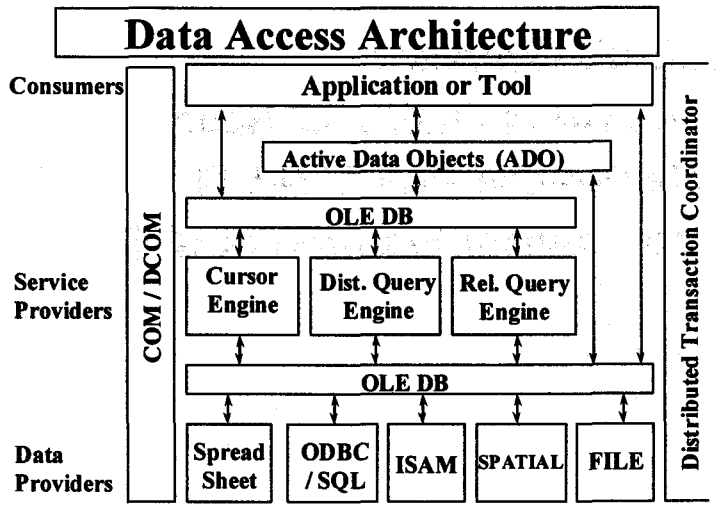
- Data Provider관련 고려사항
- Data Provider Framework 설계

OLE DB Overview

- Data Access Architecture
- Types of Data Access Components
  - Data Consumer
  - Data Provider
  - Service Provider
- What is OLE DB?
- Object Overview
- OLE DB and ADO

Data Access Architecture



Types of Data Access Components

- Data Consumer
- Data Provider
- Service Provider

Data Consumer

- Components that ***consume OLE DB data***
- As Simple as you Want, as functional as You Need
  - ADO Interface
  - OLE DB Interface
  - Or Both

Data Provider

- Implements *core OLE DB interfaces*
  - Common interfaces to native functionality
  - Does not require data to look like a relational database
- Implements *extended OLE DB interfaces* to expose native extended functionality
  - Provides a common interface to extended functionality
  - OLE DB doesn't limit what the provider can expose

Service Provider

- Exposes *extended functionality* when not implemented by Data Provider
  - Provides guaranteed level of support for consumers
- *Component Technology*
  - Multiple components can share data
  - Service Providers only invoked when needed
    - Requested functionality not natively supported by provider

What is OLE DB?(1)

1) *OLE COM interface*

- Factored OLE Interfaces
- Inherit from IUnknown

2) Supports *disconnected Data access*

- Rowsets is self-contained object
  - Supports buffered update mode
  - Keeps Current Values, Original Values, Changes

What is OLE DB?(2)

3) Provides Access to *ALL types of data*

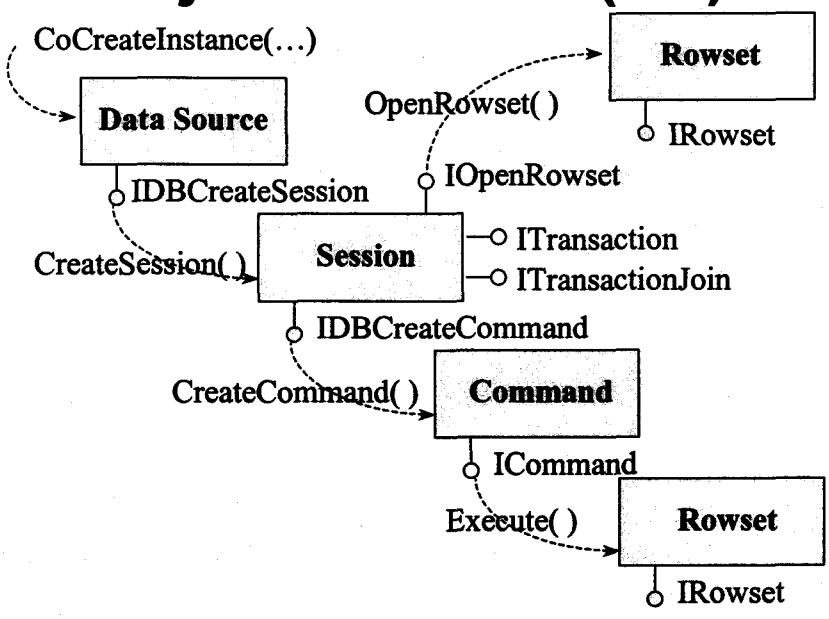
- *Base interfaces* easily implemented to ANY data
- *Common interfaces* to extended functionality
- Extended Functionality can be implemented by *"Service Providers"*
  - Components can share data
  - Notifications allow synchronization
  - Components invoked only when needed

What is OLE DB?(3)

4) Enables Universal Database functionality

- **Integration of all types of heterogeneous data**
  - **Database, Spreadsheet, ISAM, PIM, Directory Services, Email,...**
  - **Heterogeneous querying**
  - **Transaction Coordination**
- **Without putting everything in a Database!**

Object Overview(1/3)



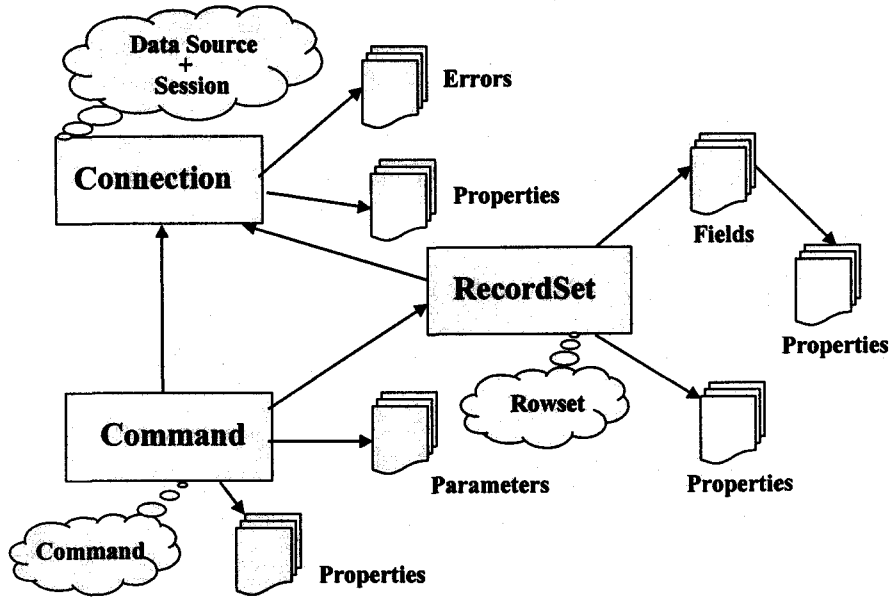
Object Overview(2/3)

- **Data Source Object**
  - Defines context, authentication,
  - Define Data Provider properties
  - Initialize the connection
- **Session Object**
  - Scopes transaction and generates data and metadata rowsets
- **Comand Object**
  - Represents Query or Statement

Object Overview(3/3)

- **Rowset Object**
  - Makes data available to the Client
  - May be shared by multiple clients
    - Activities coordinated through Notifications
  - Supports deferred updating

OLE DB and ADO(1/2)



OLE DB and ADO(2/2)

User's programmatic interface to Data

- High-level data access objects
  - Provides a uniform interface to data for all business application programmers
  - Merges RDO and DAO
- "Language Neutral"
  - C/C++, Java, Visual Basic®, VBScript
- Provides access to underlying Rowset
  - Ultimate extensibility

OLE/COM Spec(1/3)

- Three major Components
  - OLE DB
    - for implementing data providers
  - ADO
    - for presenting a simplified access model on top of OLE DB
  - Geometry and Spatial Reference
    - for detailed geometry and reference operations

OLE/COM Spec(2/3)

- 세부 내용
  - OGIS Data Provider Registry Entries
  - GIS Metadata
    - Tables containing Queryable GIS Features
    - Spatial References of the Data Source
    - Geometry Columns
    - Spatial Operators
  - IColumnsRowset

OLE/COM Spec(3/3)

- 세부 내용
  - Geometry Access
  - Spatial Reference Access
  - Spatial Filtering
  - Geometry and its WKB IDL Spec
  - Spatial Reference System and its WKT IDL Spec

OGIS Data Provider Registry Entries(1/1)

- OGIS OLEDB Data Providers
  - register support for the "OGISDataProvider" *component category*
  - GUID is CATID_OGISDataProvider
  - 다른 OLEDB Data Provider들과 구별

GIS Metadata(1/7)

- **Schema Rowset**
  - provider가 ***catalog와 schema*** 개념을 지원할 경우 사용
  - Session의 IDBSchemaRowset::GetRowset 이용(predefined schema rowset - 31개)
  - OLE DB의 mandatory schema rowsets

GUID	Number of restrictions	Restriction columns
DBSCHEMA_COLUMNS	4	TABLE_CATALOG, TABLE_SCHEMA TABLE_NAME, COLUMN_NAME
DBSCHEMA_PROVIDER_TYPES	2	DATA_TYPE, BEST_MATCH
DBSCHEMA_TABLES	4	TABLE_CATALOG, TABLE_SCHEMA TABLE_NAME, TABLE_TYPE

GIS Metadata(2/7)

- **DBSCHEMA_OGIS_FEATURE_TABLES Schema Rowset**
  - those tables that the consumer can query as features

Column_Name	Type_Indicator	Description
FEATURE_TABLE_ALIAS	DBTYPE_WSTR	User Friendly Feature Name - may be NULL.
TABLE_CATALOG	DBTYPE_WSTR	Catalog name in which the table is defined. NULL if the provider does not support catalogs.
TABLE_SCHEMA	DBTYPE_WSTR	Schema name in which the Feature Table is defined. NULL if the provider does not support schemas.
TABLE_NAME	DBTYPE_WSTR	Feature Table Name
ID_COLUMN_NAME	DBTYPE_WSTR	Preferred column name to reference rows. OGIS requires this column to have a name.
DG_COLUMN_NAME	DBTYPE_WSTR	Default Geometry column name. OGIS requires this column to have a name.

GIS Metadata(3/7)

- **DBSCHEMA_OGIS_GEOMETRY_COLUMNS Schema Rowset**
  - **feature columns in the catalog which are geographic geometry**

Column_Name	Type_Indicator	Description
TABLE_CATALOG	DBTYPE_WSTR	Catalog name in which the Feature's Table is defined. NULL if the provider does not support catalogs
TABLE_SCHEMA	DBTYPE_WSTR	Schema name in which the Feature's Table is defined. NULL if the provider does not support schemas
TABLE_NAME	DBTYPE_WSTR	The Feature Table Name
COLUMN_NAME	DBTYPE_WSTR	Name of Column Containing Geometry
GEOM_TYPE	DBTYPE_UI4	Type of geometry column. Values taken from the OGIS_Geometry Enumerated Type
SPATIAL_REF_SYSTEM_ID	DBTYPE_I4	Foreign Key - this is ID of the Spatial Reference System of the geometry column. This ID can be used to find the Spatial Reference in the DBSCHEMA_OGIS_SpatialReferenceSystems Rowset

GIS Metadata(4/7)

- **DBSCHEMA_OGIS_SPATIAL_REF_SYSTEMS Schema Rowset**
  - **the Spatial Reference Systems supported by the data provider in this session**

Column_Name	Type_Indicator	Description
SPATIAL_REF_SYSTEM_ID	DBTYPE_I4	ID of the Spatial Reference System. May be Null only if SPATIAL_REF_SYSTEM_WKT is NULL
AUTHORITY_NAME	DBTYPE_WSTR	Defining Authority for this Spatial Reference System, eg "POSC", "USGS". May be Null
AUTHORITY_ID	DBTYPE_I4	Authority specific identifier. This is a well known id assigned to the spatial reference system by the authority. May be Null.
SPATIAL_REF_SYSTEM_WKT	DBTYPE_BSTR	The Well Known Text Representation of the Spatial Reference System. May be Null.

GIS Metadata(5/7)

- OLE DB의 Properties
  - attributes of an object
  - 목적
    - set property value to request specific object behavior
    - get property value to determine the capabilities of an object
  - 종류
    - Property Set
      - 같은 GUID를 공유하는 property들의 집합
      - provider-specific property set 제공 가능
    - Property Group
      - 논리적으로 연관성을 가지는 property들의 집합
      - provider-specific property group 제공 불가능

GIS Metadata(6/7)

- OGIS Property Set
  - contains the *spatial operators* that a data provider supports
  - GUID is DBPROPSET_OGIS_SPATIAL_OPS

Property ID	Type_Indicator	Description
DBPROP_OGIS_TOUCHES	VT_BOOL	All points in the intersection of geometries of Data Source and the Spatial Filter lie on a geometry boundary and the interiors of the geometries of the Data Source and the Spatial Filter do not intersect
DBPROP_OGIS_WITHIN	VT_BOOL	Geometries of the Data Source are wholly contained by the Spatial Filter
DBPROP_OGIS_CONTAINS	VT_BOOL	The Spatial Filter is wholly contained by geometries of the Data Source
DBPROP_OGIS_CROSSES	VT_BOOL	Geometries of the Data Source and the Spatial Filter intersect, but do not wholly contain each other, and the dimension of the intersection of their interiors is one less than the maximum dimension of their interiors.

GIS Metadata(7/7)

❖ OGIS Property Set(Continued)

Property ID	Type_Indicator	Description
DBPROP_OGIS_DISJOINT	VT_BOOL	Intersection of geometries of the Data Source and the Spatial Filter is the empty set
DBPROP_OGIS_INTERSECT	VT_BOOL	Intersection of geometries of the Data Source and the Spatial Filter is not the empty set
DBPROP_OGIS_ENVELOPE_INTERSECTS	VT_BOOL	Intersection of the envelope of geometries of the Data Source and the envelope of the Spatial Filter is not the empty set
DBPROP_OGIS_INDEX_INTERSECTS	VT_BOOL	Intersection of the spatial index entries of the geometries of the Data Source and the geometry of the Spatial Filter is not the empty set

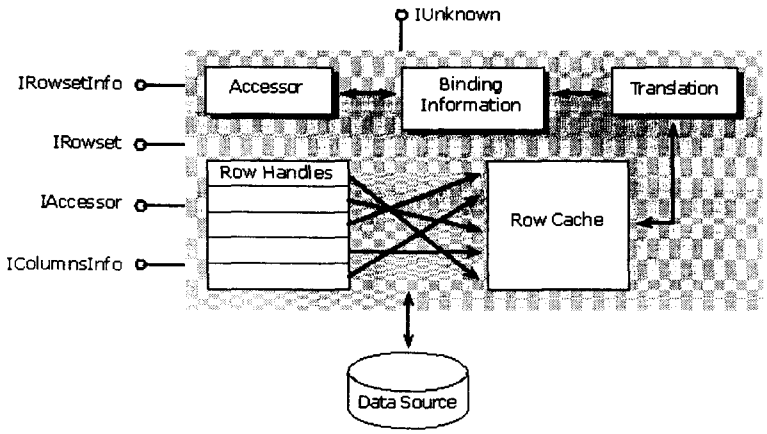
IColumnsRowset(1/3)

❖ Rowset

- ➢ **the central object**
  - † **enable all OLE DB data providers to expose data in tabular form**
- ➢ **a set of rows**
  - † **each row has columns of data**
- ➢ **다양한 navigation(traversal) 기능 제공**
  - † **IRowset, IRowsetLocate, IRowsetScroll**
  - † **Bookmark, Chapter, Hierachical rowset**

IColumnsRowset(2/3)

- Data structures supported by a generic rowset object



IColumnsRowset(3/3)

- IColumnsRowset::GetColumnsRowset
  - *column metadata rowset*
    - Returns a rowset containing metadata about each column in the current rowset
  - Standard columns in the IColumnsRowset are as defined by OLEDB Specification
  - OGIS Rowset consumer requires more columns for geometry
    - GEOM_TYPE
    - SPATIAL_REF_SYSTEM_ID
    - SPATIAL_REF_SYSTEM_WKT (optional)

Geometry Access

- C++
  - OLEDB Accessor
  - *DBBINDING Structure* specifying wType
    - DBTYPE_BYTES or
    - DBTYPE_BYTES | DBTYPE_BYREF
  - IRowset::GetData
    - accesses the Well Known Binary Representation of Geometry (WKBGeometry)

Spatial Reference Access

- C++
  - OLEDB Accessor
  - DBBINDING Structure specifying wType
    - DBTYPE_BSTR
  - IRowset::GetData
    - accesses the Well Known Text Representation of SpatialReference (WKTSpatialReference)

Spatial Filtering

- **Command Parameters are independent of the SQL string, but follow any normal SQL parameters**

Parameter Name	Type	Description
SPATIAL_FILTER	DBTYPE_VARIANT	Variant of type VT_ARRAY|VT_UI1 This is the Well Known Binary Representation of Geometry containing the geometry of the Spatial Filter
SPATIAL_OPERATOR	DBTYPE_UI4	Property ID of the spatial operator. OGIS Property Set contains the operators supported by this Data Source.
SPATIAL_GEOM_COL_NAME	DBTYPE_WSTR	Name of column to be spatially filtered.

Summary(1/1)

- OGIS Standards allow the client to
  - **Determine GIS capabilities of an OGIS OLEDB Data Provider via metadata**
  - **Get and Put GIS Geometry**
  - **Get Spatial Reference System Information**
  - **Geographically Constrain Queries via Spatial Filter**

Data Provider관련 고려사항

- Component Category 등록 기능
- Session
  - IDBSchemaRowset::GetRowset
    - Feature 관련 Metadata정보를 Schema Rowset 형태로 추가(DBSCHEMA_ ...)
  - ISessionProperties::GetProperties
    - Spatial operator 관련 Property Set 추가
- Command
  - ICommandWithParameters::SetParameterInfo
    - Command Parameter에 추가될 Spatial Filtering

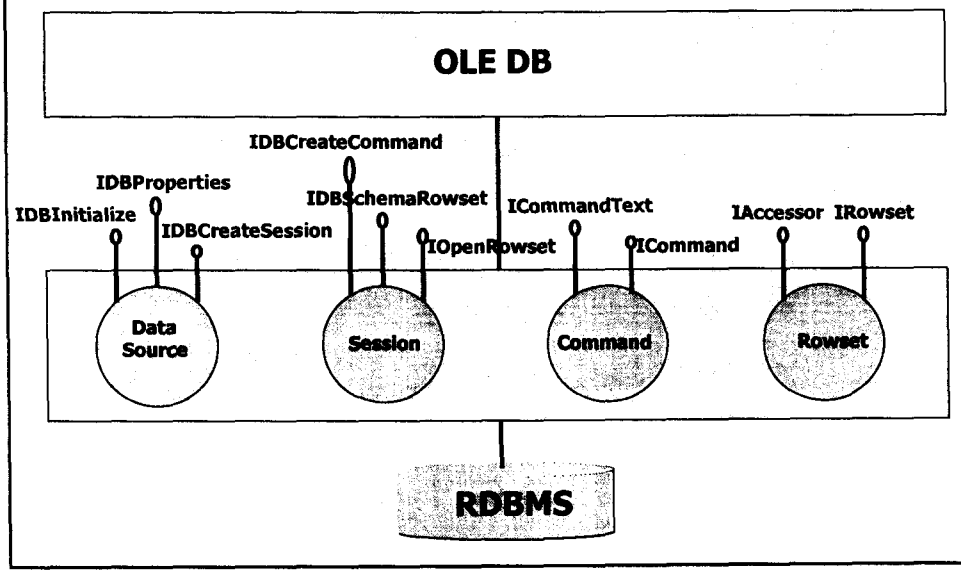
Data Provider관련 고려사항

- Rowset
  - IColumnsRowset::GetColumnsRowset
    - Column metadata rowset 관련 속성 추가
    - GEOM_TYPE, SPATIAL_REF_SYSTEM_ID
- Geometry and its WKB IDL Spec 구현
- Spatial Reference System and its WKT IDL Spec 구현

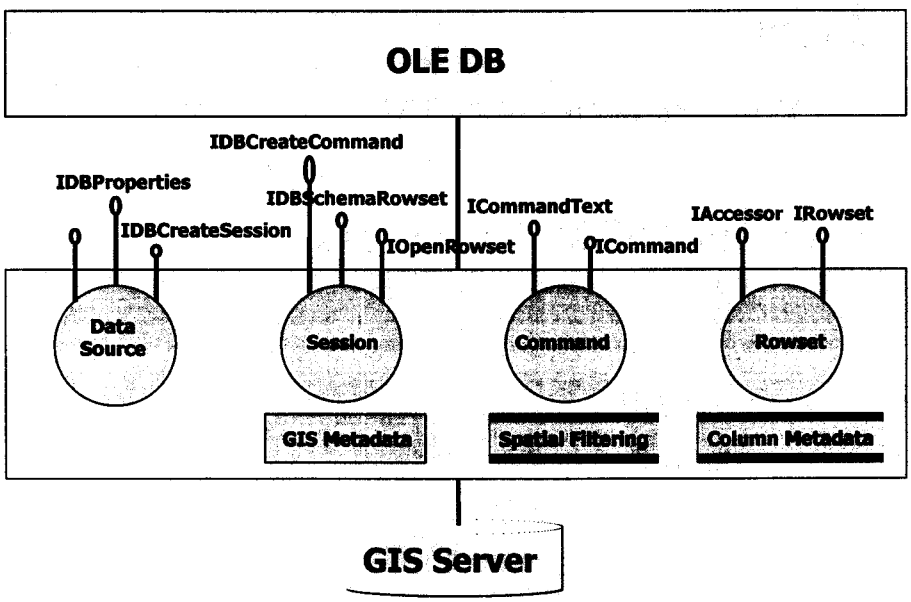
데이터 제공자 Framework 설계

- **OLE DB** 데이터 제공자
- **OGIS OLE DB** 데이터 제공자
- 데이터 제공자 **Framework**
  - 개발시 문제점
  - 전체 구조
  - **Open API**
  - 구현 과정
  - **Framework** 설계

OLE DB 데이터 제공자



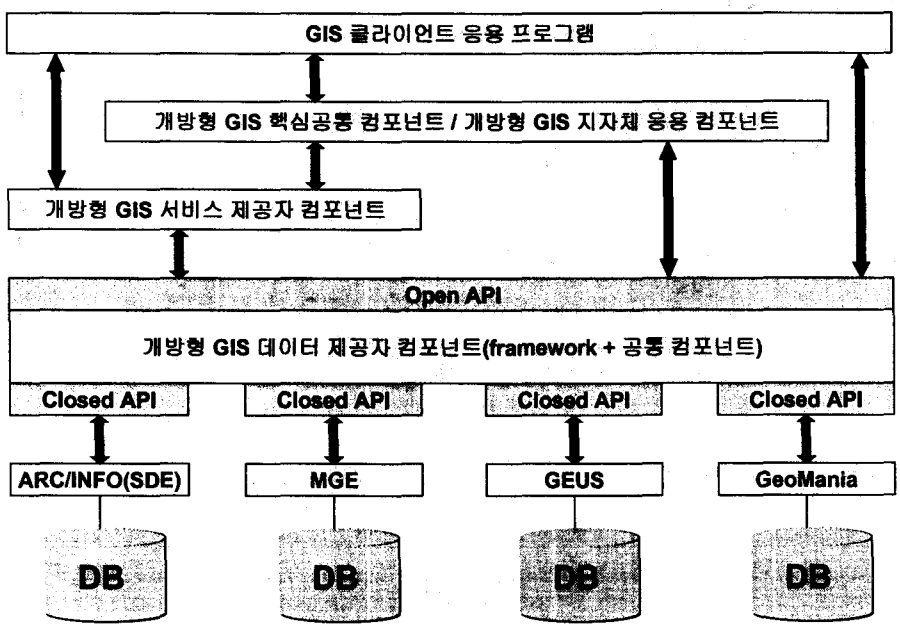
OGIS OLE DB 데이터 제공자



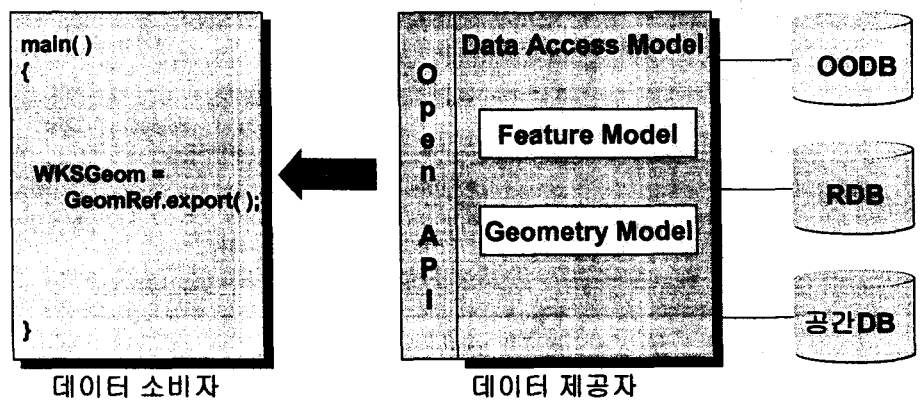
개발시 문제점

- 데이터 제공자 개발시 문제점
  - 서로 다른 **GIS S/W**만큼 데이터 제공자를 개발
  - 중복 구현에 따른 문제 및 추가 확장이 어려움
- 해결책
  - 데이터 제공자 프레임워크를 기반
  - 공통 컴포넌트 모듈은 재사용
  - **customizing**이 필요한 부분만 구현

전체 구조

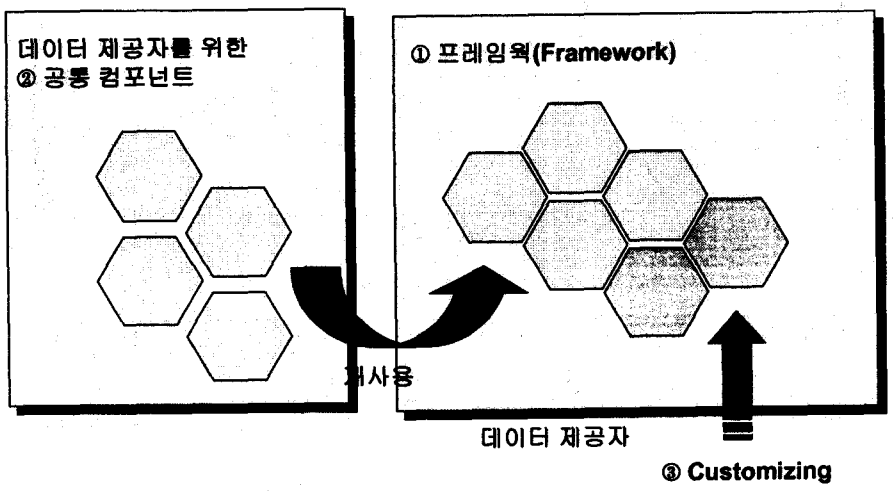


Open API



데이터 제공자의 **Open API**

구현 과정

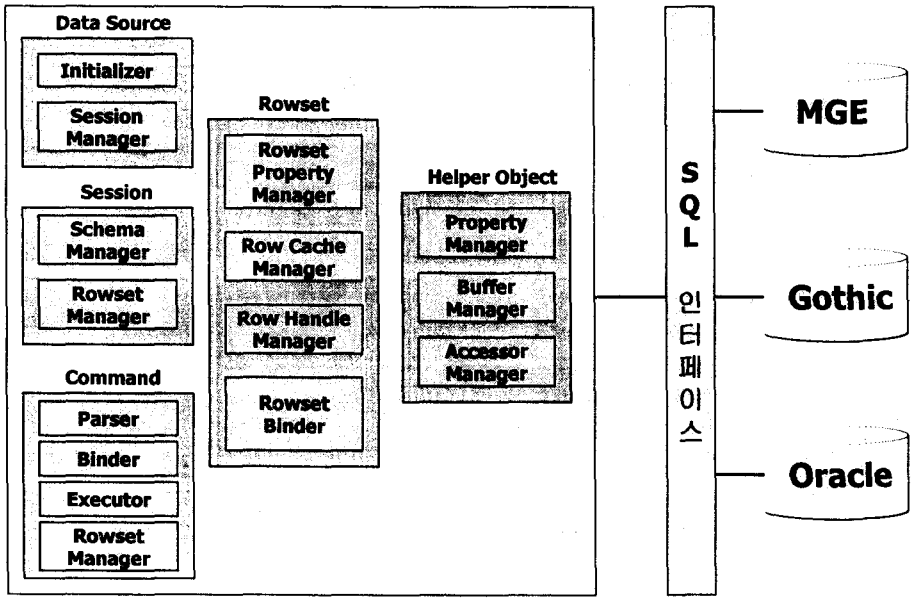


데이터 제공자 구현 과정

Framework 설계

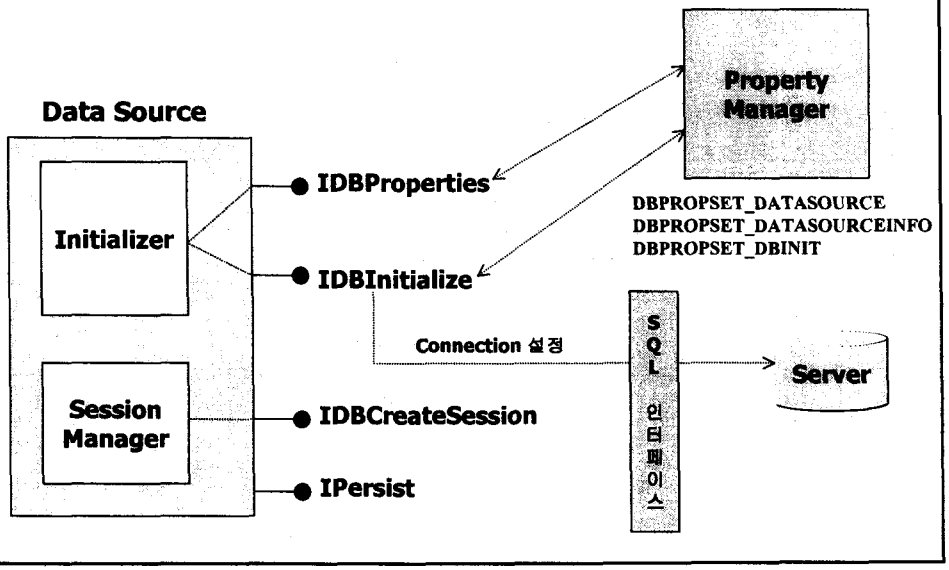
- 전체적인 구조
- **Component**별 설계
- **SQL** 인터페이스
  - **Driver COM** 인터페이스
  - **Driver Manager** 클래스 **API**

전체적인 구조



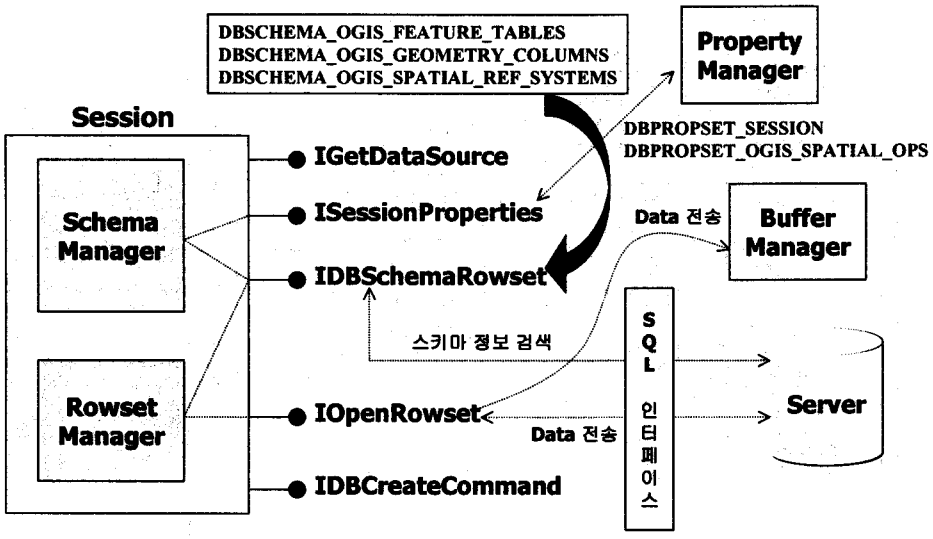
Component별 설계(1/4)

❖ Data Source



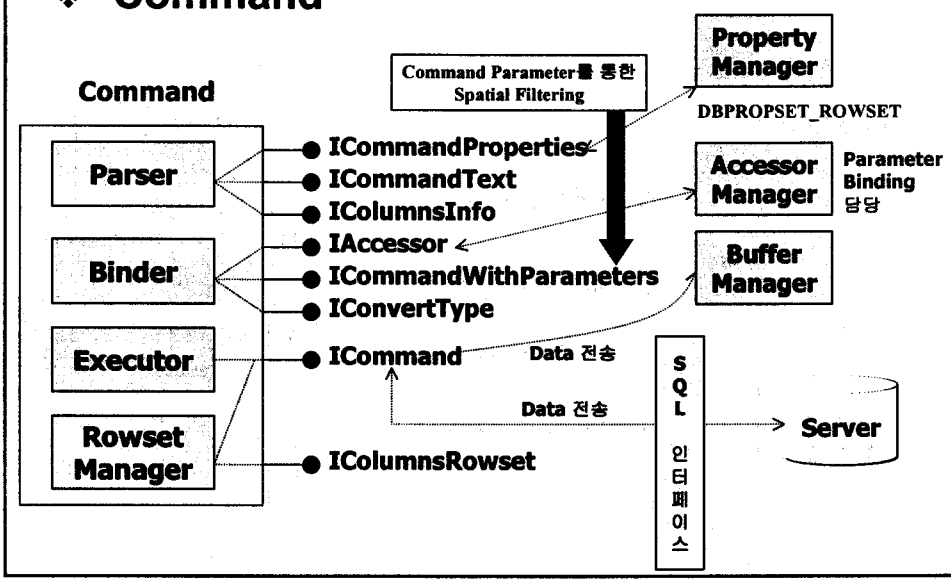
Component별 설계(2/4)

❖ Session



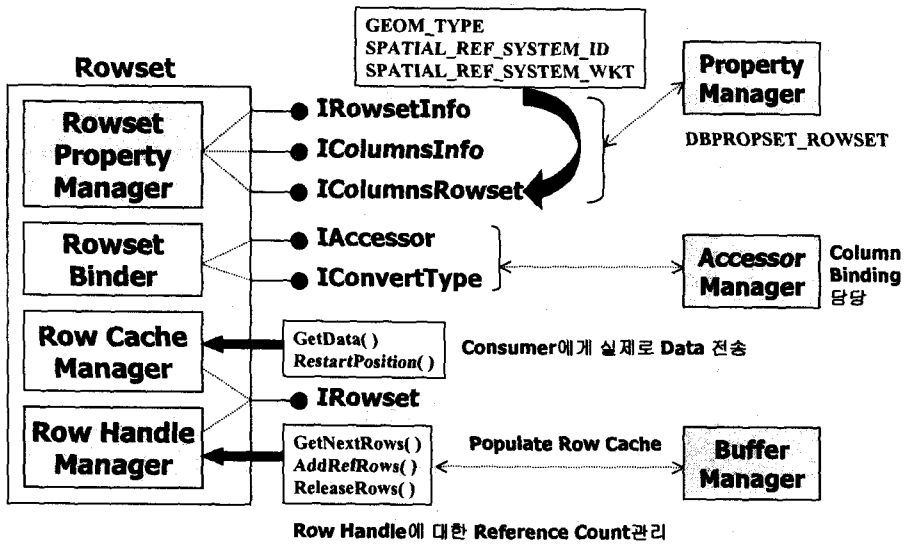
Component별 설계(3/4)

❖ Command

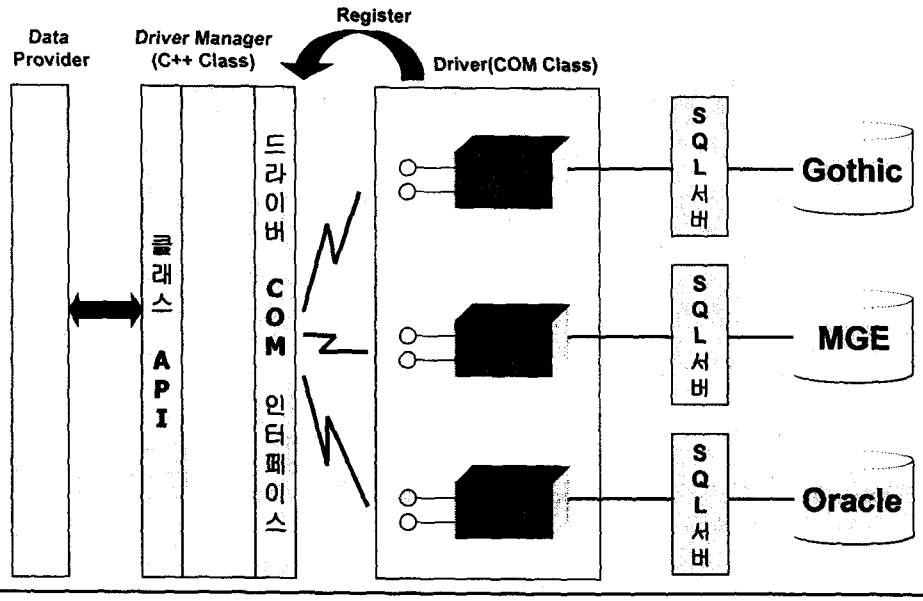


Component별 설계(4/4)

❖ Rowset



SQL 인터페이스(1/2)



SQL 인터페이스 설계(2/2)

- 자바의 **JDBC Model**을 참조
- **Driver Manager**
  - **C++ Class** 형태로 구현됨
  - **클래스 API**
    - **Data Provider**에게 **Uniform Access** 제공
  - **드라이버 COM 인터페이스**
    - 드라이버 **COM** 클래스와의 **Communication**
- **Driver**
  - **COM Class** 형태로 구현됨
  - 사용되기 위해서는 **Driver Manager**에 등록
  - 각 **GIS Server**마다 구현

Driver COM 인터페이스(1/6)

- **IConnection**
  - 특정 **Data Source**에 대한 **Connection** 설정
  - 설정시 필요한 정보
    - **IP**주소, 포트 번호, 사용자 **ID, Password**
- **IStatement**
  - **SQL**문장을 **SQL**서버로 전달
- **IResultSet**
  - **SQL** 처리 결과에 대한 **access**
  - **navigation** 기능 및 각 **Data Type**별 **Get**함수 제공

Driver COM 인터페이스(2/6)

- **IResultSetMetaData**
  - **SQL** 처리 결과에 대한 **Metadata**정보 유지
    - **Column**의 타입, **Column**의 인덱스
    - **Column**의 개수, **Row**의 개수

Driver COM 인터페이스(3/6)

```
// SQLDriver.idl

typedef short COLKIND;
typedef int COLTYPE;
typedef int COLINDEX;

typedef struct tagColumnID {
        union {
            int nIndex;
            char* pName;
        } uCOLID;
        COLKIND eKind;
} COLID;

enum COLKINDENUM
{
        COLKIND_INDEX = 0;
        COLKIND_NAME = 1
};
```

```
Enum COLTYPEENUM
{
        COLTYPE_STRING = 0,
        COLTYPE_WKBGeometry = 1,
        COLTYPE_OID = 2,
        COLTYPE_INTEGER = 3,
        COLTYPE_SHORT = 4,
        COLTYPE_FLOAT = 5,
        COLTYPE_DOUBLE = 6,
        COLTYPE_BOOLEAN = 7
};
```

Driver COM 인터페이스(4/6)

```
// SQLDriver.idl
[
        uuid(C499D6C0-4CDF-11d2-A845-00A0C92DEC80), object
]
interface IConnection : IUnknown
{
        import "unknwn.idl";
        HRESULT SetConnection([in] char* pIPAddress, [in] short nPort,
                              [in] char* pUserID, [in] char* pPassword);
        HRESULT CloseConnection(void);
        HRESULT GetStatement([out, retval] IUnknown** ppStatement);
};
[
        uuid(E27C9880-4CDF-11d2-A845-00A0C92DEC80), object
]
interface IStatement : IUnknown
{
        import "unknwn.idl";
        HRESULT ExecuteQuery([in] char* pSQL);
        HRESULT GetResultSet([out, retval] IUnknown** ppResultSet);
};
```

Driver COM 인터페이스(5/6)

```
// SQLDriver.idl
[
        uuid(C499D6C0-4CDF-11d2-A845-00A0C92DEC82), object
]
interface IResultSet : IUnknown
{
        import "unknwn.idl";
        HRESULT GetNext( );
        HRESULT GetWKBGeometry([in] COLID* pColumnID,
                               [out,retval] WKBGeometry *pWKBGeometryValue);
        HRESULT GetString([in] COLID* pColumnID, [out, retval]char* pszStringValue);
        HRESULT GetInt([in] COLID* pColumnID, [out, retval]char* pszStringValue);
        HRESULT GetShort([in] COLID* pColumnID, [out, retval]short* pShortValue);
        HRESULT GetFloat([in] COLID* pColumnID, [out, retval]float* pFloatValue);
        HRESULT GetDouble([in] COLID* pColumnID, [out, retval]double* pDoubleValue);
        HRESULT GetBoolean([in] COLID* pColumnID,
                           [out, retval]VARIANT_BOOL* pBooleanValue);
        HRESULT GetResultSetMetaData([out, retval] IUnknown** ppResultSetMetaData);
};
```

Driver COM 인터페이스(6/6)

```
// SQLDriver.idl
[
        uuid(C499D6C0-4CDF-11d2-A845-00A0C92DEC82), object
]
interface IResultSet : IUnknown
{
        import "unknwn.idl";
        HRESULT GetColumnType([in] COLID* pColumnID, [out, retval] COLTYPE* pType );
        HRESULT GetColumnIndex([in] char* pColName, [out, retval] COLINDEX* Index);
        HRESULT GetColumnCount([out, retval] int* pColNum);
        HRESULT GetRowCount([out, retval] int* pRowNum);
};
```

Driver Manager 클래스 API

- **Uniform Access**
  - Data Provider에게 다양한 GIS Server에 대한 Uniform Access제공
  - 해당 GIS Server를 위한 Driver COM Class를 Driver Manager에 등록
    - 등록된 Driver COM Class의 CLSID와 Interface pointer를 유지
  - Driver COM 인터페이스들에 대한 Wrapper
    - Data Provider가 넘겨준 매개변수를 해당 Interface function으로 전달