ICS 321 Spring 2012

SQL in a Server Environment (i)

Asst. Prof. Lipyew Lim
Information & Computer Science Department
University of Hawaii at Manoa
Three Tier Architecture

• Commonly used in large internet enterprises

Internet

Webserver

Application Server

Database Server

Eg. Apache/Tomcat
Connects clients to database systems

Eg. IBM Websphere Application Server, Jboss, SAP Netweaver, etc.
Performs business logic like shopping cart, checkout etc

Eg. IBM DB2, Oracle, MS SQL Server
Runs DBMS, performs queries and updates from app server
SQL Environment

- Schemas: tables, views, assertions, triggers
  - \texttt{CREATE SCHEMA <schema name>}
  - Your login id is your default schema
  - \texttt{SET SCHEMA <schema>}
  - A fully qualified table name is \texttt{<schema>.<table>}

- Catalogs: collection of schemas
  - Corresponds to “databases” in DB2

- Clusters: collection of catalogs
  - Corresponds to “database instance” in DB2
Client-Server Model

- CONNECT TO <server> AS <connection name> AUTHORIZATION
- DISCONNECT/CONNECT RESET/TERMINATE
- Session – SQL operations performed while a connection is active

- Programming API
  - Generic SQL Interface
  - Embedded SQL in a host language
  - True Modules. Eg. Stored procedures.

Can be on same machine or different machines

SQL-agent Module → Application Program → SQL-Server
SQL-Client → Connection → Session

3/14/2012
Lipyeow Lim -- University of Hawaii at Manoa
Two extremes of the integration spectrum:

• Highly integrated eg. Microsoft linq
  – Compiler checking of database operations
• Loosely integrated eg. ODBC & JDBC
  – Provides a way to call SQL from host language
  – Host language compiler doesn’t understand database operations.

• Requirements:
  – Perform DB operations from host language
  – DB operations need to access variables in host language
Each network “card” has a unique MAC address.

- MAC address
- IP address (assigned by network provider: static or DHCP)
- Port number (usually fixed by application type)
- Higher level protocols

Client Application

DBMS Server

- MAC address
- IP address
- Port number
- Higher level protocols

DBMS servers use their own protocols (e.g., DRDA)

Servers use a port that is known by its clients

Servers use static IP address + DNS name

Eg. http URLs, DNS

Internet
Remote Client Access

• Applications run on a machine that is separate from the DB server
• DBMS “thin” client
  – Libraries to link your app to
  – App needs to know how to talk to DBMS server via network
• DBMS “full” client layer
  – Need to pre-configure the thick client layer to talk to DBMS server
  – Your app talks to a DBMS client layer as if it is talking to the server

What information is needed for 2 machines to talk over a network?
Configuring DBMS Client Layer

• Tell the client where to find the server
  db2 CATALOG TCPIP NODE mydbsrv
  REMOTE 123.3.4.12 SERVER 50001

• Tell the client where to find the server
  db2 CATALOG DATABASE bookdb AS
  mybookdb AT NODE mydbsrv

Give a name for this node
Specify the IP address/hostname and the port number of the DB server machine
Specify the name of the database on the server
Give a local alias for the database
Specify the name of the node that is associated with this database
Embedded SQL in C Programs

- DBMS-specific Preprocessor translates special macros to DB-specific function calls.
- Pre-processor needs access to DBMS instance for validation.
- Executable needs to be bound to a specific database in a DBMS in order to execute.
Connecting SQL & Host Language

• Need a way for host language to get data from SQL environment

• Need a way to pass values from host language to SQL environment

• Shared variables
  – DECLARE SECTION
  – In SQL, refer using
  :Salary, :EmployeeNo

EXEC SQL BEGIN DECLARE SECTION;
  char EmployeeNo[7];
  char LastName[16];
  double Salary;
  short SalaryNI;
EXEC SQL END DECLARE SECTION;
An Example of Embedded SQL C Program

#include <stdio.h>
#include <string.h>
#include <sql.h>
int main()
{
    // Include The SQLCA Data Structure Variable
    EXEC SQL INCLUDE SQLCA;

    // Define The SQL Host Variables Needed
    EXEC SQL BEGIN DECLARE SECTION;
    char EmployeeNo[7];
    char LastName[16];
    double Salary;
    short SalaryNI;
    EXEC SQL END DECLARE SECTION;

    // Connect To The Appropriate Database
    EXEC SQL CONNECT TO SAMPLE USER
db2admin USING ibmdb2;

    // Declare A Static Cursor
    EXEC SQL DECLARE C1 CURSOR FOR
SELECT EMPNO, LASTNAME, DOUBLE(SALARY)
FROM EMPLOYEE
WHERE JOB = 'DESIGNER';

    // Open The Cursor
    EXEC SQL OPEN C1;
An Example of Embedded SQL C Program

// If The Cursor Was Opened Successfully,
while (sqlca.sqlcode == SQL_RC_OK)
{
    EXEC SQL
        FETCH C1 INTO :EmployeeNo,
        :LastName, :Salary, :SalaryNI;

    // Display The Record Retrieved
    if (sqlca.sqlcode == SQL_RC_OK)
    {
        printf("%-8s %-16s ", EmployeeNo,
                LastName);
        if (SalaryNI >= 0)
            printf("%lf\n", Salary);
        else
            printf("Unknown\n");
    }
}

// Close The Open Cursor
EXEC SQL CLOSE C1;
// Commit The Transaction
EXEC SQL COMMIT;
// Terminate The Database Connection
EXEC SQL DISCONNECT CURRENT;
// Return Control To The Operating System
return(0);

• A cursor is an iterator for looping through a relation instance.
• Why is a cursor construct necessary?
Updates

- SQL syntax except where clause require current of <cursor>

```sql
EXEC SQL BEGIN DECLARE SECTION;
  int certNo, worth;
  char execName[31],
  execName[31],
  execAddr [256],
  SQLSTATE [6];
EXEC SQL END DECLARE SECTION;
EXEC SQL DECLARE execCursor CURSOR FOR MovieExec;
EXEC SQL OPEN execCursor
while (1) {
  EXEC SQL FETCH FROM execCursor INTO :
    execName, :execAddr, :certNo, :worth;
  if (NO_MORE_TUPLES) break;
  if (worth < 1000)
    EXEC SQL DELETE FROM MovieExec
    WHERE CURRENT OF execCursor;
  else
    EXEC SQL UPDATE MovieExec
    SET netWorth=2*netWorth
    WHERE CURRENT OF execCursor;
}
EXEC SQL CLOSE execCursor
```
Static vs Dynamic SQL

- Static SQL refers to SQL queries that are completely specified at compile time. Eg.

```c
// Declare A Static Cursor
EXEC SQL
DECLARE C1 CURSOR FOR
SELECT EMPNO, LASTNAME,
    DOUBLE(SALARY)
FROM EMPLOYEE
WHERE JOB = 'DESIGNER';
```

- Dynamic SQL refers to SQL queries that are not completely specified at compile time. Eg.

```c
strcpy(SQLStmt, "SELECT * FROM
    EMPLOYEE WHERE JOB=");
strcat(SQLStmt, argv[1]);
EXEC SQL PREPARE SQL_STMT FROM :SQLStmt;
EXEC SQL EXECUTE SQL_STMT;
```