IBM DB2 Alphablox

DB2 Alphablox Cube Server Administrator's Guide

Version 84

SC18-9433-02

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Note:
Before using this information and the product it supports, read the information in "Notices" on page 49.

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Chapter 1. Cubing concepts

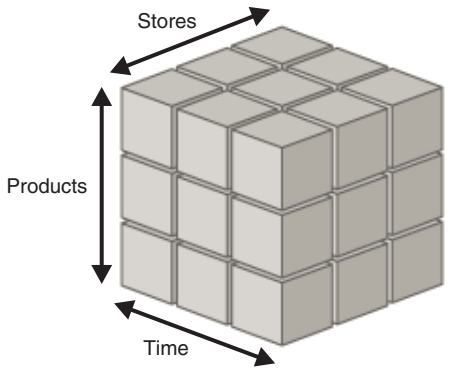
IBM DB2 Alphablox for Linux, UNIX and Windows includes the DB2 Alphablox Cube Server. The DB2 Alphablox Cube Server is designed to provide a multidimensional view of data stored in a relational database. This topic introduces the DB2 Alphablox Cube Server, provides background into the types of applications it is designed for, and describes the requirements for its use.

DB2 Alphablox Cube Server Overview

IBM DB2 Alphablox for Linux, UNIX and Windows includes the DB2 Alphablox Cube Server. The DB2 Alphablox Cube Server is designed to provide a multidimensional view of data stored in a relational database. This topic introduces the DB2 Alphablox Cube Server, provides background into the types of applications it is designed for, and describes the requirements for its use.

DB2 Alphablox Cube Server allows administrators to create a multidimensional representation of data that resides in a relational database. A *cube* is a data model often used in online analytical processing (OLAP) to represent business data that is typically analyzed over multiple dimensions. A *dimension* is a conceptual axis over which a business is analyzed. For example, a retail business's performance might be analyzed over time, products, and stores. For this business, *time*, *products*, and *stores* are each dimensions. Each of the dimensions has one or more *levels* which together define the overall hierarchy of the dimension. For example, the *time* dimension might have levels *year*, *quarter*, and *month*.

A cube is used to model the business. A three-dimensional cube is easy to visualize because it can be drawn as a geometric cube, but a cube can have any number of dimensions, from one to *n*.



At the intersection points of a cube's dimensions, analysts can view the measures. *Measures* are numeric values, usually business metrics (such as sales, profit and cost of goods), at a given set of dimension intersections. For example, to view the sales of a given product at a given store at a given time, examine the cube at the point where those dimensions intersect to find the measures.

Cubing relational data

Many organizations have invested in data marts and data warehouses to store their relational data in a queryable form. This data is typically moved, cleansed, and transformed from the transactional systems where the data originated into another relational database that is optimized for query performance.

These transformed databases contain historical information on one or more subjects, and are sometimes known as data warehouses or data marts. These data mart and data warehouses are created using IBM® DB2™, Oracle, Microsoft® SQL Server, Sybase, or other relational databases. The primary purpose of these databases is to allow users to query historical information. For details on the schema designs typical of these data warehouse and data mart databases, see Chapter 2, "Dimensional schema design," on page 9.

Querying relational databases can be made easier for users if a dimensional model is used, because dimensional models make it easier to pose business questions related to a particular business process or business area. The structure of data, when organized in dimension hierarchies, is more intuitively familiar to users and their understanding of the relationships among data categories. Depending upon the size and complexity of the dimensional model and the business requirements, users may need the power of a dedicated OLAP servers, such as IBM DB2 OLAP Server™ or Microsoft Analysis Services. In these cases, data is extracted from relational databases and built into dedicated high speed cubes that provide advanced analytical functions. In cases where the full power of dedicated OLAP servers are not necessary, but you want to provide your users with the power of OLAP analysis functionality, you can use the relational cubing capability of the DB2 Alphablox Cube Server.

With DB2 Alphablox Cube Server, an administrator can build a DB2 Alphablox cube on top of relational data; that is, the DB2 Alphablox cube is populated using queries to the underlying RDBMS.

Applications of the DB2 Alphablox Cube Server

The DB2 Alphablox Cube Server allows you to quickly present relational data in the form of an OLAP cube. It provides an intelligent subset of the functionality of full-featured OLAP servers, such as IBM DB2 OLAP Server, Hyperion Essbase, or Microsoft Analysis Services. A DB2 Alphablox cube is designed to take advantage of clean data that resides in data warehouse and data marts; it is not intended as a replacement for a full-featured OLAP server. It is useful for creating multidimensional data sources for which you do not have the time and resources to develop full-featured OLAP databases, and it is very good at presenting relatively small cubes, even if they are built from very large databases.

The DB2 Alphablox Cube Server is well-suited to building cubes that return relatively small data sets compared to the underlying databases from which they are populated. The underlying databases can be very large, including potentially billions of rows in the fact table (for a definition of a fact table, see "Fact tables" on page 10). DB2 Alphablox cubes store precomputed results in memory, not on disk. Any results not stored in memory remain in the underlying database; the cube retrieves results on an as-needed basis by sending SQL queries to the database. The results from the query are then stored in memory and are instantly accessible to DB2 Alphablox applications.

Prototyping

A relational OLAP (ROLAP) cube created using DB2 Alphablox Cube Server offers a quick way to test the potential value of a dedicated MOLAP cube. It is also possible that the DB2 Alphablox cube will offer your users a satisfactory solution without having to subsequently build a MOLAP cube on a separate MOLAP server.

Since DB2 Alphablox cubes can be created quickly, you can give users access to DB2 Alphablox applications that can quickly access corporate data and offer insights to business users. If you already have DB2 databases enabled with Cube Views functionality, you can use the DB2 Cube Views metadata to quickly define DB2 Alphablox cubes and rapidly offer users access to DB2 data. Another benefit of building DB2 Alphablox cubes using predefined Cube Views metadata is that the performance gains offered by the materialized query tables (MQTs) become available to users of your DB2 Alphablox cubes. Alternatively, DB2 Alphablox cubes can access data residing on other supported relational databases. DB2 Alphablox cubes provide an excellent way for you to prototype large scale OLAP solutions early in your development cycles. And, it is often the case that the use of DB2 Alphablox cubes is sufficient for the needs of your DB2 Alphablox application users.

Cubes with straightforward dimensions and measures

A DB2 Alphablox cube can have a single hierarchy per dimension. To represent complex dimensions with multiple hierarchies, use a full-featured OLAP server such as DB2 OLAP Server, Hyperion Essbase, or Microsoft Analysis Services. Many complex business scenarios, however, do not require multiple hierarchies per dimension.

Note: If your application requires multiple hierarchies in a single dimension, you can create multiple dimensions having the same root level but different hierarchies.

Measures in a DB2 Alphablox cube are defined with a valid SQL expression to the underlying database. In order to prevent problems with ambiguity, which happens when there are different tables with columns having the same name, there are a few restrictions on the SQL expression specified. See “Measures” on page 15 for more detail.

Different RDBMS vendors support different levels of calculations, but all of the major RDBMS vendors support a fairly rich set of calculations. If an application requires calculations that cannot be expressed in SQL, you might need to consider using a full-featured OLAP server.

Advantages of the DB2 Alphablox Cube Server

Because the DB2 Alphablox Cube Server is included with DB2 Alphablox and there is no physical disk storage to manage, many administrative tasks typical of full-featured OLAP servers are simplified or eliminated. Some of the advantages include the following:

- DB2 Alphablox Cube Server has no disk space to manage.
- DB2 Alphablox Cube Server uses the DB2 Alphablox security model, requiring no additional work to manage users.
- DB2 Alphablox Cube Server is included with DB2 Alphablox, requiring no additional software to install.

DB2 Alphablox Cube Server in an DB2 Alphablox application environment

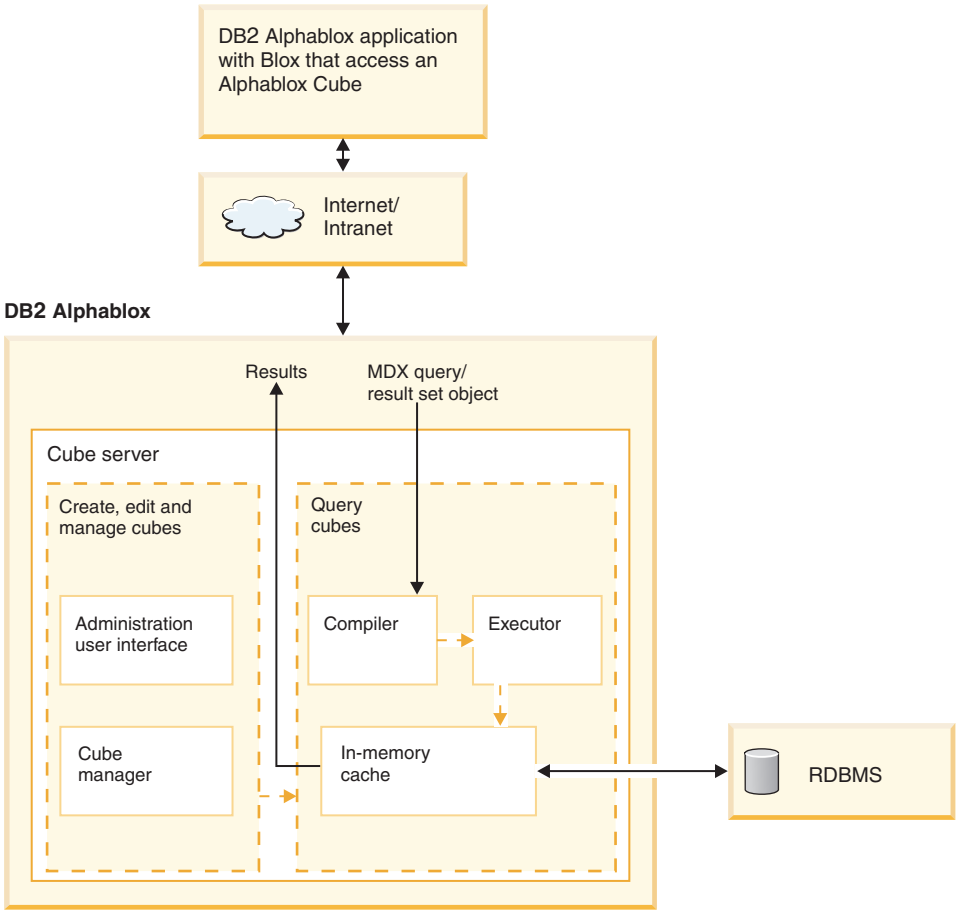
For a DB2 Alphablox application, a DB2 Alphablox cube is just another data source; that is, Blox components work with DB2 Alphablox cubes just like they do with any other supported data source. DB2 Alphablox cubes can use the same Blox components as other data sources. For example, you can change an application that accesses a DB2 Alphablox cube to access an DB2 OLAP Server cube by simply changing the values of the query and data source DataBlox parameters. The application performs the same way; it is simply accessing different data. The rich Blox component functionality available for manipulating other multidimensional and relational data sources are also available for DB2 Alphablox cubes.

DB2 Alphablox Cube Server architecture

The DB2 Alphablox Cube Server is a high performance, scalable cubing engine designed to support many users querying many different cubes. It is designed to enable quick multidimensional access to relational data stored in a data warehouse or data mart database.

DB2 Alphablox Cube Server components

The DB2 Alphablox Cube Server is composed of several components. These complementary components provide the infrastructure to define, manage, and execute queries against DB2 Alphablox cubes. The components of the DB2 Alphablox Cube Server work within the framework of DB2 Alphablox, as shown in the following figure.



Administration user interface

A cube administrator performs the tasks for setting up and managing DB2 Alphablox cubes using the DB2 Alphablox Admin Pages. Under the **General** section of the **Administration** tab, there are two relevant links for administering DB2 Alphablox cubes. Selecting the **DB2 Alphablox Cube Manager** link opens a dialog to optionally specify a maximum number of cubes to be running simultaneously and to specify an alternate location for the member cache directory. Under Runtime Management, selecting the **DB2 Alphablox Cubes** link opens a dialog for starting and stopping DB2 Alphablox cubes.

The **Cubes** link under the **Administration** tab of the DB2 Alphablox home page gives access to dialogs for creating and editing cube definitions; this is where dimensions, levels, and measures for DB2 Alphablox cubes are defined.

A DB2 Alphablox user must be a member of the administrators group in order to create, view, or modify DB2 Alphablox cubes. For detailed information on using the DB2 Alphablox cubes administration user interface, see Chapter 3, “Creating and modifying cubes,” on page 17 and Chapter 4, “Maintaining cubes,” on page 31. Also, online help is available from the DB2 Alphablox Admin Pages.

Cube Manager

The Cube Manager is the component that creates objects, performs verification checks, starts and stops, and performs other work on DB2 Alphablox cubes. The

DB2 Alphablox console also accepts commands that are carried out by the Cube Manager. For a description of the Cube Manager console commands, see "Console commands" on page 35.

In-memory cache

The DB2 Alphablox Cube Server stores calculated results in a cache that resides in memory. These stored results are then shared among all users accessing the DB2 Alphablox cube. Internally, each cube is broken down into smaller sections of results. Each of these sections is potentially stored in the cube's in-memory cache. Depending on how much memory the cube results require and how much memory is available to the cube, some entries might need to be removed from the cache. If memory needs to be freed, entries are purged from the cache. The cache is populated with queries made to the underlying relational database. If a query against a DB2 Alphablox cube requests data that is not already stored in the cache, then that data is retrieved from the underlying database and, if necessary, old data is aged out of the cache. The system performs all of these caching functions automatically.

Compiler

Query requests against DB2 Alphablox cubes use the MDX query language. The Compiler parses MDX queries, validates the requests, and generates a plan to return the results to the client application. The Compiler takes advantage of metadata stored for each cube to generate an optimized plan for each request.

Executor

The Executor runs the plan generated by the Compiler and retrieves the result set from the cache. After the results are generated, they are returned to the DataBlox, GridBlox, or PresentBlox that requested them.

MDX to SQL query translations

DB2 Alphablox applications request results from a cube through MDX queries. DB2 Alphablox Cube Server processes the MDX query which results in a plan for retrieving results from a DB2 Alphablox cube. The DB2 Alphablox cube in turn calculates those results by running SQL queries against the underlying relational database. These SQL queries either were run before the MDX query was issued and are already stored in the cache or are executed during runtime of the MDX query. If the results are already stored in the cube's in-memory cache, then there is no need to run the SQL query again for that result set. When the DB2 Alphablox application issues the MDX query, DB2 Alphablox Cube Server automatically issues any required SQL queries. Often, multiple SQL queries are needed to fulfill a single MDX request.

Schema requirements

This topic describes the requirements for the underlying database a DB2 Alphablox cube references. A DB2 Alphablox cube must reference a supported relational database. The *DB2 Alphablox Installation Guide* describes the databases supported by DB2 Alphablox. The databases should have *clean data* that is stored in a *dimensional schema*.

Clean data

The term *clean data* refers to data that follows the rules of referential integrity (whether or not referential integrity is enforced by the RDBMS). Clean data also implies that any fields in the data that might have had different values with the same meaning have been transformed to have the same values. For example, if the

transaction level data has some records in which the second quarter is referred to as *Q2* and some in which it is referred to as *Quarter_2*, the records must be transformed so that there is a unique value to identify the second quarter.

Dimensional schema

A dimensional schema in a relational database has a structure for storing clean data against which it is easy to perform historical queries. Typically, a dimensional schema can take one of the following forms:

- Single table
- Star schema
- Snowflake schema
- Combination of star and snowflake schemas

The underlying database for a DB2 Alphablox cube must contain only one fact table; multiple fact table schemas are not supported. Each dimension in a DB2 Alphablox cube must have a single hierarchy. For more information about schemas, see "Dimensional schemas" on page 9.

Note: If the database has multiple fact tables or does not conform to a dimensional schema, you can create views in the database to create a "virtual" single fact table dimensional schema for use with a DB2 Alphablox cube.

Chapter 2. Dimensional schema design

DB2 Alphablox Cube Server requires that the underlying databases have a dimensional schema. To set up a DB2 Alphablox cube correctly, the administrator should understand the data in the underlying RDBMS. This topic explains the concepts of dimensional schema design, defines terms such as star schema and snowflake schema, and explains the relationship between the database structure and the cube hierarchies.

Dimensional schemas

A database is comprised of one or more tables, and the relationships among all the tables in the database is collectively called the database *schema*. Although there are many different schema designs, databases used for querying historical data are usually set up with a dimensional schema design, typically a star schema or a snowflake schema. There are many historical and practical reasons for dimensional schemas, but the reason for their growth in popularity for decision support relational databases is driven by two main benefits:

- The ability to form queries that answer business questions. Typically, a query calculates some measure of performance over several business dimensions.
- The necessity to form these queries in the SQL language, used by most RDBMS vendors.

A dimensional schema physically separates the measures (also called *facts*) that quantify the business from the descriptive elements (also called *dimensions*) that describe and categorize the business. DB2 Alphablox cubes require the underlying database to use a dimensional schema; that is, the data for the facts and the dimensions must be physically separate (at least in different columns). Typically, this is in the form of a star schema, a snowflake schema, or a hybrid of the two. While not a common scenario, the dimensional schema can also take the form of a single table, where the facts and the dimensions are simply in separate columns of the table.

Note: If the database does not conform to a dimensional schema, you can create views in the database to create a "virtual" dimensional schema for use with a DB2 Alphablox cube.

This topic describes star and snowflake schemas and the way the business hierarchies are represented in these schemas.

For a thorough background of dimensional schema design and all of its ramifications, read *The Data Warehouse Toolkit* by Ralph Kimball, published by John Wiley and Sons, Inc.

Star and snowflake schemas

Star and snowflake schema designs are mechanisms to separate facts and dimensions into separate tables. Snowflake schemas further separate the different levels of a hierarchy into separate tables. In either schema design, each table is related to another table with a *primary key/foreign key relationship*. Primary key/foreign key relationships are used in relational databases to define many-to-one relationships between tables.

Primary keys

A *primary key* is a column or a set of columns in a table whose values uniquely identify a row in the table. A relational database is designed to enforce the uniqueness of primary keys by allowing only one row with a given primary key value in a table.

Foreign keys

A *foreign key* is a column or a set of columns in a table whose values correspond to the values of the primary key in another table. In order to add a row with a given foreign key value, there must exist a row in the related table with the same primary key value.

The primary key/foreign key relationships between tables in a star or snowflake schema, sometimes called many-to-one relationships, represent the paths along which related tables are joined together in the database. These join paths are the basis for forming queries against historical data. For more information about many-to-one relationships, see "Many-to-one relationships" on page 12.

Fact tables

A *fact table* is a table in a star or snowflake schema that stores facts that measure the business, such as sales, cost of goods, or profit. Fact tables also contain foreign keys to the dimension tables. These foreign keys relate each row of data in the fact table to its corresponding dimensions and levels.

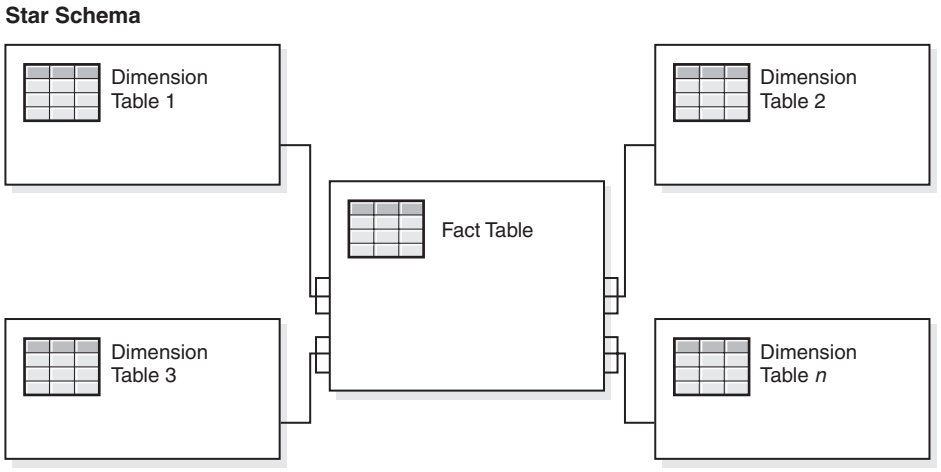
In the DB2 Alphablox Cube Server, the Measures fact table for a DB2 Alphablox cube can be specified in the cube definition for new or existing cubes, available under the **Cubes** link in the **Administration** tab of the DB2 Alphablox Admin Pages. To specify the measures fact table, you must select a valid schema and catalog combination to populate the list of available table options and then select the table or type a valid table name.

Dimension Tables

A *dimension table* is a table in a star or snowflake schema that stores attributes that describe aspects of a dimension. For example, a time table stores the various aspects of time such as year, quarter, month, and day. A foreign key of a fact table references the primary key in a dimension table in a many-to-one relationship.

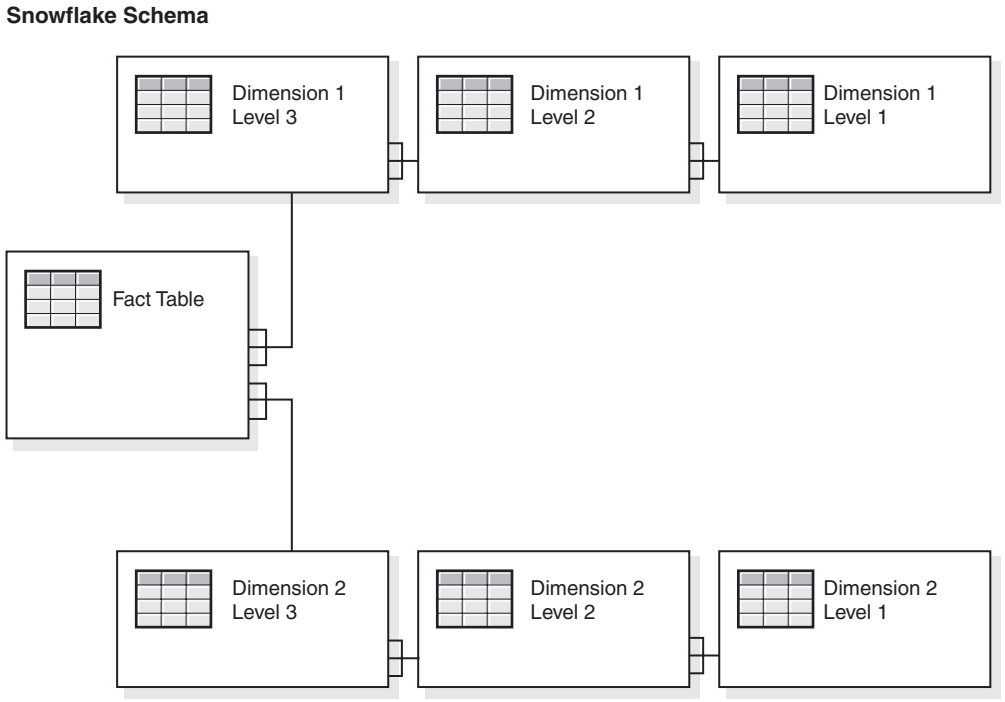
Star schemas

The following figure shows a star schema with a single fact table and four dimension tables. A star schema can have any number of dimension tables. The multiple branches at the end of the links connecting the tables indicate a many-to-one relationship between the fact table and each dimension table.



Snowflake schemas

The following figure shows a snowflake schema with two dimensions, each having three levels. A snowflake schema can have any number of dimensions and each dimension can have any number of levels.



For details about how the different levels of a dimension form a hierarchy, see "Hierarchies."

Hierarchies

A hierarchy is a set of levels having many-to-one relationships between each other, and the set of levels collectively makes up a dimension. In a relational database, the different levels of a hierarchy can be stored in a single table (as in a star schema) or in separate tables (as in a snowflake schema).

In the DB2 Alphablox Cube Server, the following hierarchy types are supported:

- balanced
- ragged
- unbalanced

Many-to-one relationships

A many-to-one relationship is where one entity (typically a column or set of columns) contains values that refer to another entity (a column or set of columns) that has unique values. In relational databases, these many-to-one relationships are often enforced by foreign key/primary key relationships, and the relationships typically are between fact and dimension tables and between levels in a hierarchy. The relationship is often used to describe classifications or groupings. For example, in a geography schema having tables *Region*, *State*, and *City*, there are many states that are in a given region, but no states are in two regions. Similarly for cities, a city is in only one state (cities that have the same name but are in more than one state must be handled slightly differently). The key point is that each city exists in exactly one state, but a state may have many cities, hence the term "many-to-one."

The different elements, or levels, of a hierarchy must have many-to-one relationships between children and parent levels, regardless of whether the hierarchy is physically represented in a star or snowflake schema; that is, the data must abide by these relationships. The clean data required to enforce the many-to-one relationships is an important characteristic of a dimensional schema. Furthermore, these relationships make it possible to create DB2 Alphablox cubes out of the relational data.

When you define a DB2® Alphablox cube, the many-to-one relationships that define the hierarchy become levels in a dimension. You enter this information through the administration user interface. For details about setting up the metadata to define a DB2 Alphablox cube, see Chapter 3, "Creating and modifying cubes," on page 17.

Balanced and unbalanced hierarchies

When a dimension has a recursive hierarchy, you do not need to create any levels. Instead, you need to specify any required member information.

Balanced hierarchies

In balanced hierarchies (**balanced/standard**), the branches of the hierarchy all descend to the same level, with each member's parent being at the level immediately above the member. An common example of a balanced hierarchy is one that represents time, where the depth of each level (year, quarter, and month) is consistent. DB2 Alphablox Cube Server supports balanced hierarchies.

Unbalanced hierarchies

Unbalanced hierarchies includes levels that have a consistent parent-child relationship, but have logically inconsistent levels. The hierarchy branches can also have inconsistent depths. An example of an unbalanced hierarchy is an organization chart, which show reporting relationships among employees in an organization. The levels within the organizational structure are unbalanced, with some branches in the hierarchy having more levels than others.

For standard unbalanced hierarchies (**unbalanced/standard**), DB2 Alphablox Cube Server ignores skipped levels, treating them as if they do not exist. Standard

deployment hierarchies use the relationship of the level definitions of the hierarchy, where each level in the hierarchy is used as one item in the deployment. Standard deployment hierarchies are supported for unbalanced hierarchies. The levels of the hierarchy are used, at least one column in the dimension table is required for each level, and missing levels contain null values. Recursive deployment hierarchies that are unbalanced and use the inherent parent-child relationships between the levels of the hierarchy are not supported in DB2 Alphablox cubes.

The recursive variation of the unbalanced hierarchy (**unbalanced/recursive**), is also supported in DB2 Alphablox Cube Server. When this hierarchy type is selected, you must also specify whether data members should be hidden or visible. By default, the data members are hidden. With a recursive hierarchy, any member can have data in the fact table, not just leaf members. For example, if your fact table has sales value of 100 for California, 15 for San Jose, and 20 for Oakland, and cities roll up to states, then the sales value for California will be 135. If ″data member″ is visible, then the California member will have a child called something like ″California data″ with value 100. If the ″data member″ is hidden, then California will only have 2 children (San Jose & Oakland) in the member hierarchy, but still have rolled up sales value of 135 (the hidden value of 100 is still included).

In an unbalanced hierarchy, null values can appear on the lower levels of the hierarchy. A parent member's children will always be in the level below that of the parent. In this hierarchy, the levels do not provide a meaningful context to its members - Washington DC is at the same level as CA in this example. A better example of an unbalanced hierarchy might be an organizational chart.

Level 1	**Level 2**	**Level 3**
USA	CA	San Francisco
USA	CA	Los Angeles
USA	Washington DC	<NULL>
Vatican City	Vatican City	<NULL>

For more information about null values and level keys, see “Creating levels” on page 23.

Ragged hierarchies

In ragged hierarchies, the parent member of at least one member of a dimension is not in the level immediately above the member. Like unbalanced hierarchies, the branches of the hierarchies can descend to different levels.

DB2 Alphablox Cube Server supports the use of ragged hierarchies. Skipped levels in ragged hierarchies are ignored and treated as if they do not exist. Only standard deployment hierarchies are supported for ragged hierarchies. The levels of the hierarchy are used, at least one column in the dimension table is required for each level, and missing levels will contain null values.

In a ragged hierarchy, null values can appear in any of the level columns. Null column values between member names are skipped, so a parent can have a child member multiple levels below the parent level. The children of USA shown in the example below are CA and Washington DC . The levels provide a meaningful context to its members in the ragged hierarchies. Thus, while Washington DC is a child of USA , it is included at the City level with San Francisco and Los Angeles.

Country	State	City
USA	CA	San Francisco
USA	CA	Los Angeles
USA	<NULL>	Washington DC
Vatican City	<NULL>	Vatican City

For more information about null values and level keys, see “Creating levels” on page 23.

Mapping relational schemas to cubes

It is important for the administrator who designs and builds a DB2 Alphablox cube to understand, at least at a high level, the mapping between the relational database and the DB2 Alphablox cube. Understanding this mapping helps to ensure there are no errors in the design or creation of the DB2 Alphablox cube. Because the cube is populated by queries to the underlying relational database, it is possible to perform quality assurance testing on the cube by comparing query results on the cube to query results on the relational database.

Dimensions, levels, and attributes

You can define any number of dimensions in a DB2 Alphablox cube and for each dimension, you can define any number of levels. In a typical snowflake schema, each level is normalized into a separate table, and the most detailed level is referenced by a foreign key from the fact table. The DB2 Alphablox Cube Server relies on the relationships among these different tables to create dimensions in the cube. When you define a DB2 Alphablox cube, you must provide details about the schema as part of the DB2 Alphablox cube definition.

For each dimension, you can specify levels in a dimensional hierarchy. At least one level is required for each dimension. Levels are used to indicate a position within a hierarchy. For example, in a Time dimension, you could have levels for Year, Quarter, Month, and Week.

The ’All’ level is a level at the top of the hierarchy with a single member. This member in the ’All’ level is know as the ’All’ level member and represents the aggregation of all members below it as it is modeled by the level objects in a dimension. For most dimensions, it makes sense to have an ’All’ level, but for the Scenario dimension, and sometimes a time dimension, you will not want to display an ’All’ level.

For each level in a dimension, you must have a level key defined. A level key consists of one or more level key expressions. Taken together, the level key expressions uniquely identify each member in the level. For example, the level key for a city level might consist of three level key expressions, <Country Name, State Name, City Name>, or it could consist of a single expression (for example, <city_id>). The order of the level key expressions might influence the member ordering in the level if member ordering expressions have not been defined. Note that best practices dictate that level key expressions should not be completely nullable (at least one of the level key expressions should be not null for each member of the level).

Note: During migration of cube definitions existing in DB2 Alphablox Cube Server prior to DB2 Alphablox 8.4, level keys will be automatically generated and

added. The generated level key of a level at the top of a hierarchy will consist of one level key expression that matches the level expression. Any level below the top level will have level key expressions that correspond to the level expressions of itself and all of its ancestors

Measures

The measures for a DB2 Alphablox cube are calculated from a fact table in the relational database. When a query requests a measure, DB2 Alphablox Cube Server calculates the values for the immediate siblings of every member specified in the query. For example, the DB2 Alphablox Cube Server calculates the sales measures for a year as the sum of the sales measures for the twelve months in the year.

Note that in the SQL expression that defines the measures, all column names are qualified with the table they are from in order to prevent problems with ambiguity, which happens when there are different tables with columns having the same name. As a result, there are a few restrictions with the SQL expression for measures:

1. The first token in the expression must be a column from the measures table. The following expression is invalid because it starts with an open parenthesis:
   ```
   (store_sales - unit_sales) / store_cost
   ```
2. All columns in the rest of the expression must exist in exactly one table.
3. The columns in the expression must not be any of the foreign key columns in the measures table.

Chapter 3. Creating and modifying cubes

An administrator uses the **Cubes** section of the **Administration** tab to define DB2 Alphablox cubes. This topic describes the steps necessary to create a DB2 Alphablox cube.

Checklist of tasks for creating cubes

This section provides a checklist of tasks needed to define a DB2 Alphablox cube, with a brief description of each task. Detailed task instructions appear later in this chapter.

Task		Description
1	Understanding the schema of the underlying database	To define a DB2 Alphablox cube, you must know the schema in the relational database from which the cube is built. Use database tools to browse the database and make sure you have access to the names of the tables, columns, primary keys, and foreign keys in the database. For information about schemas, see Chapter 2, "Dimensional schema design," on page 9.
2	Deciding which dimensions, measures, and levels are needed for your cube	In addition to understanding the schema, you must know the data in the relational database underlying a DB2 Alphablox cube. You must understand what measures to define in the cube, where those measures are stored in the database, and the relationships between the different levels of the hierarchy for each dimension.
3	"Creating relational data sources" on page 18	Create an DB2 Alphablox data source definition for the underlying relational database from which the DB2 Alphablox cube is created.
4	"Defining cubes" on page 19	Use the **Cubes** administration user interface to define the properties of a DB2 Alphablox cube.
5	"Defining measures" on page 20	Specify what facts are measured in the DB2 Alphablox cube and the mapping for each measure from the relational fact table to the DB2 Alphablox cube.

Task		Description
6	"Defining dimensions" on page 21	Specify each dimension in the DB2 Alphablox cube and each level for each dimension. Define the mapping between the relational tables and the DB2 Alphablox cube dimensions and levels.
7	"Creating Alphablox Cube Server Adapter data source definitions" on page 26	To query a DB2 Alphablox cube, define a data source created with the **Alphablox Cube Adapter** multidimensional driver.
8	"Specifying and managing cube resources" on page 27	Enter the DB2 Alphablox cube connection limits, update frequency, and other administrative parameters.
9	"Reviewing a cube" on page 29	Make sure there are no errors in the information you entered to define the DB2 Alphablox cube.

Creating relational data sources

A DB2 Alphablox cube requires that its underlying relational data source be defined as a DB2 Alphablox data source. Each DB2 Alphablox cube must reference a relational data source. The data source must reference a relational database with a dimensional schema design. For a description of the relational schema requirements for a DB2 Alphablox cube, see "Schema requirements" on page 6. For a discussion of dimensional schemas, see Chapter 2, "Dimensional schema design," on page 9.

If you have already defined a data source for the relational database, skip to the next topic, "Defining cubes" on page 19. For more information about data sources, see the *Administrator's Guide*.

To specify a relational database as an DB2 Alphablox data source, perform the following steps:

1. Log into the DB2 Alphablox home page as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab and then click the **Data Sources** link.
3. On the Data Sources window, click the **Create** button, which is located below the data sources list.
4. From the **Adapter** menu, select one of the available Relational Driver options (for example, `IBM DB2 JDBC Type 4 Driver`).
5. Type a name for your new data source in the **Data Source Name** field.
6. Add the appropriate information for **Client Host Name**, **Port Number**, **SID**, and **Database** fields. When you select a particular driver option, the relevant fields appear.
7. Type a **Default Username** and **Default Password**. The username and password must be valid on the relational database. The default username and password are always used when a DB2 Alphablox cube accesses a relational database. The specified database user requires read access to the database.

   Note: The value of the **Use DB2 Alphablox Username and Password** list is ignored when the data source is used to populate a DB2 Alphablox

cube. Use access control lists (ACLs) to control user access to DB2 Alphablox cubes. For information about ACLs, see the *Administrator's Guide*.

8. The **Maximum Rows** and **Maximum Columns** values are ignored when the data source is being used to populate a DB2 Alphablox cube. You can still enter values and they will be used when other applications use the data source, but a DB2 Alphablox cube ignores these values.
9. Set the **JDBC Tracing Enabled** menu to **No** unless you want to write JDBC logging information to the DB2 Alphablox log file. JDBC tracing should only be enabled when you are experiencing problems and need to debug their causes.
10. Click the **Save** button to save the data source.

Defining cubes

To define the general properties of a DB2 Alphablox cube:

1. Log into the DB2 Alphablox Admin Pages as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab and then click the **Cubes** link.
3. Click the **Create** button. The Cube Administration dialog appears in a new browser window.
4. In the **DB2 Alphablox Cube Name** field, type a unique name for the DB2 Alphablox cube. Allowable characters for DB2 Alphablox cube names are A-Z, a-z, 0-9, underscore (_), and space.
5. Check the **Enabled** check box to the right of the **DB2 Alphablox Cube Name** field now, or later when you are ready to start this cube. When **Enabled** is selected, this cube will start automatically whenever the server restarts. If you are working on the cube definition and do not expect it to run properly or you do not want to give others access to it yet, leave the check box cleared and enable the cube later.
6. From the **Relational Data Source** menu, select a relational data source previously defined in "Creating relational data sources" on page 18. If the list is empty, no DB2 Alphablox relational data sources have been defined.
7. (Optional) If you need to restrict access to your cube, type a predefined role (either defined in your application server or in DB2 Alphablox) into the **Security Role** field and check the Enabled check box.
8. (Optional) If you are using IBM DB2 UDB as the data source and have DB2 Cube Views cubes available on your data source, the **Enable DB2 Cube Views Settings** option is available. If you select this option, the available cube definitions in DB2 Cube Views can be used to specify your DB2 Alphablox cube. To use this option:
   a. Using the **Cube Model** menu, select a cube model.
   b. Using the **Cube** menu, select a cube.
   c. Select either the **Use Business Names** or **Use Object Names** radio button to specify the type of names to be used to define objects in your DB2 Alphablox cube.

      The **Use Business Names** option displays alternative descriptive names for objects that are more meaningful way to users, while the **Use Object Names** option displays the labels assigned to the physical objects.
   d. Click the **Import Cube Definition** button to import a cube definition and pre-populate measures and dimensions in your DB2 Alphablox cube.

Depending on the cube definition imported, DB2 Alphablox Cube Server attempts to specify a DB2 Alphablox cube that closely matches the one in DB2 Cube Views. Click the **Show Import Log** button to see a log specifying information and debugging messages related to the import operation.

e. At this point, you can edit the imported cube measures and dimensions (as described below) to customize your cube, or you can optionally check the **Import cube definition (on start, rebuild, and edit)** option. When selected, the DB2 Alphablox cube loads the latest DB2 Cube Views cube definition every time the cube is started, rebuilt, or opened for edit.

9. Click the **OK** button to save the DB2 Alphablox cube.

Defining measures

All DB2 Alphablox cubes must have one or more measures defined. For a description of measures, see "Measures" on page 15. To define measures in a DB2 Alphablox cube:

1. Log into the DB2 Alphablox home page as the *admin* user or as another user belonging to the administrators group.
2. Click the **Administration** tab and then click the **Cubes** link.
3. Select the DB2 Alphablox cube from the list of cubes and click the **Edit** button. The DB2 Alphablox **Cube Administration** dialog for the selected cube appears in a new web browser window.
4. In the cube navigation tree, click the **Measures** node. The measures panel appears.
5. In the **Measures Fact Table** field, type the fully-qualified name of the fact table as it is defined in the underlying relational database (for example, `CVSAMPLE.SALESFACT`). Alternatively, select the correct schema, catalog, and table combination in the menus to automatically insert the fact table name.
6. After the fact table has been specified, you can create a new measure by clicking the **Create New Measure** button. A new set of options appears.
7. In the **Name** field, replace "New Measure" by entering the name for your new measure. Allowable characters for measure names are A-Z, a-z, 0-9, underscore (_), and space.

   Note: The name you enter will appear in result sets sent to DB2 Alphablox applications, so enter a name that is easy to read and descriptive of its content. For example, if the measure calculates the sum of sales at a store, you can name the measure *Store Sales*.
8. In the **Expression** field, type a valid expression. The Expression Builder tool can be used to help in entering the correct syntax for columns and functions. There are shortcut buttons available for frequently used functions (AVG, COUNT, MAX, MIN, and SUM), but you can manually enter any valid function you need. These functions are used in generating the SQL sent to the underlying database to calculate the new measure. The following expression example defines the COGS measure:

   ```
   SUM(@col(CVSAMPLE.SALESFACT.COGS))
   ```
9. Click the **Apply** button to add the measure to the list.
10. Repeat these steps as needed to define any other measures you need. To delete a measure, click the measure label in the navigation tree, then click the **Delete Selected** button below the tree.
11. Click the **OK** button when you are finished modifying the DB2 Alphablox cube definition, or proceed on to define the dimensions and levels.

Defining dimensions

You must enter information to define the dimensions, levels, joins, attributes, and other information for the DB2 Alphablox cube. The following tasks explain how to create and modify dimensions, fact table joins, dimension joins, and levels.

For a description of dimensions and levels, see "Dimensions, levels, and attributes" on page 14.

Creating dimensions

To create or edit a dimension:

1. Log into the DB2 Alphablox home page as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab and then click the **Cubes** link.
3. Select a DB2 Alphablox cube from the list of cubes and click the **Edit** button. The DB2 Alphablox **Cube Administration** dialog for the selected cube appears in a new web browser window.
4. In the DB2 Alphablox cube tree on the left, click the **Dimensions** label. In the right panel the Create Dimension button appears. To edit an existing dimension, click the dimension name and the existing dimension definition appears.
5. Click the **Create New Dimension** button to create a new dimension or select a dimension from the **Dimensions** list to edit an existing dimension.
6. In the **Name** text box, enter a name for the dimension. Allowable characters for dimension names are A-Z, a-z, 0-9, underscore (_), and space. The name specified here will appear in DB2 Alphablox cubes. For a dimension listing product members ,you might enter `Products` to appear as the dimension name.
7. (Optional) In the **Description** field, type a short description of the dimension. This description is a comment field only; it has no effect on the dimension definition.
8. Specify the **Dimension Type**. By default, **Regular** is selected. If the new dimension is related displays time values, select **Time**.
9. (Optional) Type a default member in the **Default Member** field. The value you entered will be the displayed by default. For example, in a Time dimension, it is common to have the current year as the default member to be displayed.

   Note: If no default member is specified and the dimension does not have an "all" level, the first visible member becomes the default member.
10. From the **Hierarchy Type** menu, choose the appropriate type of hierarchy being represented. The options include **balanced/standard**, **ragged/standard**, **unbalanced/recursive**, or **unbalanced/standard**. When **unbalanced/recursive** is selected, the Data Members option allows you to select **Showing** or **Hidden** (the default value).
11. For the "**All**" **Level** settings, indicate whether you want your dimension to display an "all" level by checking the **Has 'All' level** option. By default, this option is selected. You can also specify the **'All' Level Member Name**. For example, if you have a Product dimension, you may choose to set the default

all level member name to `All Products`. If you do not type a value in the 'All' Level Member Name, the default member name will be displayed as All Product instead.

Note: When **'All' Level Member Name** is left blank, "All" is translated based on the server locale. You can override this by specifying the **'All' Level Member Name** based on what you want to appear in the user interface.

12. Click the **OK** button to save the dimension.

After you have created your new dimensions, you can begin defining the required fact table joins and dimension joins.

Creating fact table joins

For star or snowflake schemas, you need to define a fact table join between the fact table and each table directly related to the fact table. If you have a snowflake schema, you must create a fact table join for every table that is directly joined to the fact table. Also in a snowflake schema, you need to create dimension joins for other related tables that ware not directly related to the fact table.

To create or edit a fact table join in a dimension, perform the following steps:

1. Click on the **Fact Table Join** node under the selected dimension.
2. To create a fact table join, click the **Create New Join** button. A join specification panel appears. If a fact table join already exists, expand the Fact Table Join folder and click on the join.
3. In the **Expression** text box, enter an expression that specifies the fact table join. You can also use the Expression Builder to assist you in entering an expression defining the join. Example:

   ```
   @col(qcc_fact.Week_Ending) = @col(qcc_time.Week_Ending)
   ```

4. Click the **Apply** button to apply and save these settings without closing the dialog. Click the **OK** button to save the level definition and close the Cube Administration dialog.

Creating dimension joins

A dimension join is a join between related tables in a dimension that are not directly related to the fact table. Dimension joins are used only with snowflake schemas.

To create or edit a dimension join in the selected dimension:

1. In the Cube Administration dialog, click the **Dimension Joins** node under Joins folder of the dimension.
2. To create a new dimension join, click the **Create New Join** button that appears. A dimension join dialog appears. To edit an existing dimension join, expand the Dimension Joins folder and select the join to be edited.
3. In the **Expression** field, type an expression for the dimension join. You can also use the Expression Builder to assist you in entering an expression defining the join. Example:

   ```
   @col(QCC_PRODUCTS.FAMILYID) = @col(QCC_PRODUCTFAMILIES.FAMILYID)
   ```

4. Click the **Apply** button to apply and save these settings without closing the Cube Administration dialog. Click the **OK** button to save your changes and close the Cube Administration dialog.

Creating levels

For each dimension, you can specify levels in a dimensional hierarchy. At least one level is required for each dimension. Levels are used to indicate a position within a hierarchy. For example, in a Time dimension, you could have levels for Year, Quarter, Month, and Week.

The 'All' level is a level at the top of the hierarchy with a single member. This member in the 'All' level is know as the 'All' level member and represents the aggregation of all members below it as it is modeled by the level objects in a dimension. For most dimensions, it makes sense to have an 'All' level, but for the Scenario dimension, and sometimes a time dimension, you will not want to display an 'All' level.

For each level in a dimension, you must have a level key defined. A level key consists of one or more level key expressions. Taken together, the level key expressions uniquely identify each member in the level. For example, the level key for a city level might consist of three level key expressions <Country Name, State Name, City Name>, or it could consist of a single expression (for example, <city_id>). The order of the level key expressions might influence the member ordering in the level if member ordering expressions have not been defined. Note that best practices dictate that level key expressions should not be completely nullable (at least one of the level key expressions should be not null for each member of the level).

When you have an unbalanced or ragged hierarchy and use standard deployment, then your dimension table might have null values. Suppose you have a geography table which includes the following columns:

Country	**Region**	**State**	**City**	**City_ID**
USA	West	California	San Jose	1
USA	East	<null>	Washington, D.C.	2
Canada	Quebec	<null>	Quebec	3
Canada	Quebec	<null>	Montreal	4
Canada	British Columbia	<null>	Vancouver	5

When you model a dimension like this, you need to create four level and specify a unique level key for each level. An initial reaction might be to create the following four levels:

- Country: level key = `Country`; level expression = `Country`
- Region: level key = `Country, Region`; level expression = `Region`
- State: level key = `State`; level expression = `State`
- City: level key = `City_ID`; level expression = `City`

Looking at the data represented above, there are two countries, four regions, and five cities. But, how many states are there? Because of the null values, at first glance it seems that there is only one state (California). The DB2 Alphablox Cube Server, however, will create internal "dummy" States for the null values. If you drill into Quebec, for example, you will see the Quebec and Montreal. To the end user, there is only one state, California. Because of this internal representation, there would be four members in the State level (California, <null>, <null>, and

<null>). This would result in the cube not starting because there are three members (the three <null> values) with the same key at the State level.

To fix this, you need to change the level key for the State level to something like this:

- State: level key = `Country, Region, State`; level expression = `State`

Then the level keys for the four State members (one regular member plus three dummy members) would be:

- `<USA, West, California>`
- `<USA, East, null>`
- `<Canada, Quebec, null>`
- `<Canada, British Columbia, null>`

Since these level keys are unique, the cube will start properly.

The important point is that unique keys are required for level expression values that evaluate to <null>, even though the <null> members are not visible when you query a cube at runtime.

To create or edit levels in a dimension:

1. To create a new level, click the **Levels** node under that dimension and click the **Create New Level** button. To edit an existing level, open the Levels folder and select the level you want to edit.
2. For a new level, type a name in the **Name** field. The default name that appears is ″New Level.″ Allowable characters for DB2 Alphablox cube names are A-Z, a-z, 0-9, underscore (_), and space.
3. In the **Type** menu, select the level type. By default, the type is REGULAR. The optional types include: REGULAR, TIME, UNKNOWN, TIME_YEARS, TIME_HALF_YEARS, TIME_QUARTERS, TIME_MONTHS, TIME_WEEKS, TIME_DAYS, TIME_HOURS, TIME_MINUTES, TIME_SECONDS, or TIME_UNDEFINED. If you are using a Time dimension, choose the appropriate time-related level type (for example, TIME_QUARTERS). If an appropriate time-related level type is not available, then use the TIME_UNDEFINED level type. The TIME level type should only be used with levels in a regular dimension. Time-related MDX functions depend on the correct use of the time-related level types to work properly. If you are not using the TIME_* levels within a dimension, then you can use a mix of REGULAR, TIME, and UNKNOWN level types.
4. In the **Expression** field, enter an expression that specifies the level. You can also use the Expression Builder to assist you in entering an expression defining the level. An expression may have an associated performance penalty that you need to consider. In the following example, a SQL expression using a date function is used to create three new levels called Year, Month, and Week Ending:

   ```
   YEAR(week_ending_date)
   MONTHNAME(week_ending_date)
   week_ending_date
   ```

5. Before applying or saving these changes, you must create at least one or more level keys that uniquely identify the level (see description above).
   a. Under the new level (displayed as ″New Level″ before changes are applied or saved) in the navigation tree, click on the **Level Keys** folder and then click the **Create New Level Key** button.

b. Manually type in a level key expression or create one using the Expression builder.
c. Click the **Apply** button to save your new level key. Your new level key will appear in the navigation tree under the Level Keys folder. Continue creating additional level keys, if needed.

6. Click the **Apply** button to apply and save these settings without closing the Cube Administration dialog or click the **OK** button to save your changes and close the Cube Administration dialog.

Setting level orders

If the default ordering of the levels is not what you expected, you can modify the level order that will be displayed.

To set the level order:

1. Click the **Levels** node under the dimension that you are modifying. The **Set Level Order** option appears.
2. To move a level up or down in the level order list, select the level in the list and then click the **Move Up** or **Move Down** buttons.
3. When you are finished modifying the level orders, click the Save button.

Creating and editing attributes

Attributes are properties that can be defined for a level and can be used to provide additional information about the members of that level. For example, a member named Product might have attributes for size, color, cost, or other related product information. The MDX Properties() function, supported by the DB2 Alphablox Cube Server, can be used to display attributes in DB2 Alphablox applications.

To create or edit attributes:

1. To create a new attribute, click the **Attributes** node that appears under your dimension and then click the **Create New Attribute** button. An attribute definition dialog appears. To edit an existing attribute, click the attribute node that you want to edit.
2. In the **Expression** text box, enter an expression that specifies your attribute. You can also use the Expression Builder to assist you in entering an expression defining the attribute. Example:

   ```
   @col(FAMILY.FAMILYID)
   ```

3. Click the **Apply** button to apply and save these settings without closing the Cube Administration dialog. Click the **OK** button to save your changes and close the Cube Administration dialog.

Setting member ordering within a level

The default ordering of members is by member names. If the default ordering is not what you want, you can use Member Ordering to modify the ordering of members displayed in a level. If you do not specify a different ordering expression, the level will be ordered by the member name.

For example, months returned are ordered alphabetically by default and you will want to change the member ordering so that the months appear in their chronological order.

If months that were defined in a time dimension like this:

```
MONTHNAME(week_ending_date)
```

and displayed alphabetically, you can create a member ordering expression like this:

```
MONTH(@COL(week_ending_date)
```

which results in the months being ordered chronologically, as desired.

To modify the member ordering in a level:

1. Click on the **Member Ordering** label under the level that you want to modify.
2. Click on the **Create New Member Ordering** button.
3. Use the **Expression builder** to create an expression, or manually enter an expression, for the member ordering that you want to use.
4. Click the **Apply** button to apply and save these settings without closing the Cube Administration window, or click the **OK** button to save your changes and close the window.

Creating persistent calculated members

1. Log into the DB2 Alphablox home page as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab.
3. Click the **Cubes** link.
4. Select a DB2 Alphablox cube from the list of cubes and click the **Edit** button. The DB2 Alphablox Cube Administration dialog for the selected cube appears in a new browser window.
5. In the navigation tree for the selected cube, locate and click on the **Calculated Members** label.
6. Click the **Create New Calculated Member** button.
7. In the **Member Name** field, enter a valid member name, which includes the dimension name and member name ([*DimensionName*].[*MemberName*]. For example, to add a new calculated measure to represent an inventory backlog, the calculated member name might be "[Measures].[CalculatedCost]."
8. In the MDX Expression field, enter a valid MDX expression that specifies the new member value. For example, for a new [Measures].[CalculatedCost] calculated member, a valid MDX expression might look like this:

   ```
   [Measures].[Sales Amount]-[Measures].[Profit Amount]
   ```

9. Select an integer for the **Solve Order** value. The solve order value must be an integer value (positive, zero, or negative) for the order in which the specified calculated member should be evaluated. The solve order values are evaluated relative to each other, with negative values solved before zero or positive values.

Creating Alphablox Cube Server Adapter data source definitions

Before you can query a DB2 Alphablox cube, a DB2 Alphablox data source that uses the **Alphablox Cube Server Adapter** must be defined. A single data source can be used to access multiple DB2 Alphablox cubes from multiple applications. The cube that is accessed is determined by the FROM clause of the MDX query used by an Alphablox application. To create a DB2 Alphablox Cube Server Adapter data source, perform the following steps.

1. Log into the DB2 Alphablox home page as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab and then click the **Data Sources** link.
3. Click the **Create** button.
4. From the **Adapter** menu, select the adapter named **Alphablox Cube Server Adapter**.
5. Enter a name in the **Data Source Name** text box.
6. (Optional) Enter a description in the **Description** text box.
7. Specify a number in the **Maximum Rows** and the **Maximum Columns** text boxes. The values limit the number of rows or columns returned for queries entered through this data source. The default values are 1000.
8. Click the **Save** button to save the data source.

Specifying and managing cube resources

For each DB2 Alphablox cube, you can define a schedule for refreshing its data from the underlying database. You can also set several tuning parameters for each cube.

Defining a refresh schedule

When the underlying data in the relational database used with a DB2 Alphablox cube changes, any data cached in a DB2 Alphablox cube might be stale. When the data becomes stale, you should rebuild the cube to guarantee that answers derived from the DB2 Alphablox cube are correct with respect to the underlying database. You can manually rebuild the cube, which rebuilds the dimensions and empties the in-memory cache, by either stopping and restarting the DB2 Alphablox cube or using the `REBUILD CUBE <cube_name>` console command. Alternatively, if the dimensions have not changed but new or changed data has been added to the database, you can manually empty only the in-memory cache by using the `EMPTYCACHE <cube_name>` console command.

If the underlying database is updated at regular and predictable intervals, it might make sense to schedule regular updates to the DB2 Alphablox cube that references that database. For example, if the database is updated every night at 9:00 PM, you might want to rebuild the DB2 Alphablox cube every morning at 3:00 AM.

To configure a DB2 Alphablox cube to rebuild itself at regular intervals, perform the following steps:

1. Log into the DB2 Alphablox home page as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab.
3. Click the **Cubes** link.
4. Select a DB2 Alphablox cube from the list of cubes and click the **Edit** button. The DB2 Alphablox **Cube Administration** dialog for the selected cube will appear in a new web page window.
5. In the cube navigation tree on the left, click the **Schedule** label. A scheduling panel appears.
6. Check the **Refresh every** box to enable scheduled DB2 Alphablox cube rebuilding.

7. Set the refresh interval by clicking the desired buttons and modifying the corresponding time periods. For example, to set the DB2 Alphablox cube to rebuild every day at 3:00 AM, select the second button and enter 3:00 AM for the time.
8. Click the **Save** button to update the DB2 Alphablox cube definition.

Setting tuning parameters

For each DB2 Alphablox cube, you can set several tuning parameters for resource management. To do so, perform the following steps:

1. Log into the DB2 Alphablox home page as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab.
3. Click the **Cubes** link.
4. Select a DB2 Alphablox cube from the list of cubes and click the **Edit** button. The DB2 Alphablox **Cube Administration** dialog for the selected cube will appear in a new web page window.
5. In the cube navigation tree on the left, click the **Tuning** node to open the tuning panel.
6. Set the tuning parameter options, based on your system and user requirements. The following table describes the available options. For more detailed information on these and other tuning parameters, see "Tuning cubes" on page 36.

Tuning Parameter	Description
Maximum Concurrent Connections	The maximum number of concurrent connections to this DB2 Alphablox cube. The limit is reached only when the connections are all executing queries simultaneously. When the limit is reached, a new connection must wait for a free connection.
Data Source Connection Pooling	Connection pooling for DB2 Alphablox cubes can be enabled by selecting the **Connection Pooling Enabled** check box in the Data Source Connection Pooling group. When connection pooling is enabled, you should also specify the maximum number of persistent connections that can be made to the underlying relational database. The default value for **Maximum Persistent Connections** is 10. When the specified number of connections is reached, a new connection must wait for a free database connection. When using this limit, once each connection is opened it remains open (up to the specified maximum number of persistent connection) for use by other SQL queries. When Connection Pooling Enabled is not selected, each query uses and then closes a separate connection. **Note:** Although connection pooling is available using this setting in the DB2 Alphablox Cube Server, this setting is primarily useful for DB2 Alphablox installations on Apache Tomcat 3.2.4, where connection pooling is not available. For DB2 Alphablox installations on WebSphere and WebLogic servers, you should use the connection pooling capabilities of the application server. To use connection pooling on your WebSphere or WebLogic servers, you need to use the Application Server Adapter option when defining DB2 Alphablox relational data source definitions. See your application server documentation for details on configuring connection pooling with supported data sources.

Tuning Parameter	Description
Data Cache	By default, the **Unlimited** option is selected for the data cache associated with the selected DB2 Alphablox cube. To restrict the size of the data cache for the selected cube, you can uncheck the **Unlimited** option and then specify the maximum size (number of rows) of the data cache to be stored in the DB2 Alphablox Cube Server's in-memory data cache. After the maximum size is reached, the results from the least recently used cached queries are aged out of the cache to make room for the new rows. Optionally, you can specify an MDX query in the **Cache seeding query (optional)** field. By default, no seeding query is specified. To enable the optional query, you must also select the **Enabled** option. The query entered in this text box executes when the cube is started or rebuilt. This query will populate the DB2 Alphablox Cube Server in-memory cache with an initial set of results. These results *seed* the cache with data retrieved from the underlying database. Any subsequent DB2 Alphablox cube queries requiring only data that is already in the DB2 Alphablox Cube Server cache are answered directly from the cache, thus improving response time by avoiding additional SQL queries to the underlying database. The name of the cube referenced in the FROM clause of the MDX query must be the name previously defined in the **DB2 Alphablox Cube Name** text box.
Member Cache	By default, the **Static (All members loaded into memory)** option is selected and all members will be loaded into the member cache. Optionally, you can choose the **Dynamic (Members loaded into memory as needed)** option and members will be loaded into the member cache only as they are needed. If this dynamic member cache option is selected, the default maximum size (number of members) is set to 100,000. You can choose another non-zero value, or select the **Unlimited** option, loading all members into the data cache memory as they are needed.

7. Click the **Save** button to update the DB2 Alphablox cube definition.

Reviewing a cube

It is usually worthwhile to take a few minutes after you have created a DB2 Alphablox cube to ensure that the measures, dimensions, and levels are defined correctly. If you find any errors, you can easily correct them. To do a review on a DB2 Alphablox cube, perform the following steps:

1. Log into the DB2 Alphablox home page as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab.
3. Click the **Cubes** link.
4. Select the DB2 Alphablox cube from the list of cubes and click the **Edit** button. A page showing the Edit DB2 Alphablox Cube General tab appears.
5. Verify that the data source specified in the **Relational Data Source** text box references the desired relational database. You might need to check the settings for the data source on the **Data Sources** administration page.
6. Before attempting to start the DB2 Alphablox cube, verify that **Enabled** is selected next to the **Alphablox Cube Name** text box. If it is not enabled, you will see an error message when attempting to start the cube.

7. Verify that your measures are properly created:
   a. Click the **Measures** node to verify that the table specified in the **Measures Fact Table** text box is the correct table in the relational schema, the name is spelled correctly, and the name is a fully-qualified name.
   b. For each defined measure, check that the desired aggregation is specified in the **Expression** text box.
8. Verify that all the desired dimensions have been correctly defined, and that the names are correct. For each dimension, check the following:
   a. Verify that you had added any required fact table join and dimension joins, and that the expressions are correct.
   b. Verify that the levels are correctly specified and appear in the correct order. The first level should be the most summarized level, and each successive level should be the next level down in the hierarchy. For example, if the hierarchy for the *Time* dimension is *Year*, *Month*, *Day*, then *Year* should be the first level, followed by *Month* , followed by *Day* .
   c. Verify that any attributes that you have defined are correct, including the expected names and expressions.
9. Click the **Schedule** tab and verify that all the settings are the way you want them.
10. Click the **Tuning** tab and verify that all the settings are the way you want them.

After completing this review of your DB2 Alphablox cube, you can start the cube. For details on starting a DB2 Alphablox cube, see "Starting, stopping, and rebuilding cubes" on page 31.

Chapter 4. Maintaining cubes

DB2 Alphablox Cube Server provides functionality to perform administrative tasks on DB2 Alphablox cubes. These tasks are performed either through the DB2 Alphablox administration user interface or through the Console.

Starting, stopping, and rebuilding cubes

The most common administrative tasks you need to perform on a DB2 Alphablox cube are to start, stop, and rebuild the cube.

Starting a DB2 Alphablox cube

You must start a DB2 Alphablox cube to make it available for querying. You can start a cube either from the DB2 Alphablox Home Page from the command line of a Console window. When you start a cube, the Cube Server runs queries to the underlying relational database. The results of these queries are used to load the dimension members into the cube's in-memory cache. A DB2 Alphablox cube can have a cache seeding MDX query specified as part of its definition, which is used to precompute some results to store in the cube's cache. If one is specified, at startup time the Cube Server runs the MDX query against the DB2 Alphablox cube to populate the cache with the measure values returned from the MDX query.

Starting cubes from the DB2 Alphablox Admin Pages

To start a DB2 Alphablox cube from the DB2 Alphablox Admin Pages:

1. Log into the DB2 Alphablox Admin Pages as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab. The **General** page opens.
3. Under the **Runtime Management** section, click the **Cubes** link.
4. From the **DB2 Alphablox Cubes** list, select the DB2 Alphablox cube to start.
5. To view the current status of the DB2 Alphablox cube, click the **Details** button.
6. Click the **Start** button. When the DB2 Alphablox cube has completed the startup operation, the status field displays **Running**.

Starting cubes from a console window

To start a DB2 Alphablox cube from a console window, perform the following.

1. If DB2 Alphablox is not already running, start it. See *Administrator's Guide* for details about starting DB2 Alphablox.
2. In a Console window, enter the following command:

   ```
   start cube cube_name
   ```

   where *cube_name* is the name of the DB2 Alphablox cube to start. When using the DB2 Alphablox Admin Pages in a web browser, you can also open a console window by selecting **Administration > General > Start Console Session**.

Troubleshooting when a cube does not start

If the DB2 Alphablox cube fails to start, an error message appears that can help determine why the problem. When troubleshooting a problem, the following logging tools can provide more information:

- Check the DB2 Alphablox log file.
- Raise the message level on the Console to DEBUG by entering the following in a Console window:

  ```
  report debug
  ```
- Enable JDBC tracing in the DB2 Alphablox relational data source.

For information about enabling any of these logging options, see the *Administrator's Guide*.

The following table shows some common scenarios that might cause the startup operation to fail and lists suggestions for correcting the problem. After you determine the problem, correct it and try to start the DB2 Alphablox cube again.

Error	Description
"Make sure the cube is enabled."	Check to see if your cube is enabled. On the command line, enter the following to see if the cube is enabled: `show cube cube_name` To enable a DB2 Alphablox cube, from the **General** tab in the **Cubes** user interface, select **Enabled** next to the **DB2 Alphablox Cube Name** text box.
An error connecting to the underlying database.	Connection errors can be caused by a variety of problems. The following are some common things to check: • Check that the relational data source has the correct connect information. • Check that the relational data source has a valid, non-null username and password. • Make sure the database is available for connections.
A syntax error from the underlying database.	Syntax errors from the relational database generally indicate an error in the cube definition. For example, if the syntax error indicates that a column is not found, check the dimension definitions to ensure that the column and table names are named exactly as they are in the database.

Stopping DB2 Alphablox cubes

Stopping a DB2 Alphablox cube makes it unavailable for querying and removes all entries in the cube's in-memory cache and all the dimension members from the cube's outline.

Stopping cubes from the DB2 Alphablox Admin Pages

To stop a DB2 Alphablox cube through the DB2 Alphablox Admin Pages:

1. Log into the DB2 Alphablox Admin Pages as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab. The **General** page appears.
3. Under the **Runtime Management** section, click the **DB2 Alphablox Cubes** link.
4. Select the Alphablox cube you want to stop from the **DB2 Alphablox Cubes** list.
5. To view the current status of the DB2 Alphablox cube, click the **Details** button.

6. Click the **Stop** button. When the DB2 Alphablox cube has completed the shutdown operation, the status field displays **Stopped**.

Stopping cubes from a console window

To stop a DB2 Alphablox cube from a Console window, enter the following command:

```
stop cube cube_name
```

where *cube_name* is the name of the DB2 Alphablox cube to stop. When using the DB2 Alphablox Admin Pages in a web browser, you can also open a console window by selecting **Administration > General > Start Console Session**.

Note: The DB2 Alphablox cube will not stop until any executing queries have completed.

Rebuilding DB2 Alphablox cubes

You should either rebuild or restart a DB2 Alphablox cube when the data, including the dimension data, changes in the underlying database. You must rebuild or restart (or wait for the next refresh interval, if one is configured) the cube when you change the cube definition in order for the changes to take effect in queries.

During a rebuild operation, the cube is unavailable for querying; new queries wait and are executed after the rebuild operation completes. The rebuild operation waits until any running queries complete before starting the operation. The size of the dimensions and the performance of the queries that populate the dimension from the underlying database determine how long the operation takes.

To rebuild a DB2 Alphablox cube type the following command from a Console window:

```
rebuild cube cubeName
```

where *cubeName* is the name of the DB2 Alphablox cube to rebuild. When using the DB2 Alphablox Admin Pages in a web browser, you can also open a console window by clicking **Administration > General > Start Console Session**.

If the dimension data has not changed but the fact data has (for example, the sales numbers for the last quarter were added to the database), then you can empty the contents of the in-memory cache only. To empty all the entries in the cache but leave the dimension members as is, enter the following command from a Console window:

```
emptycache cube cubeName
```

Administration strategies

After you have defined and started a DB2 Alphablox cube, maintenance tasks are needed only if one of the following occurs:

- The data changes in the underlying database.
- The cube definition changes.

Because the DB2 Alphablox cube resides in memory, there is no disk space to manage. There are memory considerations, but those are not usually day-to-day

administrative tasks. For information about memory issues, see “DB2 Alphablox cube memory considerations” on page 39.

You do have to be aware of the environment in which the underlying relational database operates. The way the underlying database is managed can have important implications on a DB2 Alphablox cube.

Understanding database environments

Every time data changes in the database underlying a DB2 Alphablox cube, the data within the DB2 Alphablox cube may not be in synchronization (or up-to-date) with the underlying relational data changes. A DB2 Alphablox cube obtains data from queries to the underlying database. When a query requests data from a DB2 Alphablox cube, DB2 Alphablox Cube Server checks to see if the results are in its in-memory data cache. If the results are there, they are immediately available to the application, resulting in fast response times. Although the results were originally retrieved from the underlying database, those results were retrieved at some point in the past. If the data in the underlying data source has not changed, there is no problem. If the data in the underlying database changes between the time when the cache entry occurred and the time a query asks for the results, then the results will not match.

Furthermore, if some of the members in the DB2 Alphablox cube were inserted, updated, or deleted from the database, the results from the DB2 Alphablox cube would not reflect the true state of the dimensions. The results from a new query to the DB2 Alphablox cube might still match the results in the underlying database, but they might not. It depends on exactly what values changed in the database, what is stored in the in-memory cache for the Alphablox cube, and what data the query requests.

Because there is no sure way to know if the DB2 Alphablox cube is still valid and up-to-date when the data in the underlying database changes, the safest action is to rebuild the cube. Therefore, it is critical to know when and how the underlying database changes.

For example, if you know the database never changes, you never need to rebuild the DB2 Alphablox cube. If the database only adds new data to parts of the database you do not have defined in the cube, you might not need to rebuild.

If the database is updated nightly with potential changes to all parts, you probably need to rebuild the DB2 Alphablox cube nightly, after the database update is completed. The more you know about the environment in which the database operates, the better you can predict when the data in your DB2 Alphablox cube becomes stale.

Scheduling periodic updates

It is very common for data warehouse and data mart databases to be updated on a planned, periodic schedule. Based on that schedule, you can schedule periodic updates to DB2 Alphablox cubes. You can perform the updates manually using the `REBUILD CUBE` or the `EMPTYCACHE CUBE` console commands. Alternatively, you can set up an automated rebuild schedule for each DB2 Alphablox cube. For details on setting up an automatic schedule, see “Defining a refresh schedule” on page 27.

There is no one best way to schedule updates to a DB2 Alphablox cube. It is very important to know what is going on in the relational database. It is equally important to know the habits and requirements of your user community.

Rebuilding a DB2 Alphablox cube might take some time, depending on the size of the cube and its underlying database. Typically, the best time to schedule rebuilds is late at night when there are few or no users on the system. Also, particularly if the rebuild operations take a long time, make sure the users know that the cube will not be available during those times.

Console commands

You can perform most cube management tasks from the DB2 Alphablox console window. To access the console, click the **Administration** tab, **General** page, **Start Console Session**link, or use the DB2 Alphablox Console window that opens when you start DB2 Alphablox. The following table lists the cube commands and a description of what each does.

Command Syntax
Description

delete cube *cubeName*
Deletes a cube and its entire definition.

disable cube *cubeName*
Sets a cube in the disabled state. A disabled cube cannot be started until it is enabled and therefore does not automatically start when DB2 Alphablox starts. A cube should be stopped before it is disabled.

emptycache cube *cubeName*
Removes all entries from the cube's in-memory cache. After emptying the cache, a query against the DB2 Alphablox cube must retrieve the results from the underlying database. Use this command when the underlying database has changed to ensure the results retrieved from the DB2 Alphablox cube are equivalent to the data stored in the database. Note that the `EMPTYCACHE` command does not rebuild the dimension outlines of the cube. To rebuild the dimension outlines, use the REBUILD command or stop and start the cube.

enable cube *cubeName*
Sets a cube to the enabled state. A cube must be enabled before it can be started. Enabled cubes start automatically when DB2 Alphablox starts.

rebuild cube *cubeName*
First removes the member names for all the dimensions and all the measures from the in-memory cache; then queries the underlying database to repopulate the dimension member names for all the dimensions. If an initial MDX cache seeding query is specified in the cube definition, that query is executed to populate the cache.

show cube *cubeName*
Shows the current status of the cube. The cube status can be:
- disabled
- stopped
- starting
- running

To show the status of all defined DB2 Alphablox cubes, enter the following command:

```
show cube
```

start cube <*cube_name***>**
Starts a cube and makes it available for querying. When a cube starts, it

queries the underlying database to populate the dimension members and runs the MDX cache seeding query (if one is specified in the cube definition).

stop cube <*cube_name***>**
Stops a cube that is running. When a cube stops, it becomes unavailable for querying and the dimension members and the measures are removed from the in-memory cache.

Modifying cubes

You can change any part of the DB2 Alphablox cube definition at any time. Changes to a stopped cube apply immediately. Changes to a running cube are saved to the cube definition immediately but are not applied to the running cube until it is either rebuilt or restarted, either through the Console or scheduled refreshes.

You use the **Cubes** administration page to modify a DB2 Alphablox cube the same way as you create one. You can update any part of the cube definition and save it. For details on how to enter your definitions in each part of the user interface, see Chapter 3, "Creating and modifying cubes," on page 17.

Tuning cubes

There are a number of administrative controls for tuning and configuring DB2 Alphablox cubes. Because DB2 Alphablox cubes run in memory and can potentially grow to use large amounts of memory, you should be aware of some memory considerations.

Tuning controls

Use the controls described in this section to control the resources DB2 Alphablox cubes.

Connection and cache size limits

You can specify connection and cache size limits for each defined DB2 Alphablox cube on the **Cubes** page, opening the Cube Administration dialog, and clicking on the **Tuning** label in the cube navigation tree.

Maximum concurrent connections:

When there are many users querying the DB2 Alphablox cube simultaneously, machine resources on the computer running DB2 Alphablox can be consumed faster than if there are only a few users. Keep in mind, however, that the queries have to be executing at *exactly the same time* for there to be contention for resources. This might not happen very often, even if there are many users connected at the same time. If this becomes a problem on your system, you can limit the number of connections allowed for each DB2 Alphablox cube.

The amount of resources used is completely dependent on the types of queries that are being issued. Many queries use very little machine resources, but some long-running queries might consume significant resources.

To tune the maximum concurrent connections for a DB2 Alphablox cube:

1. Log into the DB2 Alphablox Home Page as the *admin* user or as a user who is a member of the administrators group.

2. Click the **Administration** tab.
3. Click the **Cubes** link.
4. Select the DB2 Alphablox cube from the list of cubes and click the **Edit** button. The DB2 Alphablox **Cube Administration** dialog for the selected cube will appear in a new web page window.
5. Click the **Tuning** tab.
6. Check any of the boxes for the limits you want to set and enter a corresponding number.
7. Click the **Save** button to save the limits to the DB2 Alphablox cube definition.

Data source connection pooling:

Connection pooling for DB2 Alphablox cubes can be enabled by selecting the **Connection Pooling Enabled** check box in the Data Source Connection Pooling group of the Tuning section of a DB2 Alphablox cube definition. When connection pooling is enabled, you must also specify the maximum number of persistent connections that can be made to the underlying relational database. The default value for **Maximum Persistent Connections** is 10. When the specified number of connections is reached, a new connection must wait for a free database connection. When using this limit, once each connection is opened it remains open (up to the specified maximum number of persistent connection) for use by other SQL queries. When **Connection Pooling Enabled** is not selected, each query the DB2 Alphablox Cube Server sends to the database opens a new connection and then closes it when the results are returned. The new connections are opened regardless of the status of any of the other connections. The connections are never shared and are never left idle.

Note: Although connection pooling is available using this setting in the DB2 Alphablox Cube Server, this setting is primarily useful for DB2 Alphablox installations on Apache Tomcat 3.2.4, where connection pooling is not available. For DB2 Alphablox installations on WebSphere and WebLogic servers, you should use the connection pooling capabilities of the application server. To use connection pooling on your WebSphere or WebLogic servers, you need to use the Application Server Adapter option when defining DB2 Alphablox relational data source definitions. See your application server documentation for details on configuring connection pooling with supported data sources.

Each connection to the database has a cost associated with it, however small. In many cases, the difference in response time is not noticeable, but in some cases it might be. It is also possible that the underlying database might restrict the number of connections it accepts, so the DBA might not want you using up too many connections.

Data and member caching:

Using the options available in the Tuning panel for a particular DB2 Alphablox cube, you can improve the performance of the cube. Two available caches, the data cache and member cache, can be modified to potentially improve the performance of a cube. The more data that is stored in the caches, the less often queries to the DB2 Alphablox cube will need to retrieve results from the underlying database, thus providing faster query response time. However, if the cache grows too large, it will use up memory on the machine, potentially slowing the performance for all users. To determine the optimal size for your system, you will need to experiment

and consider memory resources, user load, and query load. Depending on the user and query loads, balance the trade offs to decide the best data and member cache sizes.

The **data cache** stores cube cells fetched from the relational database. Once loaded into the data cache, the stored data is shared among concurrent and subsequent queries when available. The size of the data cache is configurable. See "Setting tuning parameters" on page 28 for details about data cache options.

The **member cache** stores dimension metadata (members) and can be tuned to either completely or partially cache members. For member caching, there are two modes available: static caching (default) and dynamic caching. When **static caching** is used, dimension members are read from the relational data source and preloaded into memory during cube startup.

When **dynamic caching** is selected, dimension members are read from the relational data source and stored in compressed data files in a user-specified location on the file system. Disk space usage is proportional to the number of members in the cube. The amount of memory used for the member cache is proportional to the number of members and the size of each member. The fixed cost for each member is approximately 168 bytes on 32-bit systems and approximately 290 bytes on 64-bit systems. Variable costs depend on the member keys, the average member name length, the number and type of member properties, the number of children a member has, and other costs.

For each dimension in a cube, two files are created in the member cache directory, one containing dimension data (named [*cubeName*].[*dimensionName*] and an associated index file (named [*cubeName*].[*dimensionName*].idx). The dimension file contains information about member names, member properties, member keys, and other member data. For each cube, there is also a cube index file (named [*cubeName*].idx).

When a cube is started or refreshed, the cube's member cache files are generated and any previous files are overwritten. As long as the cube is running, dimension members are dynamically read into memory from the dimension files on an as-needed basis. If the member cache grows larger than user-specified parameters, the space is managed according to the DB2 Alphablox Cube Server's caching policies.

The location of this directory, which applies to all cubes, can be specified using the **DB2 Alphablox Cube Manager** link on the **Administration** tab of the DB2 Alphablox Admin Pages. The **Member Cache Directory Path** value specifies the directory path for the disk storage of dimension data for each DB2 Alphablox cube. By default, the directory path is *alphablox_dir*\analytics\repository\temp (for example, c:\alphablox\analytics\repository\temp). You can specify a different directory path location, based on performance or backup requirements. For optimal I/O performance, the member cache directory should be on a local file system rather than a network-mounted file system. See "Setting tuning parameters" on page 28 for details about member cache options.

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For more information about memory, see "DB2 Alphablox cube memory considerations" on page 39.

To tune the data and member caches for a DB2 Alphablox cube:

1. Log into the DB2 Alphablox Home Page as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab.
3. Click the **Cubes** link.
4. Select the DB2 Alphablox cube from the list of cubes and click the **Edit** button. The DB2 Alphablox **Cube Administration** dialog for the selected cube will appear in a new web page window.
5. Click the **Tuning** tab.
6. Check any of the boxes for the limits you want to set and enter a corresponding number.
7. Click the **Save** button to save the limits to the DB2 Alphablox cube definition.

Maximum number of cubes

If you have defined many DB2 Alphablox cubes, and if each cube starts using large amounts of memory and machine resources, the performance of your entire system will be affected. To help control this, you can limit the number of DB2 Alphablox cubes allowed to run in DB2 Alphablox. The limit controls the number of DB2 Alphablox cubes that can run simultaneously; it does not limit the number that can be defined.

To set a limit on the number of concurrently running DB2 Alphablox cubes, perform the following steps:

1. Log into the DB2 Alphablox Home Page as the *admin* user or as a user who is a member of the administrators group.
2. Click the **Administration** tab. The **General** page appears.
3. Under the **General Properties** section, click the **DB2 Alphablox Cube Manager** link.
4. Check the box labeled **Maximum Cubes** and enter a number for the limit you want to set.
5. Click the **Save** button to save your changes.

Maximum rows and columns

By restricting the maximum number of rows and columns in a DB2 Alphablox Cube Data Source, you can restrict applications from issuing queries that return large amounts of data. You set these limits in the DB2 Alphablox cube data source on the **Data Sources** administration page. The data source is the one used to issue MDX queries against a DB2 Alphablox cube.

DB2 Alphablox cube memory considerations

The DB2 Alphablox Cube Server runs as part of the Java™ process in which DB2 Alphablox runs. Therefore, as the Cube Server uses more memory, the Java process uses more memory. The memory limits for the DB2 Alphablox Java process are set at installation. If you find that the DB2 Alphablox is running out of memory due to DB2 Alphablox cubes using large amounts of memory, there are several possible actions you might take:

- Limit the size of the in-memory cache for each cube. For details, see “Connection and cache size limits” on page 36.
- Limit the number of Alphablox cubes in the system. For details, see “Maximum number of cubes.”

- Change the maximum size of the memory heap for the Java process in which DB2 Alphablox runs. For details, see "Changing the maximum memory heap size" below.
- Increase the memory capacity of the computer in which DB2 Alphablox runs. For details, see "Adding more memory to your system."

Changing the maximum memory heap size

The DB2 Alphablox Cube Server runs as part of the Java process for DB2 Alphablox. If you are experiencing out-of-memory errors in DB2 Alphablox, you might need to raise the maximum memory heap size of the Java process. Set the maximum memory heap size to a value high enough to accommodate your memory requirements but low enough so that it does not cause the operating system to excessively swap to disk when the process size approaches the maximum. Also, leave some room for unexpected memory use on the machine. For example, if your machine has 1024 megabytes of memory and other resources on the machine use about 300 megabytes of memory, consider setting the maximum memory heap size to a value as large as 600 megabytes.

It might require some experimentation to find the ideal maximum for your system. If you are not having any problems, performance is good, and there are no out-of-memory errors in your DB2 Alphablox cubes, then the limits are set well for your environment.

Adding more memory to your system

One often overlooked solution to memory issues is to add more memory to the system in which DB2 Alphablox runs. Check with your hardware vendor to determine how much memory you can install on your computer. As the memory use on a system grows toward the limits of the installed physical memory, the system will swap memory to disk to make room for new memory requests, resulting in much more inefficient memory management.

A memory upgrade is often a relatively inexpensive way to increase server capacity. Also, it often helps or eliminates memory usage issues. If there is room on the system for adding more memory, consider doing so.

Chapter 5. Using MDX to query DB2 Alphablox cubes

DB2 Alphablox applications use the Multidimensional Expressions (MDX) language to query a DB2 Alphablox cube. MDX is the query language component of the OLE DB for OLAP specification, created and maintained by Microsoft. DB2 Alphablox cubes support a subset of the MDX syntax and functions. This section describes the supported MDX syntax for querying DB2 Alphablox cubes and provides example queries.

Supported MDX syntax

MDX is a multidimensional query language used by several multidimensional databases including Microsoft Analysis Services. DB2 Alphablox Cube Server uses a subset of the MDX syntax as the query language for DB2 Alphablox cubes. For a DB2 Alphablox application that accesses a DB2 Alphablox cube, the MDX query is used as the value for the DataBlox query parameter (or associated methods).

Basic syntax

The basic syntax for an MDX query against a DB2 Alphablox cube is as follows:

```
SELECT {axisSpecification} ON COLUMNS,
       {axisSpecification} ON ROWS
FROM cubeName
WHERE (slicerItems)
```

where:

axisSpecification
: is a set of one or more tuples. Tuples can be entered as a list or "generated" with the CrossJoin function.

cubeName
: is the name of a defined Alphablox cube.

slicerItems
: is a tuple (often a comma-separated list of members) on which the query result set is filtered. If there is more than one slicer member, each must be from a different dimension, and the dimension cannot be referenced in any of the axes specified in the query.

Usage notes

The following points include important information about MDX usage in the context of DB2 Alphablox.

- A dimension can only appear on a single axis in a query. Queries that place a dimension on more than one axis fail with an error.
- A query can specify zero or more axes, although it is typical to specify two axes. The COLUMNS axes can also be specified as AXIS(0), the ROWS axis as AXIS(1). Each subsequent axis are referred to as AXIS(*n*), where *n* is the next consecutive integer. Note that DB2 Alphablox applications that display the data from a query (GridBlox, ChartBlox, or PresentBlox) can only accept queries with at most two specified axes. A query rendered as an XML data set can accept any number of axes.
- Keywords in MDX on DB2 Alphablox are not case-sensitive, but member names in an MDX query are case-sensitive when surrounded by square brackets [ ].

When member names are not surrounded by square brackets [ ], they are converted to uppercase before being sent to the server. Unless all of your member names are uppercase in the database, you should use the square bracket syntax

- If you include only a dimension name in an MDX function where a member was expected, DB2 Alphablox Cube Server will return results using the [dimensionName].currentMember as the value.

Specifying member sets

A *member set* is comprised of one or more members from the same dimension. It is good practice to always enclose member names in square brackets [ ], although it is not required. When a member name contains spaces, the square brackets are required. Member names are case sensitive; therefore, the following member specifications are not equivalent:

```
[Time].[Fiscal Year]
[Time].[fiscal year]
```

Qualifying member names

You can qualify a member name by using the dimension name and its parents in the hierarchy, similar to object syntax, as follows:

```
[Dimension].[Level].[Member]
```

You can also qualify a member name by using the dimension name and one or more ancestors of the member, as follows:

```
[Dimension].[Member].[Member]
```

Note: Always qualify a member name at least enough to make it unique.

Curly braces

Curly braces denote sets, and a set placed on an axis in an MDX query must be enclosed in curly braces { }. For example, the syntax to specify a set containing the products Golden Oats and Sugar Grains is as follows:

```
{[Product].[Golden Oats], [Product].[Sugar Grains]}
```

FROM:TO syntax

You can specify a member set that extends from one point in the level to another (inclusive) by using a colon (:) to separate the members. For example, if you have a dimension called *Alphabet* with members A-Z, the following evaluates to the set {D, E, F, G, H}:

```
{[Alphabet].[D]:[Alphabet].[H]}
```

Calculated members

Calculated members enable derived members to be created without adding new members to the underlying relational data source.

Calculated members (also known as derived members) are members of dimensions that are derived from the values of other members by using mathematical or logical operations. Any values written to them are overwritten when the next calculation occurs.

Calculated members allow new members to be added to your data source, without requiring the rebuilding of the cube or adding new values to a data source. Calculated members are also useful in situations where the derived values are infrequently accessed.

Non-persistent calculated members

Non-persistent calculated members can be defined as part of an MDX query, using the WITH MEMBER clause. Non-persistent calculated members are only available for the lifetime of the query and may have limited usefulness in analytic applications.

Persistent calculated members

Persistent calculated members are defined as part of the cube, during cube definition. The advantage of persistent calculated members is that they are available for any query. In DB2 Alphablox Cube Server, the persistent calculated members belong to the specified dimension and act similar to regular members, having a parent and fitting into the dimension hierarchy. To create a persistent calculated member, you must specify the full name of the calculated member, including the dimension and the place in the hierarchy where the calculated member fits, and you must specify the expression that respresents the calculated member. Optionally, you can also specify the solve order.

Supported MDX Functions

MDX functions are used to simplify and broaden the possible scope of MDX queries. The following table lists the subset of MDX functions and operators supported in queries against DB2 Alphablox cubes.

For information on the syntax and usage of the MDX functions listed below, see the following information resources:

- Microsoft MDX Function Reference (http://msdn.microsoft.com/library/en-us/olapdmad/agmdxfunctintro_6n5f.asp)
- Spofford, George. 2001. *MDX Solutions*. New York: John Wiley & Sons.

Operators
Is, And, Or, Not, XOR, >, >=, <, <=, =, <>

MDX Function	**Syntax**
Operators Supported	
Aggregate	`Aggregate(`*`Set`*`[,`*`NumericExpression`*`])`
AllMembers	*`Dimension`*`.AllMembers`
Ancestor	`Ancestor(`*`Member`*`,`*`Level`*`)` `Ancestor(`*`Member`*`,`*`NumericExpression`*`)`
Ancestors	`Ancestors(`*`Member`*`,`*`Level`*`)` `Ancestors(`*`Member`*`,`*`NumericExpression`*`)`
Ascendants	`Ascendants(`*`Member`*`)`
Avg	`Avg(`*`Set`*`[,`*`Count`*`])`
BottomCount	`BottomCount(`*`Set`*`,`*`Member`*`[,`*`NumericExpression`*`])`

MDX Function	Syntax
BottomPercent	BottomPercent(*Set*,*Percentage*[,*NumericExpression*]) **Note:** *NumericExpression* is optional here, but is required in MSAS.
BottomSum	BottomSum(*Set*,*Value*[,*NumericExpression*]) **Note:** *NumericExpression* is optional here, but is required in MSAS.
Children	*Member*.Children
ClosingPeriod	ClosingPeriod(*Level*,*Member*)
CoaleseEmpty	CoalesceEmpty(*NumericExpression* [,*NumericExpression*]... | *StringExpression*[,*StringExpression*]...)
Count	Count(*Set*[, ExcludeEmpty | IncludeEmpty]) **Note:** OnlyCount(*Set*[,ExcludeEmpty | IncludeEmpty]) is supported here. The .Count syntax is not supported here.
Cousin	Cousin(*Member1*,*Member2*)
CrossJoin	Crossjoin(*Level*,*Member*)
CurrentMember	*Dimension*.CurrentMember
DataMember	*Member*.DataMember
DefaultMember	{*DimensionExpression* | *HierarchyExpression*}.DefaultMember
Descendants	Descendants(*Member*,[*Level*[,*DescFlags*]]) **Note:** OnlyDescendants(*Member*,[*Level*[,*DescFlags*]]) is supported here. Descendants() with the *Set* option is not supported here.
Distinct	Distinct(*Set*)
DrilldownLevel	DrilldownLevel(*Set*[,{*Level*|,*Index*}])
DrilldownMember	DrilldownMember(*Set1*,*Set2*[,RECURSIVE])
DrillupMember	DrillupMember(*Set1*,*Set2*)
Except	Except(*Set1*,*Set2*[,ALL])
Filter	Filter(*SetExpression*, { Logical_Expression | [CAPTION | KEY | NAME] =String_Expression })
FirstChild	*Member*.FirstChild
FirstSibling	*Member*.FirstSibling

MDX Function	Syntax
Generate	`Generate(Set1,Set2[,ALL])` **Note:** `Generate(Set1,Set2[,ALL])` is supported. `Generate(Set,<String Expression>[,Delimiter])` is not supported here.
Head	`Head(Set[,NumericExpression])`
Hierarchize	`Hierarchize(Set[,POST])`

Hierarchy	`Member.Hierarchy`
	
	`Level.Hierarchy`

IIf	`IIf(LogicalExpression, {Expression1, Expression2})`
Intersect	`Intersect(Set1,Set2[,ALL])`
IsEmpty	`IsEmpty(MDXExpression)`
Item	`Set.Item(Index)` **Note:** `Set.Item(StringExpression[,StringExpression])` is not supported.
Lag	`Member.Lag(NumericExpression)`
LastChild	`Member.LastChild`
LastPeriods	`LastPeriods(Index,Member)`
LastSibling	`Member.LastSibling`
Lead	`Member.Lead(NumericExpression)`
Level	`Member.Level`
Max	`Max(Set[,NumericExpression])`
Median	`Median(Set[,NumericExpression])`

Members	`Dimension.Members`
	
	`Hierarchy.Members`
	
	`Level.Members`
	
	Note: `Members(StringExpression)` is not supported.

Min	`Min(Set[,NumericExpression])`
MTD	`MTD([MemberExpression])`

MDX Function	Syntax
Name	*Dimension*.Name *Level*.Name *Member*.Name *Hierarchy*.Name
NameToSet	NameToSet(*MemberName*)
NextMember	*Member*.NextMember
NonEmptyCrossjoin	NonEmptyCrossjoin(*SetExpression*[,*SetExpression ...*] [,*CrossjoinSetCount*])
OpeningPeriod	OpeningPeriod(*Level*,*Member*)
Order	Order(*Set*,*NumericExpression*[,ASC|DESC|BASC|BDESC])
Ordinal	*Level*.Ordinal
ParallelPeriod	ParallelPeriod(*Level*,*NumericExpression*,*Member*)
Parent	*Member*.Parent
PeriodsToDate	PeriodsToDate(*Level*,*Member*)
PrevMember	*Member*.PreviousMember
Properties	*Member*.Properties(*StringExpression*) **Note:** Only user-defined member properties are supported here by the Properties() function. This function can be used to access member properties for members in a level and are generally referenced in calculated member definitions.
QTD	QTD([*MemberExpression*])
Rank	Rank(*Tuple*, *Set*[, *CalcExpression*])
Stdev	Stdev(*SetExpression*[,*NumericExpression*])
Stdevp	Stdevp(*SetExpression*[,*NumericExpression*])
Stddev	Stddev(*SetExpression*[,*NumericExpression*])
Stddevp	Stddevp(*SetExpression*[,*NumericExpression*])
Subset	Subset(*Set*,*Start*[,*Count*])
Sum	Sum(*Set*,*NumericExpression*)
Tail	Tail(*Set*[,*Count*])
TopCount	TopCount(*Set*,*Count*[,*NumericExpression*])
TopPercent	TopPercent(*Set*,*Percentage*[,*NumericExpression*]) **Note:** *NumericExpression* is optional here; required in MSAS.

MDX Function	Syntax
TopSum	`TopSum(Set,Value[,NumericExpression])` **Note:** *NumericExpression* is optional here; required in MSAS.
Union	`Union(Set1,Set2[,ALL])` `Union({Set1,Set2})`
UniqueName	*Dimension*`.UniqueName` *Level*`.UniqueName` *Member*`.UniqueName` *Hierarchy*`.UniqueName`
Value	*SetExpression*`.Value`
Var	`Var(NumericExpression[,NumericExpression])`
Variance	`Variance(SetExpression[,NumericExpression])`
VarianceP	`VarianceP(SetExpression[,NumericExpression])`
VarP	`VarP(SetExpression[,NumericExpression])`
WTD	`WTD([MemberExpression])`
YTD	`YTD([MemberExpression])`

MDX query examples

This section shows some examples of MDX queries against an DB2 Alphablox cube named *DB2AlphabloxCube*. Assume the DB2 Alphablox cube in the examples has the following dimensions, levels, and measures.

Time	Products	Measures
Year {1998, 1999, 2000, 2001}	Imported {Yes, No}	{Sales, Cost, Profit}
Quarter {Q1, Q2, Q3, Q4}	Product Name {A-Z}	
Month {1-12}		

Example 1

The following query selects several members (*A*, *B*, *C*, *D*, and *Z*) from the *Product Name* level on the columns axis, uses the Children function on the *Time* dimension for the rows axis to generate a set of years, and slices the query by the *Sales* measure in the WHERE clause.

```
SELECT {[Products].[Product Name].[A]:[D],
     [Products].[Product Name].[Z]} ON COLUMNS,
       {[Time].Children} ON ROWS
FROM [DB2AlphabloxCube]
WHERE ([Sales])
```

Time	A	B	C	D	Z
2001	12.5	14.25	34.95	2,503.22	

2002					
2003					
2004					179.7

Example 2

The following query uses the CrossJoin function to show both the product members E and F and the 4 quarters from 1999 on the columns axis. The rows axis shows the three measures in the DB2 Alphablox cube.

```
SELECT CrossJoin({[Products].[Product Name].[E],
     [Products].[Product Name].[F]}, [Time].[1999].Children)
     ON COLUMNS,
  {[Sales], [Cost], [Profit]} ON ROWS
FROM [DB2AlphabloxCube]
```

	E				F			
Measures	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Sales	17,700	16,80044	44	18,100	1,413.87	1413.87	5,510	1,413.87
Cost	12,300	12,300	50	13,200	599.97	599.97	4,400	599.97
Profit	5,400	4,500	—6	4,900	813.9	813.9	1,110	813.9

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