5 Database Support for XML

This chapter contains the following sections:

What are the Oracle9i Native XML Database Features?

Oracle9*i* supports `XMLType`, a new system defined object type. `XMLType` has built-in member functions that offer a powerful mechanism to create, extract and index XML data. Users can also generate XML documents as `XMLType` instances dynamically using the SQL functions, `SYS_XMLGEN` and `SYS_XMLAGG`, and the PL/SQL package `DBMS_XMLGEN`.

Table 5–1 summarizes the new XML features natively supported in Oracle9*i*.

Table 5–1 Oracle9i Native XML Support Feature Summary

XML Feature	Description
XMLType	(new) `XMLType` is a system defined datatype with predefined member functions to access XML data. You can perform the following tasks with XMLType: ▪ Create columns of `XMLType` and use `XMLType` member functions on instances of the type. See "XMLType Datatype" on page 5-3. ▪ Create PL/SQL functions and procedures, with `XMLType` as argument and return parameters. See, "When to use XMLType" on page 5-8. ▪ Store, index, and manipulate XML data in `XMLType` columns. Refer to "XMLType Datatype" on page 5-3.
DBMS_XMLGEN	(new) `DBMS_XMLGEN` is a PL/SQL package that converts the results of SQL queries to canonical XML format, returning it as `XMLType` or CLOB. DBMS_XMLGEN is implemented in C, and compiled in the database kernel. DBMS_XMLGEN is similar in functionality to DBMS_XMLQuery package. Refer to "DBMS_XMLGEN" on page 5-31.

Table 5–1 Oracle9i Native XML Support Feature Summary (Cont.)

XML Feature	Description
SYS_XMLGEN	(new) SYS_XMLGEN is a SQL function, which generates XML within SQL queries. DBMS_XMLGEN and other packages operate at a query level, giving aggregated results for the *entire* query. SYS_XMLGEN operates on a *single* argument inside a SQL query and converts the result to XML. SYS_XMLGEN takes in a scalar value, object type, or a XMLType instance to be converted to an XML document. It also takes an optional XMLGenFormatType object to specify formatting options for the result. SYS_XMLGEN returns a XMLType. Refer to "SYS_XMLGEN" on page 5-63.
SYS_XMLAGG	(new) SYS_XMLAGG is an aggregate function, which aggregates over a set of XMLType's. SYS_XMLAGG aggregates all the input XML documents/fragments and produces a single XML document by concatenating XML fragments, and adding a top-level tag. Refer to "SYS_XMLAGG" on page 5-72.
UriTypes	(new) The UriType family of types can store and query Uri-refs in the database. SYS.UriType is an abstract object type which provides functions to access the data pointed to by the URL. SYS.HttpUriType and SYS.DBUriType are subtypes of UriType. The HttpUriType can store HTTP URLs and the DBUriType can store intra-database references. You can also *define your own subtypes* of SYS.UriType to handle different URL protocols. **UriFactory package:** This is a factory package that can generate instances of these UriTypes automatically by scanning the prefix, such as, http:// or ftp:// etc. Users can also register their own subtype with UriFactory, specifying the supported prefix. For example, a subtype to handle the gopher protocol can be registered with UriFactory, specifying that URLs with the prefix "gopher://" are to be handled by your subtype. UriFactory now generates the registered subtype instance for any URL starting with that prefix. See Chapter 6, "Database Uri-references".

XMLType Datatype

XMLType is a new server datatype that can be used as columns in tables, and views. Variables of XMLType can be used in PL/SQL stored procedures as parameters, return values, and so on. You can use XMLType *inside the server,* in PL/SQL, SQL and Java. It is not currently supported through OCI.

XMLType includes useful built-in member functions that operate on XML content. For example, function *Extract* extracts a specific node(s) from an XMLType instance.

New SQL functions such as SYS_XMLGEN that return XML documents return them as XMLType. This provides strong typing in SQL statements. You can use

XMLType in SQL queries in the same way as any other user-defined datatypes in the system.

Note: In this release, XMLType is only supported in the server in SQL, PL/SQL, and Java. To use XMLType on the client side, use functions such as getClobVal() or other functions that retrieve the complete XML document.

How to use XMLType

XMLType can be used to create table columns. The createXML() static function in the XMLType can be used to create XMLType instances for insertion. By storing your XML documents as XMLType, XML content can be readily searched using standard SQL queries.

We will show some simple examples on how to create an XMLType column and use it in a SQL statement.

Example of Creating XMLType columns

The XMLType column can be created like any other user-defined type column,

```
CREATE TABLE warehouses(
  warehouse_id NUMBER(3),
  warehouse_spec SYS.XMLTYPE,
  warehouse_name VARCHAR2(35),
  location_id NUMBER(4));
```

Example of Inserting values into an XMLType column

To insert values into the XMLType column, you would need to bind an XMLType instance. An XMLType instance can be easily created from a VARCHAR or a CLOB by using the XMLType's createXML() static function.

```
INSERT into warehouses (warehouse_id, warehouse_spec)
   VALUES (1001, sys.XMLType.createXML(
                    '<Warehouse whNo="100">
                       <Building>Owned</Building>
                     </Warehouse>'));
```

This example created an XMLType instance from a string literal. The input to createXML could be any expression that returns a VARCHAR2 or CLOB.

The createXML function also checks that the input XML is well-formed. It does not check for validity of the XML.

Example of Using XMLType in a SQL Statement

The following simple SELECT statement shows how you can use XMLType in an SQL statement:

```
SELECT
  w.warehouse_spec.extract('/Warehouse/Building/text()').getStringVal()
     "Building"
FROM warehouses w
```

where warehouse_spec is an XMLType column operated on by member function Extract(). The result of this simple query is a string (varchar2):

```
Building
-----------------
Owned
```

See Also: "How to use XMLType" on page 5-4.

Example of Updating an XMLType column

In this release, an XML document in an XMLType is stored packed in a CLOB. Consequently updates, have to replace the document in place. We do not support piece-wise update of the XML for this release.

To update an XML document, you would fire a standard SQL update statement, except that you would bind an XMLType instance.

```
UPDATE warehouses SET warehouse_spec =
           sys.XMLType.createXML(
                    '<Warehouse whono="200">
                       <Building>Leased</Building>
                     </Warehouse>'));
```

In this example, we are creating an XMLType instance from a string literal and updating the warehouse_spec column with the new value. Note that any triggers would get fired on the update statement and you can see and modify the XML value inside the triggers.

Example of Deleting a row containing an XMLType column

Deleting a row containing an XMLType column is no different from any other datatype.

You can use the Extract and ExistsNode functions to identify rows to delete as well. For example to delete all warehouse rows for which the warehouse building is Leased, we can write a statement such as,

```
DELETE FROM warehouses e
   WHERE e.warehouse_spec.extract('//Building/text()').getStringVal()
           = 'Leased';
```

Guidelines for Using XMLType Columns

The following are guidelines for storing XML data in XMLType columns:

- *Define column XMLType.* First, define a column of XMLType. You can include optional storage characteristics with the column definition.
- *Create an XMLType instance.* Use the XMLType constructor to create the XMLType instance before inserting into the column. You can also use the SYS_XMLGEN and SYS_XMLAGG functions to directly create instances of XMLType. See "SYS_XMLGEN Example 3: Converting XMLType Instance" on page 5-68 and "SYS_XMLAGG Example 2: Aggregating XMLType Instances Stored in Tables" on page 5-74.
- *Select or extract a particular XMLType instance.* You can select out the XMLType instance from the column. XMLType offers a choice of member functions, such as, extract() and existsNode(), to extract a particular node or check to see if a node exists, respectively. See Table 5–3, "XMLType Member and Static Functions".

  See Also:

  - "XMLType Query Example 6 — Extract fragments from XMLType" on page 28
  - "XMLType Query Example 1 — Retrieve an XML Document as a CLOB" on page 5-20

- *You can define an Oracle Text index.* You can define an Oracle Text (*inter*Media Text) index on XMLType columns. This enables you to use CONTAINS, HASPATH, INPATH, and other text operators on the column. All the text operators and index functions that operate on LOB columns, also work on XMLType columns.

See Also:

- "Indexing XMLType columns" on page 31
- Chapter 8, "Searching XML Data with Oracle Text"
- *Oracle9i Application Developer's Guide - Large Objects (LOBs)*

Benefits of XMLType

Using `XMLType` has the following advantages:

- It brings the worlds of XML and SQL together as it enables:
  - SQL operations on XML content
  - XML operations on SQL content
- It is convenient to implement as it includes built-in functions, indexing support, navigation, and so on.

XMLType Interacts with Other SQL Constructs

You can use `XMLType` in SQL statements combined with other columns and datatypes. For example, you can query `XMLType` columns, join the result of the extraction with a relational column, and then Oracle can determine an *optimal* way to execute these queries.

You Can Select a Tree or Serialized Format for Your Resulting XML

`XMLType` is optimized to not materialize the XML data into a tree structure unless needed. Hence when SQL selects `XMLType` instances inside queries, only a serialized form is exchanged across function boundaries. These are exploded into tree format only when operations such as `extract()` and `existsNode()` are performed. The internal structure of `XMLType` is also an optimized DOM-like tree structure.

You Can Create functional indexes and Text indexes on XMLType

Oracle9i text index has been enhanced to support `XMLType` columns as well. You can create functional indexes on Existsnode and Extract functions as well to speed up query evaluation.

See Also: Chapter 8, "Searching XML Data with Oracle Text"

When to use XMLType

Use `XMLType` in the following cases:

- You need to store XML as a whole in the database and retrieve it.
- You need SQL queriability on some or the whole document. The functions ExistsNode and Extract provide the necessary SQL queriability over XML documents.
- You need strong typing inside SQL statements and PL/SQL functions. Strong typing implies that you ensure that the values passed in are XML values and not any arbitrary text string.
- You need the XPath functionality provided by Extract and ExistsNode functions to work on your XML document. Note that the `XMLType` uses the built-in C XML parser and processor and hence would provide better performance and scalability when used inside the server.
- You need indexing on XPath searches on documents. `XMLType` provides member functions that can be used to create functional indexes to optimize searches.
- You do not need piecewise updates of the document.
- Shield applications from storage models - In future releases, the `XMLType` would support different storage alternatives. Using `XMLType` instead of CLOBs or relational storage, allows applications to gracefully move to various storage alternatives later, without affecting any of the query or DML statements in the application.
- Preparing for future optimizations - All new functionality related to XML will only support the `XMLType`. Since the server is natively aware that the `XMLType` can only store XML data, better optimizations and indexing techniques can be done in the future.By writing applications to use `XMLType`, these optimizations and enhancements can be easily achieved in the future without rewriting the application.

XMLType Storage in the Database

In this release, `XMLType` offers a single CLOB storage option. In future releases, Oracle may provide other storage options, such as BLOBs, NCLOBS, and so on.

When you create an `XMLType` column, a hidden CLOB column is automatically created to store the XML data. The `XMLType` column itself becomes a virtual column over this hidden CLOB column. It is not possible to directly access the

CLOB column, however, you can set the storage characteristics for the column using the XMLType storage clause.

You cannot create VARRAYs of XMLType and store it in the database since VARRAYs do not support CLOBs when stored in tables.

Note: You cannot create columns of VARRAY types which contain XMLType. This is because Oracle does not support LOB locators inside VARRAYs, and XMLType (currently) always stores the XML data in a CLOB.

XMLType Creation Example 1 — Creating XMLType Columns

As explained earlier, you can create XMLType columns by simply using the XMLType as the datatype.

The following statement creates a purchase order document column of XMLType.

```
CREATE TABLE po_xml_tab(
  poid number,
  poDoc SYS.XMLTYPE);
```

XMLType Creation Example 2 — Adding XMLType Columns

You can alter tables to add XMLType columns as well. This is similar to any other datatype,

The following statement adds a new customer document column to the table,

```
ALTER TABLE po_xml_tab add (custDoc sys.XMLType);
```

XMLType Creation Example 3 — Dropping XMLType Columns

You can alter tables to drop XMLType columns, similar to any other datatype,

The following statement drops the custDoc column.

```
ALTER TABLE po_xml_tab drop (custDoc sys.XMLType);
```

Specifying Storage Characteristics on XMLType Columns

As previously mentioned, the XML data in a `XMLType` column is stored as a CLOB column. You can also specify LOB storage characteristics for the CLOB column. In the previous example, the warehouse spec column is an `XMLType` column.

Figure 5–1 illustrates the `XMLType` storage clause syntax.

Figure 5–1 XMLType Storage Clause Syntax

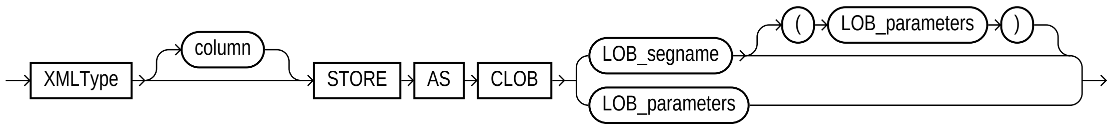


Table 5–2 explains the `XMLType` storage clause syntax.

Table 5–2 XMLType Storage Clause Syntax Description - See Figure 5–1

Syntax Member	Description
column	Specifies the XML name for which you are explicitly defining tablespace and storage characteristics that are different from those of the table. Oracle automatically creates a system-managed index for each *`column`* you create.
LOB_segname	Specify the name of the LOB data segment.
LOB_parameters	The *`LOB_parameters`* clause lets you specify various elements of LOB storage. ■ `ENABLE STORAGE IN ROW`: If you enable storage in row, the LOB value is stored in the row (inline) if its length is less than approximately 4000 bytes minus system control information. This is the default. **Restriction:** For an index-organized table, you cannot specify this parameter unless you have specified an `OVERFLOW` segment in the *`index_org_table_clause`*. ■ `DISABLE STORAGE IN ROW`: If you disable storage in row, the LOB value is stored out of line (outside of the row) regardless of the length of the LOB value.Note:The LOB locator is always stored inline (inside the row) regardless of where the LOB value is stored. You cannot change the value of `STORAGE IN ROW` once it is set except by moving the table. See *Oracle9i SQL Reference*, ALTER TABLE — *`move_table_clause`*. ■ `CHUNK` *`integer`*: Specifies bytes to be allocated for LOB manipulation. If *`integer`* is not a multiple of the database block size, Oracle rounds up (in bytes) to the next multiple. If database block size is 2048 and *`integer`* is 2050, Oracle allocates 4096 bytes (2 blocks). Maximum value is 32768 (32K). Default `CHUNK` size is one Oracle database block.You cannot change the value of `CHUNK` once it is set. Note: The value of `CHUNK` must be less than or equal to the value of `NEXT` (either the default value or that specified in the *`storage_clause`*). If `CHUNK` exceeds the value of `NEXT`, Oracle returns an error. ■ `PCTVERSION` *`integer`*: Specify the maximum percentage of overall LOB storage space used for creating new versions of the LOB. The default value is 10, meaning that older versions of the LOB data are not overwritten until 10% of the overall LOB storage space is used.

You can specify storage characteristics on this column when creating the table as follows:

```
CREATE TABLE po_xml_tab(
     poid NUMBER(10),
     poDoc SYS.XMLTYPE
     )
     XMLType COLUMN poDoc
        STORE AS CLOB (
            TABLESPACE lob_seg_ts
            STORAGE (INITIAL 4096 NEXT 4096)
            CHUNK 4096 NOCACHE LOGGING
         );
```

The storage clause is also supported while adding columns to the table. If you want to add a new XMLType column to this table and specify the storage clause for that you can do the following:-

```
ALTER TABLE po_xml_tab  add(
     custDoc SYS.XMLTYPE
   )
   XMLType COLUMN custDoc
      STORE AS CLOB (
           TABLESPACE lob_seg_ts
           STORAGE (INITIAL 4096 NEXT 4096)
           CHUNK 4096 NOCACHE LOGGING
         );
```

See also: *Oracle9i Application Developer's Guide - Large Objects (LOBs)* for more information about LOB storage options.

Specifying Constraints on XMLType Columns

You can specify the NOT NULL constraint on a XMLType column. For example:

```
CREATE TABLE po_xml_tab (
  poid number(10),
  poDoc sys.XMLType NOT NULL
);
```

prevents inserts such as:

```
INSERT INTO po_xml_tab (poDoc) VALUES (null);
```

You can also use the ALTER TABLE statement to change the NOT NULL information of a XMLType column, in the same way you would for other column types:

```
ALTER TABLE po_xml_tab MODIFY (poDoc NULL);
ALTER TABLE po_xml_tab MODIFY (poDoc NOT NULL);
```

Default values and other check constraints are not supported on this datatype.

XMLType Functions

Oracle9*i* has introduced two new SQL functions `ExistsNode` and `Extract` that operate on `XMLType` values.

`existsNode()` function uses the `XMLType.existsNode()` member function for its implementation. The syntax of ExistsNode function is:

```
existsNode ("XMLType_instance" IN sys.XMLType,
            "XPath_string" IN VARCHAR2) RETURN NUMBER
```

`extract()` function applies an XPath expression and returns an `XMLType` containing the resultant XML fragment. The syntax is:

```
extract ("XMLType_instance" IN sys.XMLType,
          "XPath_string" IN VARCHAR2) RETURN sys.XMLType;
```

Note: In this release, existsNode() and extract() SQL functions only use the functional implementation. In future releases, these functions will use new indices and be further optimized.

Table 5–3 lists all the `XMLType` and member functions, their syntax and descriptions.

You can use the SQL functions instead of the member functions ExistsNode and Extract inside any SQL statement. All the `XMLType` functions use the built-in C parser and processor to parse the XML data, validate it and apply XPath expressions over it. It also uses an optimized in-memory DOM tree to do processing (such as Extract).

Table 5–3 XMLType Member and Static Functions

XMLType Function	Syntax Summary	Description

`createXML()`	STATIC FUNCTION
	createXML(xmlval IN varchar2)
	RETURN sys.XMLType deterministic
		Static function to create the `XMLType` instance from a string. Checks for well-formed XML value.
		PARAMETERS: xmlval (IN) - string containing the XML document.
		RETURNS: A `XMLType` instance. String must contain a well-formed XML document.
		See also "XMLType Query Example 6 — Extract fragments from XMLType" on page 5-28, and other examples in this chapter.

`createXML()`	STATIC FUNCTION
	createXML(xmlval IN clob)
	RETURN sys.XMLType deterministic
		Static function to create the `XMLType` instance from a CLOB. Checks for well-formed XML value.
		PARAMETERS: xmlval (IN) - CLOB containing the XML document
		RETURNS: A `XMLType` instance. CLOB must contain a well-formed XML document.
		See "XMLType Query Example 2 — Using extract() and existsNode()" on page 5-24 and other examples in this chapter.

`existsNode()`	MEMBER FUNCTION
	existsNode(xpath IN varchar2)
	RETURN number deterministic
		Given an XPath expression, checks if the XPath applied over the document can return any valid nodes.
		PARAMETERS: xpath (IN) - the XPath expression to test
		RETURNS: 0 if the XPath expression does not return any nodes else 1. If the XPath string is null or the document is empty, then a value of 0 is returned.
		See also "XMLType Query Example 2 — Using extract() and existsNode()" on page 5-24.

`extract()`	MEMBER FUNCTION
	extract(xpath IN varchar2)
	RETURN sys.XMLType deterministic
		Given an XPath expression, applies the XPath to the document and returns the fragment as a `XMLType`
		PARAMETERS: xpath (IN) - the XPath expression to apply
		RETURNS: A `XMLType` instance containing the result node(s). If the XPath does not result in any nodes, then the result is NULL.
		See also "XMLType Query Example 6 — Extract fragments from XMLType" on page 5-28.

Table 5–3 XMLType Member and Static Functions(Cont.)

XMLType Function	Syntax Summary	Description

`isFragment()`	MEMBER FUNCTION
	isFragment()
	RETURN number
		Checks if the document is really a fragment. A fragment might be present, if an EXTRACT or other operation was done on an XML document that may have resulted in many nodes.
		RETURNS: A numerical value 1 or 0 indicating if the `XMLType` instance contains a fragment or a well-formed document.
		See also "XMLType Query Example 6 — Extract fragments from XMLType" on page 5-28.

`getClobVal()`	MEMBER FUNCTION
	getClobVal()
	RETURN clob deterministic
		Gets the document as a CLOB.
		RETURNS: A CLOB containing the serialized XML representation.Free the temporary CLOB after use.
		See also: "XMLType Query Example 1 — Retrieve an XML Document as a CLOB" on page 5-55.

`getStringVal()`	MEMBER FUNCTION
	getStringVal()
	RETURN varchar2 deterministic
		Gets the XML value as a string.
		RETURNS: A string containing the serialized XML representation, or in case of text nodes, the text itself. If the XML document is bigger than the maximum size of VARCHAR2, (4000 bytes), an error is raised at run time.
		See"XMLType Delete Example 1 — Deleting Rows Using extract" and also, "How to use XMLType" on page 5-4.

getNumberVal()	MEMBER FUNCTION
	getNumberVal()
	RETURN number deterministic
		Gets the numeric value pointed to by the `XMLType` as a number
		RETURNS: A number formatted from the text value pointed to by the `XMLType` instance. The XMLType must point to a valid text node that contains a numeric value.
		See also: "XMLType Query Example 2 — Using extract() and existsNode()" on page 5-24.

See Also: "How to use XMLType" examples starting on page 5-4, for ideas on how you can use `extract()`, `existsNode()`, `getClobVal()`, and other functions.

Manipulating XML Data in XMLType Columns

Since `XMLType` is a user-defined data type with functions defined on it, you can invoke functions on `XMLType` and obtain results. You can use `XMLType` wherever you use a user-defined type. This includes columns of tables, views, trigger body, type definitions, and so on.

You can perform the following manipulations (DML) on XML data in `XMLType` columns:

- Insert XML data
- Update XML data
- Delete XML data

Inserting XML Data into XMLType Columns

You can insert data into `XMLType` columns in the following ways:

- By using the INSERT statement (in SQL, PL/SQL, and Java)
- By using SQL*Loader

The `XMLType` columns can only store well-formed XML documents. Fragments and other non-well formed XML cannot be stored in such columns.

Using INSERT Statements

If you use the INSERT statement to insert XML data into `XMLType`, you need to first create XML documents to perform the insert with. You can create the insertable XML documents as follows:

1. Using `XMLType` constructors, `SYS.XMLType.createXML().`This can be done in SQL, PL/SQL, and Java.
2. Using `SYS_XMLGEN` and `SYS_XMLAGG` SQL functions. This can be done in PL/SQL,SQL, and Java.

XMLType Insert Example 1- Using createXML() with CLOB

The following examples use INSERT...SELECT and the XMLType.createXML() construct to first create an XML document and then insert the document into XMLType columns.

For example, if the po_clob_tab is a table containing a CLOB that stores an XML document,

```
CREATE TABLE po_clob_tab
(
  poid number,
  poClob CLOB
);

-- some value is present in the po_clob_tab
INSERT INTO po_clob_tab
     VALUES(100, '<?xml version="1.0"?>
                    <PO pono="1">
                       <PNAME>Po_1</PNAME>
                       <CUSTNAME>John</CUSTNAME>
                       <SHIPADDR>
                         <STREET>1033, Main Street</STREET>
                         <CITY>Sunnyvalue</CITY>
                         <STATE>CA</STATE>
                       </SHIPADDR>
                    </PO>');
```

Now you can insert a purchase order XML document into table, po_xml_tab by simply creating an XML instance from the CLOB data stored in the other po_clob_tab,

```
INSERT INTO po_xml_tab
       SELECT poid, sys.XMLType.createXML(poClob)
       FROM po_clob_tab;
```

Note that we could have gotten the clob value from any expression including functions which can create temporary CLOBs or select out CLOBs from other table or views.

XMLType Insert Example 2 - Using createXML() with string

This example inserts a purchase order into table, po_tab using the createXML() construct.

```
insert into po_xml_tab
```

```
VALUES(100, sys.XMLType.createXML('<?xml version="1.0"?>
                 <PO pono="1">
                    <PNAME>Po_1</PNAME>
                    <CUSTNAME>John</CUSTNAME>
                    <SHIPADDR>
                      <STREET>1033, Main Street</STREET>
                      <CITY>Sunnyvalue</CITY>
                      <STATE>CA</STATE>
                    </SHIPADDR>
                 </PO>'));
```

Here the XMLType was created using the createXML function by passing in a string literal.

XMLType Insert Example 3 - Using SYS_XMLGEN()

This example inserts PurchaseOrder into table, po_xml_tab by generating it using the SYS_XMLGEN() SQL function which is explained later in this chapter. Assume that the *PO* is an object view that contains a purchase order object. The whole definition of the *PO* view is given in "DBMS_XMLGEN Example 5: Generating a Purchase Order From the Database in XML Format" on page 5-55.

```
INSERT into po_xml_tab
  SELECT SYS_XMLGEN(value(p),
               sys.xmlgenformatType.createFormat('PO'))
  FROM po p
  WHERE p.pono=2001;
```

The SYS_XMLGEN creates an XMLType from the purchase order object which is then inserted into the po_xml_tab table.

Updating XML Data in XMLType Columns

You can only update the whole XML document. You can perform the update in SQL, PL/SQL, or Java.

See also "XMLType Java Example 4: Updating an Element in XMLType Column" on page 5-36, for updating XMLType through Java.

XMLType Update Example 1 — Updating Using createXML()

This example updates the XMLType using the createXML() construct. It updates only those documents whose purchase order number is 2001.

```
update po_xml_tab e
```

```
set  e.poDoc = sys.XMLType.createXML(
'<?xml version="1.0"?>
<PO pono="2">
   <PNAME>Po_2</PNAME>
   <CUSTNAME>Nance</CUSTNAME>
   <SHIPADDR>
      <STREET>2 Avocet Drive</STREET>
      <CITY>Redwood Shores</CITY>
      <STATE>CA</STATE>
   </SHIPADDR>
</PO>')
WHERE e.po.extract('/PO/PONO/text()').getNumberVal() = 2001;
```

Note: UPDATEs, currently are supported only at the document level. So to update a piece of a particular document, you have to update the entire document.

Deleting XML Data

DELETEs on the row containing the `XMLType` column are handled in the same way as for any other datatype.

XMLType Delete Example 1 — Deleting Rows Using extract

For example, to delete all purchase order rows with a purchase order name of “Po_2”, you can execute a statement such as:

```
DELETE from po_xml_tab e
WHERE e.poDoc.extract('/PO/PNAME/text()').getStringVal()='Po_2';
```

Using XMLType Inside Triggers

You can use the NEW and OLD binds inside triggers to read and modify the `XMLType` column values. In the case of INSERTs and UPDATE statements, you can modify the NEW value to change the value being inserted.

XMLType Trigger Example 1 -

For instance, you can write a trigger to change the purchase order to be a different one if it does not contain a shipping address.

```
CREATE OR REPLACE TRIGGER po_trigger
    BEFORE insert or update on po_xml_tab for each row
```

```
  pono Number;
begin

   if INSERTING then
     if :NEW.poDoc.existsnode('//SHIPADDR') = 0 then
      :NEW.poDoc := sys.xmltype.createxml('<PO>INVALID_PO</PO>'); end if;
     end if;

     -- when updating, if the old poDoc has purchase order number
     -- different from the new one then make it an invalid PO.
     if UPDATING then

        if :OLD.poDoc.extract('//PONO/text()').getNumberVal() !=
            :NEW.poDoc.extract('//PONO/text()').getNumberVal() then

          :NEW.poDoc := sys.xmltype.createXML('<PO>INVALID_PO</PO>');
        end if;
     end if;
end;
/
```

This example is only for illustration purposes. You can use the `XMLType` value to perform useful operations inside the trigger, such as validation of business logic or rules that the XML document should conform to, auditing, and so on.

Selecting and Querying XML Data

You can query XML Data from `XMLType` columns in the following ways:

- By selecting `XMLType` columns through SQL, PL/SQL, or Java.
- By querying `XMLType` columns directly and using `extract()` and/or `existsNode()`.
- By using Text operators to query the XML content

Selecting XML data

You can select the `XMLType` data through PL/SQL or Java. You can also use the getClobVal(), getStringVal() or getNumberVal() functions to get out the XML as a CLOB, varchar or a number respectively.

XMLType Query Example 1 — Retrieve an XML Document as a CLOB

This example shows how to select an `XMLType` column through SQL*Plus

```
set long 2000

select e.poDoc.getClobval() AS poXML
from po_xml_tab e;

POXML
---------------------
<?xml version="1.0"?>
<PO pono="2">
   <PNAME>Po_2</PNAME>
   <CUSTNAME>Nance</CUSTNAME>
   <SHIPADDR>
      <STREET>2 Avocet Drive</STREET>
      <CITY>Redwood Shores</CITY>
      <STATE>CA</STATE>
   </SHIPADDR>
</PO>
```

Querying XML data

We can query the `XMLType` data and extract portions of it using the ExistsNode and Extract functions. Both these functions use a limited set of the W3C standard XPath to navigate the document.

Using XPath Expressions for Searching

XPath is a W3C standard way to navigate XML documents. XPath models the XML document as a tree of nodes. It provides a rich set of operations to “walk” the tree and to apply predicates and node test functions. Applying an XPath expression to an XML document can result in a set of nodes. For instance, /PO/PONO selects out all the “PONO” child elements under the “PO” root element of the document.

Here are some of the common constructs used in XPath:-

The “/” denotes the root of the tree in an XPath expression. e.g. /PO refers to the child of the root node whose name is “PO”.

The “/” is also used as a path separator to identify the children node of any given node. e.g. /PO/PNAME identifies the purchase order name element which is a child of the root element.

The “//” is used to identify all descendants of the current node. e.g. PO//ZIP matches any zip code element under the “PO” element.

The “*” is used as a wildcard to match any child node. e.g. /PO/*/STREET would match any street element that is a grandchild of the “PO” element.

The [ ] are used to denote predicate expressions. XPath supports a rich list of binary operators such as OR, AND and NOT. e.g. /PO[PONO=20 and PNAME=”PO_2”]/SHIPADDR selects out the shipping address element of all purchase orders, whose purchase order number is 20 and whose purchase order name is “PO_2”

The [ ] is also used for denoting an index into a list. For instance, /PO/PONO[2] identifies the second purchase order number element under the "PO" root element.

Supported XPath constructs

Oracle’s Extract and ExistsNode functions support a limited set of XPath expressions. XPath constructs supported in this release are:

- Child traversals /PO/SHIPADDR/STREET
- Attribute traversals /PO/@PONO
- Index access /PO/PONO[2]
- Wild card searches /PO/*/STREET
- Descendant searches PO//STREET
- Node text functions - /PO/PNAME/text()

Only the non-order dependant axes such as the child, descendant axes are supported. No sibling or parent axes are supported.

Note: Extract and ExistsNode functions do not yet support multi-byte character sets.

Predicates are Not Supported For this release, `XMLType` does not support any predicates. If you need predicate support, you can rewrite the function into multiple functions with the predicates expressed in SQL, when possible.

Finally, the XPath must identify a single or a set of element, text or attribute nodes. The result of the XPath cannot be a boolean expression.

existsNode() Function with XPath

The `ExistsNode` function on `XMLType`, checks if the given XPath evaluation results in at least a single XML element or text node. If so, it returns the numeric value 1 otherwise it returns a 0. For example, consider an XML document such as:

```
<PO>
  <PONO>100</PONO>
  <PNAME>Po_1</PNAME>
  <CUSTOMER CUSTNAME="John"/>
  <SHIPADDR>
    <STREET>1033, Main Street</STREET>
    <CITY>Sunnyvalue</CITY>
    <STATE>CA</STATE>
  </SHIPADDR>
</PO>
```

An XPath expression such as /PO/PNAME, results in a single node and hence the ExistsNode will return true for that XPath. This is the same with /PO/PNAME/text() which results in a single text node. The XPath, /PO/@pono also returns a value.

An XPath expression such as, /PO/POTYPE does not return any nodes and hence an ExistsNode on this would return the value 0.

Hence, the `ExistsNode()` member function can be directly used in the following ways:

- In queries as will be shown in the next few examples
- To create functional indexes to speed up evaluation of queries

Extract Function with XPath

The `Extract` function on `XMLType`, extracts the node or a set of nodes from the document identified by the XPath expression. The extracted nodes may be elements, attributes or text nodes. When extracted out all text nodes are collapsed into a single text node value.

The `XMLType` resulting from applying an XPath through Extract need not be a well-formed XML document but can contain a set of nodes or simple scalar data in some cases. You can use the `getStringVal()` or `getNumberVal()` methods on `XMLType` to extract this scalar data.

For example, the XPath expression /PO/PNAME identifies the PNAME element inside the XML document shown above. The expression /PO/PNAME/text() on the other hand refers to the text node of the PNAME element. Note that the latter is still considered an `XMLType`. In other words, *EXTRACT(poDoc, '/PO/PNAME/text()')* still returns an `XMLType` instance though the instance may actually contain only text. You can use the getStringVal() to get the text value out as a VARCHAR2 result.

Use the text() node test function to identify text nodes in elements before using the getStringVal() or getNumberVal() to convert them to SQL data. Not having the text() node would produce an XML fragment. For example, the XPath expression */PO/PNAME* identifies the fragment <PNAME>PO_1</PNAME> whereas the expression */PO/PNAME/text()* identifies the text value "PO_1".

You can use the index mechanism to identify individual elements in case of repeated elements in an XML document. For example if we had an XML document such as,

```
<PO>
  <PONO>100</PONO>
  <PONO>200</PONO>
</PO>
```

you can use //PONO[1] to identify the first "PONO" element (with value 100) and //PONO[2] to identify the second "PONO" element in the document.

The result of the extract is always an `XMLType`. If applying the XPath produces an empty set, then the Extract returns a NULL value.

Hence, the `extract()` member function can be used in a number of ways, including the following:

- Extracting numerical values on which functional indexes can be created to speed up processing
- Extracting collection expressions to be used in the FROM clause of SQL statements
- Extracting fragments to be later aggregated to produce different documents

XMLType Query Example 2 — Using extract() and existsNode()

Assume the po_xml_tab table which contains the purchase order id and the purchase order XML columns - and assume that the following values are inserted into the table,

```
INSERT INTO po_xml_tab values (100,
   sys.xmltype.createxml('<?xml version="1.0"?>
                          <PO>
                            <PONO>221</PONO>
                            <PNAME>PO_2</PNAME>
                          </PO>'));

INSERT INTO po_xml_tab values (200,
   sys.xmltype.createxml('<?xml version="1.0"?>
                          <PO>
```

```
                                                    <PONAME>PO_1</PONAME>
                                                  </PO>'));
```

Now we can extract the numerical values for the purchase order numbers using the EXTRACT function.

```
SELECT e.poDoc.extract('//PONO/text()').getNumberVal() as pono
FROM po_xml_tab e
WHERE e.podoc.existsnode('/PO/PONO')  = 1 AND poid > 1;
```

Here `extract()` extracts the contents of tag, purchase order number, "PONO". `existsnode()` finds those nodes where there exists "PONO" as a child of "PO".

Note the use of the text() function to return only the text nodes. The getNumberVal() function can convert only text values into numerical quantity.

See Also: "XMLType Functions" on page 5-13.

XMLType Query Example 3 — Querying Transient XMLType data

The following example shows how you can select out the XML data and query it inside PL/SQL.

```
-- create a transient instance from the purchase order table and then
perform some extraction on it...
declare
   poxml SYS.XMLType;
   cust SYS.XMLType;
  val VARCHAR2;
begin

 -- select the adt instance
  select poDoc into poxml
     from po_xml_tab p where p.poid = 100;

  -- do some traversals and print the output
  cust := poxml.extract('//SHIPADDR');

   -- do something with the customer XML fragment
  val := cust.getStringVal();
  dbms_output.put_line(' The customer XML value is '|| val);

end;
/
```

XMLType Query Example 4 — Extracting data from XML

The following example shows how you can extract out data from a purchase order XML and insert it into a SQL relation table.

Assume the following relational tables,

```
CREATE TABLE cust_tab
(
  custid number primary key,
  custname varchar2(20)
);

insert into cust_tab values (1001, "John Nike");

CREATE table po_rel_tab
(
  pono number,
  pname varchar2(100),
  custid number refernces cust_tab
  shipstreet varchar2(100),
  shipcity varchar2(30),
  shipzip varchar2(20)
);
```

You can write a simple PL/SQL block to transform any XML of the form,

```
<?xml version = '1.0'?>
<PO>
  <PONO>2001</PONO>
  <CUSTOMER CUSTNAME="John Nike"/>
  <SHIPADDR>
    <STREET>323 College Drive</STREET>
    <CITY>Edison</CITY>
    <STATE>NJ</STATE>
    <ZIP>08820</ZIP>
  </SHIPADDR>
</PO>
```

into the relational tables, using the Extract functions.

Here is a SQL example, (assuming that the XML described above is present in the po_xml_tab) -

```
insert into po_rel_tab as
select p.poDoc.extract('/PO/PONO/text()').getnumberval(),
       p.poDoc.extract('/PO/PNAME/text()').getstringval(),
       -- get the customer id corresponding to the customer name
       ( SELECT custid
         FROM   cust_tab c
         WHERE  c.custname =
               p.poDoc.extract('/PO/CUSTOMER/@CUSTNAME').getstringval()
        ),
       p.poDoc.extract('/PO/SHIPADDR/STREET/text()').getstringval(),
       p.poDoc.extract('//CITY/text()').getstringval(),
       p.poDoc.extract('//ZIP/text()').getstringval(),

from po_xml_tab p;


The po_tab would now have the following values,

PONO    PNAME   CUSTID   SHIPSTREET         SHIPCITY   SHIPZIP
----------------------------------------------------------------
2001            1001     323 College Drive  Edison     08820
```

Note how the PNAME is null, since the input XML document did not have the element called PNAME under PO. Also, note that we have used the //CITY to search for the city element at any depth.

We can do the same in an equivalent fashion inside a PL/SQL block-

```
declare
  poxml SYS.XMLType;
  cname varchar2(200);
  pono number;
  pname varchar2(100);
  shipstreet varchar2(100);
  shipcity varchar2(30);
  shipzip varchar2(20);

begin

 -- select the adt instance
  select poDoc into poxml from po_xml_tab p;

  cname := poxml.extract('//CUSTOMER/@CUSTNAME').getstringval();

  pono := poxml.extract('/PO/PONO/text()').getnumberval(),
  pname := poxml.extract('/PO/PNAME/text()').getstringval(),
  shipstreet := poxml.extract('/PO/SHIPADDR/STREET/text()').getstringval(),
  shipcity := poxml.extract('//CITY/text()').getstringval(),
  shipzip := poxml.extract('//ZIP/text()').getstringval(),

  insert into po_rel_tab
    values (pono, pname,
           (select custid from cust_tab c where custname = cname),
            shipstreet, shipcity, shipzip);
end;
/
```

XMLType Query Example 5 — Using extract() to Search

Using Extract, Existsnode functions, you can perform a variety of operations on the column, as follows:

```
select e.poDoc.extract('/PO/PNAME/text()').getStringVal() PNAME
from po_xml_tab e
where e.poDoc.existsNode('/PO/SHIPADDR') = 1 and
      e.poDoc.extract('//PONO/text()').getNumberVal() = 300 and
      e.poDoc.extract('//@CUSTNAME').getStringVal() like '%John%';
```

This SQL statement extracts the purchase order name “PNAME” from the purchase order element PO, from all the documents which contain a shipping address and whose purchase order number is 300 and the customer name “CUSTNAME” contains the string “John”.

XMLType Query Example 6 — Extract fragments from XMLType

The `extract()` member function *extracts* the nodes identified by the XPath expression and returns an `XMLType` containing the fragment. Here, the result of the traversal may be a set of nodes, a singleton node, or a text value. You can check if the result is a fragment by using the `isFragment()` function on the `XMLType`. For example:

```
select e.po.extract('/PO/SHIPADDR/STATE').isFragment()
    from po_xml_tab e;
```

Note: You cannot insert fragments into XMLType columns. You can use the SYS_XMLGEN function to convert a fragment into a well formed document by adding an enclosing tag. See "SYS_XMLGEN" on page 5-63.You can, however, query further on the fragment using the various XMLType functions.

The previous SQL statement would return 0, since the extraction /PO/SHIPADDR/STATE returns a singleton well formed node which is not a fragment.

On the other hand, an XPath such as, /PO/SHIPADDR/STATE/text() would be considered a fragment, since it is not a well-formed XML document.

Querying XMLType Data using Text Operators

Oracle Text index works on CLOB and VARCHAR columns. It has been extended in Oracle9i to work on XMLType columns as well. The default behavior of Oracle Text index is to automatically create XML sections, when defined over XMLType columns. It also provides the CONTAINS operator which has been extended to support XPath.

Creating Text index over XMLType columns

Text index can be created by using the CREATE INDEX with the INDEXTYPE specification as with other CLOB or VARCHAR columns. However, since the XMLType is implemented as a virtual column, the text index is created using the functional index mechanism.

This requires that to create and use the text index in queries, in additional to having the privileges to create indexes and the privileges necessary to create text indexes, you would need to also need to have the privileges and settings necessary to create functional indexes. This includes

- QUERY_REWRITE privilege - You must have this privilege granted to create text indexes on XMLType columns in your own schema. If you need to create text indexes on XMLType columns in other schemas or on tables residing in other schemas, you must have the GLOBAL_QUERY_REWRITE privilege granted.
- QUERY_REWRITE_ENABLED parameter must be set to true.

- QUERY_REWRITE_INTEGRITY must be set to trusted for the queries to be rewritten to use the text index.

  See Also:

  - Chapter 8, "Searching XML Data with Oracle Text"
  - *Oracle Text Reference*
  - *Oracle Text Application Developer's Guide*

Differences between CONTAINS and ExistsNode/Extract

There are certain differences with regard to the XPath support inside CONTAINS and that supported through the `ExistsNode and Extract` functions.

- In this release, the XPath supported by the Oracle Text index is more powerful than the functional implementation, as it can satisfy certain equality predicates as well
- Since Oracle Text index ignores spaces, the XPath expression may not yield accurate results when spaces are significant.
- Oracle Text index also supports certain predicate expressions with string equality, but cannot support numerical and range comparisons.
- One other limitation is that the Oracle Text index may give wrong result if the XML document only has tag names and attribute names without any text. For example in the case of the following document,

  ```
  <A>
    <B>
        <C>
        </C>
    </B>
    <D>
        <E>
        </E>
     </D>
   </A>
  ```

  the XPath expression - A/B/E will falsely match the above XML document.
- Both the functional and the Oracle Text index support navigation. Thus you can use the text index as a primary filter, to filer out all the documents that can potentially match the criterion in an efficient manner, and then apply secondary

filters such as `existsNode()` or `extract()` operations on the remainder of the documents.

Indexing XMLType columns

We can create the following indexes using `XMLType` to speed up query evaluation.

- *Functional Indexes with XMLType.* Queries can be speeded up by building functional indexes on the ExistsNode or the Extracted portions of an XML document.

  Example of Functional Indexes on Extract operation:

  For instance to speed up the search on the query,

```
SELECT * FROM po_xml_tab e
WHERE e.poDoc.extract('//PONO/text()').getNumberVal()= 100;
```

  we can create a functional index on the Extract function as:

```
CREATE INDEX city_index ON po_xml_tab
   (poDoc.extract('//PONO/text()').getNumberVal());
```

  With this index, the SQL query would use the functional index to evaluate the predicate instead of parsing the XML document per row and evaluating the XPath expression.

  Example of Functional indexes on ExistsNode:

  We can also create bitmapped functional indexes to speed up the evaluation of the operators. In particular, the ExistsNode is best suited, since it returns a value of 1 or 0 depending on whether the XPath is satisfied in the document or not.

  For instance to speed up the query, that searches for whether the XML document contains an element called Shipping address at any level -

```
SELECT * FROM po_xml_tab e
WHERE e.poDoc.existsNode('//SHIPADDR') = 1;
```

  we can create a bitmapped functional index on the ExistsNode function as:

```
CREATE INDEX po_index ON po_xml_tab
   (poDoc.existsNode('//SHIPADDR'));
```

  to speed up the query processing.

- *Creating Text Indexes on XMLType Columns.* As explained earlier, you can create text indexes on the XMLType column. The index uses the PATH_SECTION_GROUP as the default section group when indexing XMLType columns. This is the default and can be overridden during index creation.

  ```
  CREATE INDEX po_text_index ON
      po_xml_tab(poDoc) indextype is ctxsys.context;
  ```

  You can do text operations such as CONTAINS and SCORE.. on this XMLType column. In Oracle9i CONTAINS function has been enhanced to support XPath using two new operators, INPATH and HASPATH.

  INPATH checks if the given word appears within the path specified and HASPATH checks if the given XPath is present in the document.

  ```
  SELECT * FROM po_xml_doc  w
  WHERE CONTAINS(w.poDoc,
                'haspath(/PO[./@CUSTNAME="John Nike"])') > 0;
  ```

Java Access to XMLType (oracle.xdb.XMLType)

XMLType can be accessed through the oracle.xdb.XMLType class in Java. The class provides functions similar to the XMLType in PL/SQL. The oracle.xdb.XMLType is a subclass of Oracle JDBC's *oracle.sql.OPAQUE* class.

Since the XMLType in the server is implemented as an opaque type, you would need to use the *getOPAQUE* call in JDBC to get the opaque type instance from the JDBC Resultset and then create an XMLType instance out of it. In future releases, JDBC would instantiate XMLTypes automatically.

You can bind XMLType to any XML data instance in JDBC using the *setObject* call in the *java.sql.PreparedStatement* interface.

The functions defined in the oracle.xdb.XMLType class help to retrieve the XML data in Java. Use the SQL functions to perform any queries etc.

XMLType Java Example 1: Selecting XMLType data in Java

You can select the XMLType in java in one of 2 ways,

- Use the getClobVal() or getStringVal() in SQL and get the result as a oracle.sql.CLOB or java.lang.String in Java. Here is a snippet of Java code that shows how to use this,

```
 DriverManager.registerDriver(new oracle.jdbc.driver.OracleDriver());

 Connection conn =
    DriverManager.getConnection("jdbc:oracle:oci8:@", "scott", "tiger");

 OraclePreparedStatement stmt =
    (OraclePreparedStatement) conn.prepareStatement(
          "select e.poDoc.getClobVal() poDoc, "+
                  e.poDoc.getStringVal() poString "+
          " from po_xml_tab e");

ResultSet rset = stmt.executeQuery();
OracleResultSet orset = (OracleResultSet) rset;

// the first argument is a CLOB
oracle.sql.CLOB clb = orset.getCLOB(1);

// the second argument is a string..
String poString = orset.getString(2);

// now use the CLOB inside the program..
```

- Use the getOPAQUE() call in the PreparedStatement to get the whole XMLType instance and use the `XMLType` constructor to construct an oracle.xdb.`XMLType` class out of it. Then you can use the Java functions on the `XMLType` class to access the data.

```
import oracle.xdb.XMLType;
...

 OraclePreparedStatement stmt =
    (OraclePreparedStatement) conn.prepareStatement(
          "select e.poDoc from po_xml_tab e");

ResultSet rset = stmt.executeQuery();
OracleResultSet orset = (OracleResultSet) rset;

// get the XMLType
XMLType poxml = XMLType(orset.getOPAQUE(1));

// get the XML as a string...
String poString = poxml.getStringVal();
```

XMLType Java Example 2: Updating XMLType Data in Java

You can insert an XMLType in java in one of 2 ways,

- Bind a CLOB or a string to an insert/update/delete statement and use the createXML() constructor inside SQL to construct the XML instance,

```
 OraclePreparedStatement stmt =
    (OraclePreparedStatement) conn.prepareStatement(
        "update po_xml_tab set poDoc = sys.XMLType.createXML(?) ");

// the second argument is a string..
String poString = "<PO><PONO>200</PONO><PNAME>PO_2</PNAME></PO>";

// now bind the string..
stmt.setString(1,poString);
stmt.execute();
```

- Use the setObject() (or setOPAQUE()) call in the PreparedStatement to set the whole XMLType instance.

```
import oracle.xdb.XMLType;
...
OraclePreparedStatement stmt =
    (OraclePreparedStatement) conn.prepareStatement(
        "update po_xml_tab set poDoc = ? ");

// the second argument is a string..
String poString = "<PO><PONO>200</PONO><PNAME>PO_2</PNAME></PO>";
XMLType poXML = XMLType.createXML(conn, poString);

// now bind the string..
stmt.setObject(1,poXML);
stmt.execute();
```

XMLType Java Example 3: Getting Metadata on XMLType

When selecting out XMLType values, JDBC describes the column as an OPAQUE type. You can select the column type name out and compare it with “XMLTYPE” to check if you are dealing with an XMLType,

```
import oracle.sql.*;
import oracle.jdbc.*;
...
OraclePreparedStatement stmt =
    (OraclePreparedStatement) conn.prepareStatement(
        "select poDoc from po_xml_tab");

OracleResultSet rset = (OracleResultSet)stmt.exuecuteQuery();

// Now, we can get the resultset metadata
OracleResultSetMetaData mdata =
        (OracleResultSetMetaData)rset.getMetaData();

// Describe the column = the column type comes out as OPAQUE
// and column type name comes out as SYS.XMLTYPE
if (mdata.getColumnType(1) == OracleTypes.OPAQUE &&
    mdata.getColumnTypeName(1).oompareTo("SYS.XMLTYPE") == 0)
{
   // we know it is an XMLtype..
}
```

Table 5–4 Summary of oracle.xdb.XMLType Member and Static Functions

Functions	Syntax Summary	Description
`XMLType()` (constructor)	PUBLIC oracle.xdb. XMLType(oracle.sql.OPAQUE opt)	Constructor to create the `oracle.xdb.XMLType` instance from an opaque instance. Currently, JDBC returns the `XMLType` data as an oracle.sql.OPAQUE instance. Use this constructor to construct an `XMLType` from the opaque instance. PARAMETERS: opq (IN) - A valid opaque instance.
`createXML()`	PUBLIC STATIC oracle.xdb.XMLType createXML(Connection conn, String xmlval)	Static function to create the `oracle.xdb.XMLType` instance from a string. Does not checks for well-formed XML value. Any database operation on the XML value would check for well-formedness. PARAMETERS: conn (IN) - A valid Oracle Connection xmlval (IN) - A Java string containing the XML value. RETURNS: An oracle.xdb.`XMLType` instance.
`createXML()`	PUBLIC STATIC oracle.xdb.XMLType createXML(Connection conn, oracle.sql.clob xmlVal)	Static function to create the `XMLType` instance from an oracle.sql.CLOB. Does not check for well-formedness. Any database operation would check for that. PARAMETERS: conn (IN) - A valid Oracle Connection. xmlval (IN) - CLOB containing the XML document RETURNS: An oracle.xdb.`XMLType` instance.
`getClobVal()`	PUBLIC oracle.sql.CLOB getClobVal()	Gets the document as a oracle.sql.CLOB. RETURNS: A CLOB containing the serialized XML representation. Free the temporary CLOB after use.
`getStringVal()`	PUBLIC java.lang.String getStringVal()	Gets the XML value as a string. RETURNS: A string containing the serialized XML representation, or in case of text nodes, the text itself.

XMLType Java Example 4: Updating an Element in XMLType Column

This example updates the “DISCOUNT” element inside PurchaseOrder stored in a `XMLType` column. It uses Java (JDBC) and the `oracle.xdb.XMLType` class. This example also shows you how to insert/update/delete `XMLType`s using Java (JDBC).

It uses the parser to update an in-memory DOM tree and write the updated XML value to the column.

```
-- create po_xml_hist table to store old PurchaseOrders
create table po_xml_hist (
 xpo sys.xmltype
);

/*
   DESCRIPTION
    Example for oracle.xdb.XMLType

   NOTES
   Have classes12.zip, xmlparserv2.jar, and oraxdb.jar in CLASSPATH

*/

import java.sql.*;
import java.io.*;

import oracle.xml.parser.v2.*;
import org.xml.sax.*;
import org.w3c.dom.*;

import oracle.jdbc.driver.*;
import oracle.sql.*;

import oracle.xdb.XMLType;

public class tkxmtpje
{

  static String conStr = "jdbc:oracle:oci8:@";
  static String user = "scott";
  static String pass = "tiger";
  static String qryStr =
        "SELECT x.poDoc from po_xml_tab x "+
        "WHERE  x.poDoc.extract('/PO/PONO/text()').getNumberVal()=200";


 static String updateXML(String xmlTypeStr)
  {
     System.out.println("\n===============================");
     System.out.println("xmlType.getStringVal():");
     System.out.println(xmlTypeStr);
     System.out.println("===============================");
     String outXML = null;
     try{
        DOMParser parser  = new DOMParser();
        parser.setValidationMode(false);
        parser.setPreserveWhitespace (true);

        parser.parse(new StringReader(xmlTypeStr));
        System.out.println("xmlType.getStringVal(): xml String is well-formed");

        XMLDocument doc = parser.getDocument();

        NodeList nl = doc.getElementsByTagName("DISCOUNT");

        for(int i=0;i<nl.getLength();i++){
           XMLElement discount = (XMLElement)nl.item(i);
           XMLNode textNode = (XMLNode)discount.getFirstChild();
           textNode.setNodeValue("10");
        }

       StringWriter sw = new StringWriter();
       doc.print(new PrintWriter(sw));

       outXML = sw.toString();

      //print modified xml
       System.out.println("\n===============================");
       System.out.println("Updated PurchaseOrder:");
       System.out.println(outXML);
       System.out.println("===============================");
      }
    catch ( Exception e )
    {
      e.printStackTrace(System.out);
    }
    return outXML;
  }

 public static void main(String args[]) throws Exception
  {
    try{

        System.out.println("qryStr="+ qryStr);

        DriverManager.registerDriver(new oracle.jdbc.driver.OracleDriver());
```

```
Connection conn =
  DriverManager.getConnection("jdbc:oracle:oci8:@", user, pass);

Statement s = conn.createStatement();
OraclePreparedStatement stmt;

ResultSet rset = s.executeQuery(qryStr);
OracleResultSet orset = (OracleResultSet) rset;

while(orset.next()){

//retrieve PurchaseOrder xml document from database
 XMLType xt = XMLType.createXML(orset.getOPAQUE(1));

 //store this PurchaseOrder in po_xml_hist table
 stmt = (OraclePreparedStatement)conn.prepareStatement(
           "insert into po_xml_hist values(?)");

 stmt.setObject(1,xt);  // bind the XMLType instance
 stmt.execute();

 //update "DISCOUNT" element
 String newXML = updateXML(xt.getStringVal());

 // create a new instance of an XMLtype from the updated value
 xt = XMLType.createXML(conn,newXML);

// update PurchaseOrder xml document in database
 stmt = (OraclePreparedStatement)conn.prepareStatement(
   "update po_xml_tab x set x.poDoc =? where "+
     "x.poDoc.extract('/PO/PONO/text()').getNumberVal()=200");

 stmt.setObject(1,xt);  // bind the XMLType instance
 stmt.execute();

 conn.commit();
 System.out.println("PurchaseOrder 200 Updated!");

}

//delete PurchaseOrder 1001
s.execute("delete from po_xml x "+
   "where x.xpo.extract"+
     "('/PurchaseOrder/PONO/text()').getNumberVal()=1001");
```

```
        System.out.println("PurchaseOrder 1001 deleted!");
    }
    catch( Exception e )
    {
      e.printStackTrace(System.out);
    }
  }
}

----------------------
-- list PurchaseOrders
----------------------

set long 20000
set pages 100
select x.xpo.getClobVal()
from po_xml x;
```

Here is the resulting updated purchase order in XML:

```
<?xml version = '1.0'?>
<PurchaseOrder>
  <PONO>200</PONO>
  <CUSTOMER>
   <CUSTNO>2</CUSTNO>
   <CUSTNAME>John Nike</CUSTNAME>
   <ADDRESS>
    <STREET>323 College Drive</STREET>
    <CITY>Edison</CITY>
    <STATE>NJ</STATE>
    <ZIP>08820</ZIP>
   </ADDRESS>
   <PHONELIST>
    <VARCHAR2>609-555-1212</VARCHAR2>
    <VARCHAR2>201-555-1212</VARCHAR2>
   </PHONELIST>
  </CUSTOMER>
  <ORDERDATE>20-APR-97</ORDERDATE>
  <SHIPDATE>20-MAY-97 12.00.00.000000 AM</SHIPDATE>
  <LINEITEMS>
   <LINEITEM_TYP LineItemNo="1">
    <ITEM StockNo="1004">
     <PRICE>6750</PRICE>
     <TAXRATE>2</TAXRATE>
    </ITEM>
    <QUANTITY>1</QUANTITY>
    <DISCOUNT>10</DISCOUNT>
   </LINEITEM_TYP>
   <LINEITEM_TYP LineItemNo="2">
    <ITEM StockNo="1011">
     <PRICE>4500.23</PRICE>
     <TAXRATE>2</TAXRATE>
    </ITEM>
    <QUANTITY>2</QUANTITY>
    <DISCOUNT>10</DISCOUNT>
   </LINEITEM_TYP>
  </LINEITEMS>
  <SHIPTOADDR>
   <STREET>55 Madison Ave</STREET>
   <CITY>Madison</CITY>
   <STATE>WI</STATE>
   <ZIP>53715</ZIP>
  </SHIPTOADDR>
</PurchaseOrder>
```

Installing and Using oracle.xdb.XMLType Class

The oracle.xdb.`XMLType` is available in the *xdb_g*.jar file in the *ORACLE_HOME*/rdbms/jlib where *ORACLE_HOME* refers to the Oracle home directory.

Using oracle.xdb.XMLType inside JServer:

This class is pre-loaded in to the JServer and is available in the SYS schema.

It is not loaded however, if you have upgraded your database from an earlier version. If you need to upload the class into the JServer, you would need to run the *initxdbj.sql* file located in the *ORACLE_HOME*/rdbms/admin directory, while connected as SYS.

Using oracle.xdb.XMLType on the client:

If you need to use the oracle.xdb.`XMLType` class on the client side, then ensure that the xdb_g.jar file is listed in your CLASSPATH environment variable.

Native XML Generation

Oracle9*i* supports native XML generation with the following packages and functions:

- ***DBMS_XMLGEN*** PL/SQL supplied package. Gets XML from SQL queries. This is written in C and linked to the server for enhanced performance.
- SQL functions for getting XML from SQL queries are:
  - ***SYS_XMLGEN*** operates on rows, generating XML documents
  - ***SYS_XMLAGG*** operates on groups of rows, aggregating several XML documents into one

DBMS_XMLGEN

DBMS_XMLGEN creates XML documents from any SQL query by mapping the database query results into XML. It gets the XML document as a CLOB. It provides a "fetch" interface whereby you can specify the maximum rows and rows to skip. This is useful for pagination requirements in web applications. DBMS_XMLGEN also provides options for changing tag names for ROW, ROWSET, and so on.

The parameters of the package can restrict the number of rows retrieved, the enclosing tag names. To summarize, DBMS_XMLGEN PL/SQL package allows you:

- To create an XML document instance from any SQL query and get the document as a CLOB
- A "fetch" interface with maximum rows and rows to skip. For example, the first fetch could retrieve a maximum of 10 rows, skipping the first four. This is useful for pagination in web-based applications.
- Options for changing tag names for ROW, ROWSET, and so on.

See Also: "Generating XML with XSU's OracleXMLQuery" on page 7-2, in Chapter 7, "XML SQL Utility (XSU)", and compare the functionality of OracleXMLQuery with DBMS_XMLGEN.

Sample Query Result

The following shows a sample result from executing the "select * from scott.emp" query on a database:

```
<?xml version="1.0"?>
```

```
<ROWSET>
<ROW>
  <EMPNO>30</EMPNO>
  <ENAME>Scott</ENAME>
  <SALARY>20000</SALARY>
</ROW>
<ROW>
  <EMPNO>30</EMPNO>
  <ENAME>Mary</ENAME>
  <AGE>40</AGE>
</ROW>
</ROWSET>
```

The result of the `getXML()` using `DBMS_XMLGen` package is a CLOB. The default mapping is as follows:

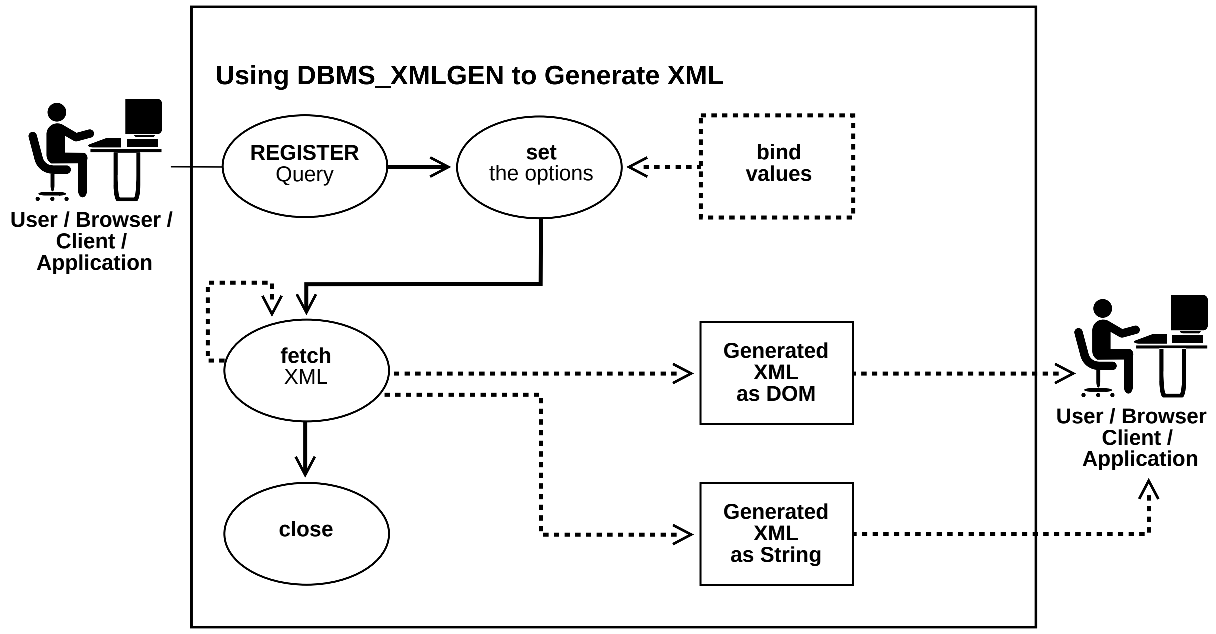
- Every row of the query result maps to an XML element with the default tag name “ROW”.
- The entire result is enclosed in a “ROWSET” element. These names are both configurable, using the `setRowTagName()` and `setRowSetTagName()` procedures in `DBMS_XMLGEN`.
- Each column in the SQL query result, maps as a subelement of the ROW element.
- All datatypes other than CURSOR expressions are supported by `DBMS_XMLGEN.` Binary data is transformed to its hexadecimal representation.

As the document is in a CLOB, it has the same encoding as the database character set. If the database character set is SHIFTJIS, then the XML document is SHIFTJIS.

DBMS_XMLGEN Calling Sequence

Figure 5–2 summarizes the `DBMS_XMLGEN` calling sequence.

Figure 5–2 DBMS_XMLGEN Calling Sequence


Using DBMS_XMLGEN to Generate XML
User / Browser / Client / Application
REGISTER Query
set the options
bind values
fetch XML
Generated XML as DOM
Generated XML as String
close
User / Browser Client / Application

Here is DBMS_XMLGEN's calling sequence:

1. Get the context from the package by supplying a SQL query and calling the `newContext()` call.
2. Pass the context to all the procedures/functions in the package to set the various options. For example to set the ROW element's name, use `setRowTag(ctx)`, where ctx is the context got from the previous `newContext()` call.
3. Get the XML result, using the `getXML()`. By setting the maximum rows to be retrieved per fetch using the `setMaxRows()` call, you can call this function repeatedly, getting the maximum number of row set per call. The function returns a null CLOB if there are no rows left in the query.

   `getXML()` always returns an XML document, even if there were no rows to retrieve. If you want to know if there were any rows retrieved, use the function `getNumRowsProcessed()`.

4. You can reset the query to start again and repeat step 3.
5. Close the `closeContext()` to free up any resource allocated inside.

Table 5–5 summarizes `DBMS_XMLGEN` functions and procedures.

Table 5–5 DBMS_XMLGEN Functions and Procedures

Function or Procedure	Description
DBMS_XMLGEN Type definitions SUBTYPE ctxHandle IS NUMBER	The context handle used by all functions. DTD or schema specifications: ▪ NONE CONSTANT NUMBER:= 0; -- supported for this release. ▪ DTD CONSTANT NUMBER:= 1; S ▪ SCHEMA CONSTANT NUMBER:= 2; Can be used in getXML function to specify whether to generate a DTD or XML Schema or none. Only the NONE specification is supported in the getXML functions for this release.
FUNCTION PROTOTYPES newContext()	Given a query string, generate a new context handle to be used in subsequent functions.
FUNCTION newContext(queryString IN VARCHAR2)	Returns a new context PARAMETERS: queryString (IN)- the query string, the result of which needs to be converted to XML RETURNS: Context handle. Call this function first to obtain a handle that you can use in the getXML() and other functions to get the XML back from the result.
setRowTag()	Sets the name of the element separating all the rows. The default name is ROW.
PROCEDURE setRowTag(ctx IN ctxHandle, rowTag IN VARCHAR2);	PARAMETERS: ctx (IN) - the context handle obtained from the newContext call, rowTag (IN) - the name of the ROW element. NULL indicates that you do not want the ROW element to be present. Call this function to set the name of the ROW element, if you do not want the default "ROW" name to show up. You can also set this to NULL to suppress the ROW element itself. Its an error if both the row and the rowset are null and there is more than one column or row in the output.

Table 5–5 DBMS_XMLGEN Functions and Procedures (Cont.)

Function or Procedure	Description
setRowSetTag()	Sets the name of the document's root element. The default name is "ROWSET"
PROCEDURE setRowSetTag(ctx IN ctxHandle, rowSetTag IN VARCHAR2);	PARAMETERS: ctx (IN) - the context handle obtained from the newContext call, rowsetTag (IN) - the name of the document element. NULL indicates that you do not want the ROW element to be present. Call this to set the name of the document root element, if you do not want the default "ROWSET" name in the output. You can also set this to NULL to suppress the printing of this element. However, this is an error if both the row and the rowset are null and there is more than one column or row in the output.
getXML()	Gets the XML document by fetching the maximum number of rows specified. It appends the XML document to the CLOB passed in.
PROCEDURE getXML(ctx IN ctxHandle, clobval IN OUT NCOPY clob, dtdOrSchema IN number:= NONE);	PARAMETERS: ctx (IN) - The context handle obtained from the newContext() call, clobval (IN / OUT) - the clob to which the XML document is to be appended, dtdOrSchema (IN) - whether we should generate the DTD or Schema. This parameter is NOT supported. Use this version of the getXML function, to avoid any extra CLOB copies and if you want to reuse the same CLOB for subsequent calls. This getXML call is more efficient than the next flavor, though this involves that you create the lob locator. When generating the XML, the number of rows indicated by the setSkipRows call are skipped, then the maximum number of rows as specified by the setMaxRows call (or the entire result if not specified) is fetched and converted to XML. Use the getNumRowsProcessed function to check if any rows were retrieved or not.
getXML()	Generates the XML document and return it as a CLOB.

Table 5–5 DBMS_XMLGEN Functions and Procedures (Cont.)

Function or Procedure	Description

FUNCTION
getXML(ctx IN ctxHandle, dtdOrSchema IN number:= NONE)
RETURN clob
	PARAMETERS: ctx (IN) - The context handle obtained from the newContext() call,
	dtdOrSchema (IN) - whether we should generate the DTD or Schema. This parameter is NOT supported.
	RETURNS: A temporary CLOB containing the document.Free the temporary CLOB obtained from this function using the dbms_lob.freetemporary call.

FUNCTION getXMLType(ctx IN ctxHandle, dtdOrSchema IN number:= NONE) RETURN sys.XMLType	PARAMETERS: ctx (IN) - The context handle obtained from the newContext() call, dtdOrSchema (IN) - whether we should generate the DTD or Schema. This parameter is NOT supported. RETURNS: An XMLType instance containing the document.
getNumRowsProcessed()	Gets the number of SQL rows processed when generating the XML using the getXML call. This count does not include the number of rows skipped before generating the XML.
FUNCTION getNumRowsProcessed(ctx IN ctxHandle) RETURN number	PARAMETERS: queryString (IN)- the query string, the result of which needs to be converted to XML RETURNS: This gets the number of SQL rows that were processed in the last call to getXML. You can call this to find out if the end of the result set has been reached. This does not include the number of rows skipped. Use this function to determine the terminating condition if you are calling getXML in a loop. Note that getXML would always generate a XML document even if there are no rows present.
setMaxRows()	Sets the maximum number of rows to fetch from the SQL query result for every invocation of the getXML call.
PROCEDURE setMaxRows(ctx IN ctxHandle, maxRows IN NUMBER);	PARAMETERS: ctx (IN) - the context handle corresponding to the query executed, maxRows (IN) - the maximum number of rows to get per call to getXML. The maxRows parameter can be used when generating paginated results using this utility. For instance when generating a page of XML or HTML data, you can restrict the number of rows converted to XML and then in subsequent calls, you can get the next set of rows and so on. This also can provide for faster response times.

Table 5–5 DBMS_XMLGEN Functions and Procedures (Cont.)

Function or Procedure	Description
setSkipRows()	Skips a given number of rows before generating the XML output for every call to the getXML routine.
PROCEDURE setSkipRows(ctx IN ctxHandle, skipRows IN NUMBER);	PARAMETERS: ctx (IN) - the context handle corresponding to the query executed, skipRows (IN) - the number of rows to skip per call to getXML. The skipRows parameter can be used when generating paginated results for stateless web pages using this utility. For instance when generating the first page of XML or HTML data, you can set skipRows to zero. For the next set, you can set the skipRows to the number of rows that you got in the first case.
setConvertSpecialChars()	Sets whether special characters in the XML data need to be converted into their escaped XML equivalent or not. For example, the "<" sign is converted to &lt;. The default is to perform conversions.
PROCEDURE setConvertSpecialChars(ctx IN ctxHandle, conv IN boolean);	PARAMETERS: ctx (IN) - the context handle to use, conv (IN) - true indicates that conversion is needed. You can use this function to speed up the XML processing whenever you are sure that the input data cannot contain any special characters such as <, >, ", ’ etc. which need to be escaped. Note that it is expensive to actually scan the character data to replace the special characters, particularly if it involves a lot of data. So in cases when the data is XML-safe, then this function can be called to improve performance.
useItemTagsForColl()	Sets the name of the collection elements. The default name for collection elements it he type name itself. You can override that to use the name of the column with the “_ ITEM” tag appended to it using this function.
PROCEDURE useItemTagsForColl(ctx IN ctxHandle);	PARAMETERS: ctx (IN) - the context handle. If you have a collection of NUMBER, say, the default tag name for the collection elements is NUMBER. You can override this behavior and generate the collection column name with the _ITEM tag appended to it, by calling this procedure.
restartQuery()	Restarts the query and generate the XML from the first row again.

Table 5–5 DBMS_XMLGEN Functions and Procedures (Cont.)

Function or Procedure	Description
PROCEDURE restartQuery(ctx IN ctxHandle);	PARAMETERS: ctx (IN) - the context handle corresponding to the current query. You can call this to start executing the query again, without having to create a new context.
closeContext()	Closes a given context and releases all resources associated with that context, including the SQL cursor and bind and define buffers etc.
PROCEDURE closeContext(ctx IN ctxHandle);	PARAMETERS: ctx (IN) - the context handle to close. Closes all resources associated with this handle. After this you cannot use the handle for any other `DBMS_XMLGEN` function call.

DBMS_XMLGEN Example 1: Generating Simple XML

This example creates an XML document by selecting out the employee data from an object-relational table and puts the resulting CLOB into a table.

```
CREATE TABLE temp_clob_tab(result CLOB);

DECLARE
   qryCtx DBMS_XMLGEN.ctxHandle;
   result CLOB;
BEGIN
  qryCtx := dbms_xmlgen.newContext('SELECT * from scott.emp;');

  -- set the row header to be EMPLOYEE
  DBMS_XMLGEN.setRowTag(qryCtx, 'EMPLOYEE');

  -- now get the result
  result := DBMS_XMLGEN.getXML(qryCtx);

  INSERT INTO temp_clob_tab VALUES(result);

  --close context
  closeContext(qryCtx);
END;
/
```

Here is the XML generated from this example:

```
select * from temp_clob_tab;
```

```
RESULT
-----------------------------------
<?xml version=''1.0''?>
<ROWSET>
 <EMPLOYEE>
  <EMPNO>7369</EMPNO>
  <ENAME>SMITH</ENAME>
  <JOB>CLERK</JOB>
  <MGR>7902</MGR>
  <HIREDATE>17-DEC-80</HIREDATE>
  <SAL>800</SAL>
  <DEPTNO>20</DEPTNO>
 </EMPLOYEE>
 <EMPLOYEE>
  <EMPNO>7499</EMPNO>
  <ENAME>ALLEN</ENAME>
  <JOB>SALESMAN</JOB>
  <MGR>7698</MGR>
  <HIREDATE>20-FEB-81</HIREDATE>
  <SAL>1600</SAL>
  <COMM>300</COMM>
  <DEPTNO>30</DEPTNO>
 </EMPLOYEE>
...
</ROWSET>
```

DBMS_XMLGEN Example 2: Generating Simple XML with Pagination

Instead of getting the whole XML for all the rows, we can use the “fetch” interface that the DBMS_XMLGEN provides to retrieve a fixed number of rows each time. This speeds up the response time and also can help in scaling applications which would need to use a DOM API over the result XML - particularly if the number of rows is large.

The following example illustrates how to use `DBMS_XMLGEN` to retrieve results from the scott.emp table:

```
-- create a table to hold the results..!
create table temp_clob_tab ( result clob);

declare
   qryCtx dbms_xmlgen.ctxHandle;
   result CLOB;
begin
```

```
  -- get the query context;
  qryCtx := dbms_xmlgen.newContext('select * from scott.emp');

  -- set the maximum number of rows to be 5,
  dbms_xmlgen.setMaxRows(qryCtx, 5);

  loop
    -- now get the result
    result := dbms_xmlgen.getXML(qryCtx);

    -- if there were no rows processed, then quit..!
    exit when dbms_xmlgen.getNumRowsProcessed(qryCtx) = 0;

    -- do some processing with the lob data..!
    -- Here, we are inserting the results
    -- into a table. You can print the lob out, output it to a stream,
    -- put it in a queure
    -- or do any other processing.
    insert into temp_clob_tab values(result);

  end loop;
  --close context
  closeContext(qryCtx);
end;
/
```

Here, for each set of 5 rows, we would get an XML document.

DBMS_XMLGEN Example 3: Generating Complex XML

Complex XML can be generated using Object types to represent nested structures

```
 CREATE TABLE new_departments (
    department_id   NUMBER PRIMARY KEY,
    department_name VARCHAR2(20)
  );

 CREATE TABLE new_employees (
    employee_id    NUMBER PRIMARY KEY,
    last_name    VARCHAR2(20),
    department_id  NUMBER REFERENCES departments
  );

 CREATE TYPE emp_t AS OBJECT(
    "@employee_id" NUMBER,
     last_name VARCHAR2(20)
  );

 CREATE TYPE emplist_t AS TABLE OF emp_t;

 CREATE TYPE dept_t AS OBJECT(
    "@department_id" NUMBER,
     department_name VARCHAR2(20),
     emplist emplist_t
  );

 qryCtx := dbms_xmlgen.newContext
     ('SELECT dept_t(department_id, department_name,
              CAST(MULTISET
                   (SELECT e.employee_id, e.last_name
                    FROM new_employees e
                    WHERE e.department_id = d.department_id)
                            AS   emplist_t))  AS deptxml
         FROM new_departments d');
DBMS_XMLGEN.setRowTag(qryCtx, NULL);
```

Here is the resulting XML:

```
 <ROWSET>
    <DEPTXML DEPARTMENT_ID="10">
       <DEPARTMENT_NAME>SALES</DEPARTMENT_NAME>
           <EMPLIST>
             <EMP_T EMPLOYEE_ID="30">
               <LAST_NAME>Scott</LAST_NAME>
             </EMP_T>
             <EMP_T EMPLOYEE_ID="31">
               <LAST_NAME>Mary</LAST_NAME>
             </EMP_T>
           </EMPLIST>
       </DEPTXML>
    <DEPTXML DEPARTMENT_ID="20">
    ...
</ROWSET>
```

Now, you can select the LOB data from the temp_clob_Tab table and verify the results. The result looks like the sample result shown in the previous section, "Sample Query Result" on page 5-42.

With relational data, the results are a flat non-nested XML document. To obtain *nested* XML structures, you can use object-relational data, where the mapping is as follows:

- *Object types* map as an XML element
- *Attributes of the type*, map to sub-elements of the parent element

Note: Complex structures can be obtained by using object types and creating object views or object tables. A canonical mapping is used to map object instances to XML.

The @ sign, when used in column or attribute names, is translated into an attribute of the enclosing XML element in the mapping.

DBMS_XMLGEN Example 4: Generating Complex XML #2 - Inputting User Defined Types To Get Nesting in XML Documents

When you input a user-defined type (UDT) value to `DBMS_XMLGEN` functions, the user-defined type gets mapped to an XML document using a canonical mapping. In the canonical mapping, user-defined type's *attributes* are mapped to XML *elements*.

Any attributes with names starting with "@" are mapped to an attribute of the preceding element.

User-defined types can be used to get nesting within the result XML document.

For example, consider the two tables, EMP and DEPT:

```
CREATE TABLE DEPT
(
 deptno number primary key,
 dname varchar2(20)
);

CREATE TABLE EMP
(
  empno number primary key,
  ename varchar2(20),
  deptno number references dept
);
```

Now, to generate a hierarchical view of the data, that is, departments with employees in them, you can define suitable object types to create the structure inside the database as follows:

```
CREATE TYPE EMP_T AS OBJECT
(
  "@empno" number,  -- empno defined as an attribute!
   ename varchar2(20),
);
/
```

You have defined the empno with an @ sign in front, to denote that it must be mapped as an attribute of the enclosing Employee element.

```
CREATE TYPE EMPLIST_T AS TABLE OF EMP_T;
/
CREATE TYPE DEPT_T AS OBJECT
(
  "@deptno" number,
  dname varchar2(20),
  emplist emplist_t
);
    /
```

Department type, DEPT_T, represents the department as containing a list of employees. You can now query the employee and department tables and get the result as an XML document, as follows:

```
declare
   qryCtx dbms_xmlgen.ctxHandle;
   result CLOB;
begin

  -- get the query context;
  qryCtx := dbms_xmlgen.newContext(
     'SELECT
      dept_t(deptno,dname,
               CAST(MULTISET(select empno, ename
                    from emp e
                    where e.deptno = d.deptno) AS emplist_t))) AS deptxml
    FROM dept d');

  -- set the maximum number of rows to be 5,
  dbms_xmlgen.setMaxRows(qryCtx, 5);

  -- set no row tag for this result as we have a single ADT column
  dbms_xmlgen.setRowTag(qryCtx,null);

  loop
    -- now get the result
    result := dbms_xmlgen.getXML(qryCtx);

    -- if there were no rows processed, then quit..!
    exit when dbms_xmlgen.getNumRowsProcessed(qryCtx) = 0;

    -- do whatever with the result..!
  end loop;
end;
/
```

The MULTISET operator treats the result of the subset of employees working in the department as a list and the CAST around it, cast's it to the appropriate collection type. You then create a department instance around it and call the DBMS_XMLGEN routines to create the XML for the object instance. The result is:

```
    <?xml version="1.0"?>
    <ROWSET>
     <DEPTXML deptno="10">
       <DNAME>Sports</DNAME>
       <EMPLIST>
        <EMP_T empno="200">
         <ENAME>John</ENAME>
        </EMP_T>
        <EMP_T empno="300">
         <ENAME>Jack</ENAME>
        </EMP_T>
       </EMPLIST>
     </DEPTXML>
       <DEPTXML deptno="20">
          <!-- .. other columns -->
       </DEPTXML>
     </ROWSET>
```

The default name "ROW" is not present because you set that to NULL. The deptno and empno have become attributes of the enclosing element.

DBMS_XMLGEN Example 5: Generating a Purchase Order From the Database in XML Format

This example uses `DBMS_XMLGEN.getXMLType()` to generate PurchaseOrder in XML format from a relational database using object views.

```
------------------------------------------------------
-- Create relational schema and define Object Views
-- Note: DBMS_XMLGEN Package maps UDT attributes names
--       starting with '@' to xml attributes
------------------------------------------------------
-- Purchase Order Object View Model

-- PhoneList Varray object type
CREATE TYPE PhoneList_vartyp AS VARRAY(10) OF VARCHAR2(20)
/

-- Address object type
CREATE TYPE Address_typ AS OBJECT (
  Street         VARCHAR2(200),
  City           VARCHAR2(200),
  State          CHAR(2),
  Zip            VARCHAR2(20)
  )
/

-- Customer object type
CREATE TYPE Customer_typ AS OBJECT (
  CustNo           NUMBER,
  CustName         VARCHAR2(200),
  Address          Address_typ,
  PhoneList        PhoneList_vartyp
)
/

-- StockItem object type
CREATE TYPE StockItem_typ AS OBJECT (
  "@StockNo"    NUMBER,
  Price      NUMBER,
  TaxRate    NUMBER
)
/

-- LineItems object type
CREATE TYPE LineItem_typ AS OBJECT (
  "@LineItemNo"   NUMBER,
  Item    StockItem_typ,
  Quantity     NUMBER,
  Discount     NUMBER
  )
/
-- LineItems Nested table
CREATE TYPE LineItems_ntabtyp AS TABLE OF LineItem_typ
```

```
/

-- Purchase Order object type
CREATE TYPE PO_typ AUTHID CURRENT_USER AS OBJECT (
  PONO                   NUMBER,
  Cust_ref               REF Customer_typ,
  OrderDate              DATE,
  ShipDate               TIMESTAMP,
  LineItems_ntab         LineItems_ntabtyp,
  ShipToAddr             Address_typ
 )
/

-- Create Purchase Order Relational Model tables

--Customer table
CREATE TABLE Customer_tab(
  CustNo                  NUMBER NOT NULL,
  CustName                VARCHAR2(200) ,
  Street                  VARCHAR2(200) ,
  City                    VARCHAR2(200) ,
  State                   CHAR(2) ,
  Zip                     VARCHAR2(20) ,
  Phone1                  VARCHAR2(20),
  Phone2                  VARCHAR2(20),
  Phone3                  VARCHAR2(20),
  constraint cust_pk PRIMARY KEY (CustNo)
)
ORGANIZATION INDEX OVERFLOW;

-- Purchase Order table
CREATE TABLE po_tab (
   PONo         NUMBER, /* purchase order no */
   Custno       NUMBER constraint po_cust_fk references Customer_tab,
                                 /*  Foreign KEY referencing customer */
   OrderDate    DATE, /*  date of order */
   ShipDate     TIMESTAMP, /* date to be shipped */
   ToStreet     VARCHAR2(200), /* shipto address */
   ToCity       VARCHAR2(200),
   ToState      CHAR(2),
   ToZip        VARCHAR2(20),
   constraint po_pk PRIMARY KEY(PONo)
);

--Stock Table
```

```
CREATE TABLE Stock_tab (
  StockNo      NUMBER constraint stock_uk UNIQUE,
  Price        NUMBER,
  TaxRate      NUMBER
);

--Line Items Table
CREATE TABLE LineItems_tab(
  LineItemNo          NUMBER,
  PONo                NUMBER constraint LI_PO_FK REFERENCES po_tab,
  StockNo             NUMBER ,
  Quantity            NUMBER,
  Discount            NUMBER,
  constraint LI_PK PRIMARY KEY (PONo, LineItemNo)
);

-- create Object Views

--Customer Object View
CREATE OR REPLACE VIEW Customer OF Customer_typ
   WITH OBJECT IDENTIFIER(CustNo)
   AS SELECT c.Custno, C.custname,
             Address_typ(C.Street, C.City, C.State, C.Zip),
             PhoneList_vartyp(Phone1, Phone2, Phone3)
        FROM Customer_tab c;

--Purchase order view
CREATE OR REPLACE VIEW PO OF PO_typ
  WITH OBJECT IDENTIFIER (PONO)
   AS SELECT P.PONo,
             MAKE_REF(Customer, P.Custno),
             P.OrderDate,
             P.ShipDate,
             CAST( MULTISET(
                    SELECT LineItem_typ( L.LineItemNo,
                                  StockItem_typ(L.StockNo,S.Price,S.TaxRate),
                                            L.Quantity, L.Discount)
                     FROM LineItems_tab L, Stock_tab S
                     WHERE L.PONo = P.PONo and S.StockNo=L.StockNo )
                 AS LineItems_ntabtyp),
         Address_typ(P.ToStreet,P.ToCity, P.ToState, P.ToZip)
        FROM PO_tab P;

-- create table with XMLType column to store po in XML format
create table po_xml_tab(
  poid number,
  poDoc SYS.XMLType /* purchase order in XML format */
)
/

--------------------
-- Populate data
-------------------
-- Establish Inventory

INSERT INTO Stock_tab VALUES(1004, 6750.00, 2) ;
INSERT INTO Stock_tab VALUES(1011, 4500.23, 2) ;
INSERT INTO Stock_tab VALUES(1534, 2234.00, 2) ;
INSERT INTO Stock_tab VALUES(1535, 3456.23, 2) ;

-- Register Customers

INSERT INTO Customer_tab
  VALUES (1, 'Jean Nance', '2 Avocet Drive',
         'Redwood Shores', 'CA', '95054',
         '415-555-1212', NULL, NULL) ;

INSERT INTO Customer_tab
  VALUES (2, 'John Nike', '323 College Drive',
         'Edison', 'NJ', '08820',
         '609-555-1212', '201-555-1212', NULL) ;

-- Place Orders

INSERT INTO PO_tab
  VALUES (1001, 1, '10-APR-1997', '10-MAY-1997',
          NULL, NULL, NULL, NULL) ;

INSERT INTO PO_tab
  VALUES (2001, 2, '20-APR-1997', '20-MAY-1997',
         '55 Madison Ave', 'Madison', 'WI', '53715') ;

-- Detail Line Items

INSERT INTO LineItems_tab VALUES(01, 1001, 1534, 12,  0) ;
INSERT INTO LineItems_tab VALUES(02, 1001, 1535, 10, 10) ;
INSERT INTO LineItems_tab VALUES(01, 2001, 1004,  1,  0) ;
INSERT INTO LineItems_tab VALUES(02, 2001, 1011,  2,  1) ;
```

```
-------------------------------------------------------
-- Use DBMS_XMLGEN Package to generate PO in XML format
-- and store SYS.XMLType in po_xml table
-------------------------------------------------------

declare
   qryCtx dbms_xmlgen.ctxHandle;
   pxml SYS.XMLType;
   cxml clob;
begin

  -- get the query context;
  qryCtx := dbms_xmlgen.newContext('
                  select pono,deref(cust_ref) customer,p.OrderDate,p.shipdate,
                         lineitems_ntab lineitems,shiptoaddr
                  from po p'
             );

  -- set the maximum number of rows to be 1,
  dbms_xmlgen.setMaxRows(qryCtx, 1);
  -- set rowset tag to null and row tag to PurchaseOrder
  dbms_xmlgen.setRowSetTag(qryCtx,null);
  dbms_xmlgen.setRowTag(qryCtx,'PurchaseOrder');

  loop
    -- now get the po in xml format
    pxml := dbms_xmlgen.getXMLType(qryCtx);

    -- if there were no rows processed, then quit..!
    exit when dbms_xmlgen.getNumRowsProcessed(qryCtx) = 0;

    -- Store SYS.XMLType po in po_xml table (get the pono out)
    insert into po_xml_tab (poid, poDoc)
       values(
            pxml.extract('//PONO/text()').getNumberVal(),
            pxml);
  end loop;
end;
/

---------------------------
-- list xml PurchaseOrders
---------------------------

set long 100000
set pages 100
select x.xpo.getClobVal() xpo
from   po_xml x;

PurchaseOrder 1001:
```

This produces the following purchase order XML document:

```
<?xml version="1.0"?>
 <PurchaseOrder>
  <PONO>1001</PONO>
  <CUSTOMER>
   <CUSTNO>1</CUSTNO>
   <CUSTNAME>Jean Nance</CUSTNAME>
   <ADDRESS>
    <STREET>2 Avocet Drive</STREET>
    <CITY>Redwood Shores</CITY>
    <STATE>CA</STATE>
    <ZIP>95054</ZIP>
   </ADDRESS>
   <PHONELIST>
    <VARCHAR2>415-555-1212</VARCHAR2>
   </PHONELIST>
  </CUSTOMER>
  <ORDERDATE>10-APR-97</ORDERDATE>
  <SHIPDATE>10-MAY-97 12.00.00.000000 AM</SHIPDATE>
  <LINEITEMS>
   <LINEITEM_TYP LineItemNo="1">
    <ITEM StockNo="1534">
     <PRICE>2234</PRICE>
     <TAXRATE>2</TAXRATE>
    </ITEM>
    <QUANTITY>12</QUANTITY>
    <DISCOUNT>0</DISCOUNT>
   </LINEITEM_TYP>
   <LINEITEM_TYP LineItemNo="2">
    <ITEM StockNo="1535">
     <PRICE>3456.23</PRICE>
     <TAXRATE>2</TAXRATE>
    </ITEM>
    <QUANTITY>10</QUANTITY>
    <DISCOUNT>10</DISCOUNT>
   </LINEITEM_TYP>
  </LINEITEMS>
  <SHIPTOADDR/>
 </PurchaseOrder>

PurchaseOrder 2001:

<?xml version="1.0"?>
 <PurchaseOrder>
  <PONO>2001</PONO>
  <CUSTOMER>
   <CUSTNO>2</CUSTNO>
   <CUSTNAME>John Nike</CUSTNAME>
   <ADDRESS>
    <STREET>323 College Drive</STREET>
    <CITY>Edison</CITY>
    <STATE>NJ</STATE>
    <ZIP>08820</ZIP>
   </ADDRESS>
   <PHONELIST>
    <VARCHAR2>609-555-1212</VARCHAR2>
    <VARCHAR2>201-555-1212</VARCHAR2>
   </PHONELIST>
  </CUSTOMER>
  <ORDERDATE>20-APR-97</ORDERDATE>
  <SHIPDATE>20-MAY-97 12.00.00.000000 AM</SHIPDATE>
  <LINEITEMS>
   <LINEITEM_TYP LineItemNo="1">
    <ITEM StockNo="1004">
     <PRICE>6750</PRICE>
     <TAXRATE>2</TAXRATE>
    </ITEM>
    <QUANTITY>1</QUANTITY>
    <DISCOUNT>0</DISCOUNT>
   </LINEITEM_TYP>
   <LINEITEM_TYP LineItemNo="2">
    <ITEM StockNo="1011">
     <PRICE>4500.23</PRICE>
     <TAXRATE>2</TAXRATE>
    </ITEM>
    <QUANTITY>2</QUANTITY>
    <DISCOUNT>1</DISCOUNT>
   </LINEITEM_TYP>
  </LINEITEMS>
  <SHIPTOADDR>
   <STREET>55 Madison Ave</STREET>
   <CITY>Madison</CITY>
   <STATE>WI</STATE>
```

```
    <ZIP>53715</ZIP>
  </SHIPTOADDR>
</PurchaseOrder>
```

SYS_XMLGEN

Oracle9*i* introduces a new SQL function, `SYS_XMLGEN()`, that generates XML in SQL queries. `DBMS_XMLGEN` and other packages operate at the query level, giving aggregated results for the *entire* query. `SYS_XMLGEN` takes in a *single* argument in an SQL query and converts it (the result) to XML.

`SYS_XMLGEN` takes a scalar value, object type, or `XMLType` instance to be converted to an XML document. It also takes an optional `XMLGenFormatType` object that you can use to specify formatting options for the resulting XML document. `SYS_XMLGEN` returns an `XMLType`.

It is used to create and query XML instances within SQL queries, as follows:

```
SQL> SELECT SYS_XMLGEN(employee_id)
            2  FROM employees WHERE last_name LIKE
             'Scott%';
```

The resulting XML document is:

```
<?xml version=''1.0''?>
<employee_id>60</employee_id>
```

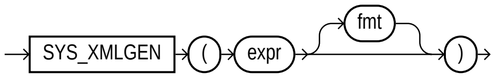
SYS_XMLGEN Syntax

The `SYS_XMLGEN` function takes an expression that evaluates to a particular row and column of the database, and returns an instance of type `XMLType` containing an XML document. See Figure 5–3. The *`expr`* can be a scalar value, a user-defined type, or a `XMLType` instance.

- If *`expr`* is a scalar value, the function returns an XML element containing the scalar value.
- If *`expr`* is a type, the function maps the user-defined type attributes to XML elements.
- If *`expr`* is a `XMLType` instance, then the function encloses the document in an XML element whose default tag name is `ROW`.

By default the elements of the XML document match the elements of *`expr`*. For example, if *`expr`* resolves to a column name, the enclosing XML element will be the same column name. If you want to format the XML document differently, specify *fmt*, which is an instance of the XMLGenFormatType object.

Figure 5–3 SYS_XMLGEN Syntax



The following example retrieves the employee email ID from the sample table oe.employees where the employee_id value is 205, and generates an instance of a XMLType containing an XML document with an EMAIL element.

```
SELECT SYS_XMLGEN(email).getStringVal()
   FROM employees
   WHERE employee_id = 205;

SYS_XMLGEN(EMAIL).GETSTRINGVAL()
----------------------------------------------------------------
<EMAIL>SHIGGENS</EMAIL>
```

Why is SYS_XMLGEN so Powerful?

SYS_XMLGEN() is powerful for the following reasons:

- You can create and query XML instances *within* SQL queries.
- Using the object-relational infrastructure, you can create complex and nested XML instances from simple relational tables.

SYS_XMLGEN() creates an XML document from either of the following:

- A user-defined type (UDT) instance
- A scalar value passed
- XML

and returns an XMLType instance contained in the document.

SYS_XMLGEN() also optionally inputs a *XMLGenFormatType* object type through which you can customize the SQL results. A NULL format object implies that the default mapping behavior is to be used.

XMLGenFormatType Object

`XMLGenFormatType` can be used to specify formatting arguments to `SYS_XMLGEN` and `SYS_XMLAGG` functions. Table 5–6 lists the XMLGenFormatType attributes.

Table 5–6 XMLGenFormatType Attributes

XMLGenFormatType Attribute	Description
enclTag	The name of the enclosing tag to use
schemaType	Not currently supported, but in future will be used to specify how the XMLSchema should be generated.
processingIns	Can specify processing instructions such as stylesheet instructions that need to be appended to the beginning of the document.
schemaName	Will be used for XMLSchema.
dburl	Not used currently.
targetNameSpace	Not used currently, but will be used for XMLSchema generation.

Creating a Formatting Object with createFormat

You can use the static member function *createformat* to create a formatting object. This function has most of the values defaulted. For example:

```
  -- function to create the formatting object..
  STATIC MEMBER FUNCTION createFormat(
       enclTag IN varchar2 := null,
        schemaType IN varchar2 := 'NO_SCHEMA'
        schemaName IN varchar2 := null,
        targetNameSpace IN varchar2 := null,
       dburl IN varchar2 := null,
        processingIns IN varchar2 := null)
   RETURN XMLGenFormatType;
```

SYS_XMLGEN Example 1: Converting a Scalar Value to an XML Document Element's Contents

When you input a scalar value to `SYS_XMLGEN()`, `SYS_XMLGEN()` converts the scalar value to an *element* containing the scalar value. For example:

```
select sys_xmlgen(empno) from scott.emp where rownum < 1;
```

returns an XML document that contains the empno value as an element, as follows:

```
<?xml version="1.0"?>
<EMPNO>30</EMPNO>
```

The enclosing element name, in this case EMPNO, is derived from the column name passed to the operator. Also, note that the result of the SELECT statement is a row containing a `XMLType`.

Note: Currently, SQL*Plus cannot display `XMLType` properly, so you need to extract the LOB value out and display that. Use the `getClobval()` function on the `XMLType` to retrieve the CLOB value. For example,

SELECT sys_xmlgen(empno).getclobval() FROM scott.emp
WHERE rownum < 1;

In the last example, you used the column name "EMPNO" for the document. If the column name cannot be derived directly, then the default name "ROW" is used. For example, in the following case:

```
select sys_xmlgen(empno).getclobval()
from scott.emp
where rownum < 1;
```

you get the following XML output:

```
<?xml version="1.0"?>
<ROW>60</ROW>
```

since the function cannot infer the name of the expression. You can override the default ROW tag by supplying an `XMLGenFormatType` object to the first argument of the operator.

For example, in the last case, if you wanted the result to have EMPNO as the tag name, you can supply a formatting argument to the function, as follows:

```
select sys_xmlgen(empno *2,
     sys.xmlgenformattype.createformat('EMPNO')).getClobVal()
from dual;
```

This results in the following XML:

```
<?xml version="1.0"?>
<EMPNO>60</EMPNO>
```

Note: Currently, CURSOR expressions are not supported as input values.

SYS_XMLGEN Example 2: Converting a User-Defined Type (UDT) to XML

When you input a user-defined type (UDT) value to `SYS_XMLGEN()`, the user-defined type gets mapped to an XML document using a canonical mapping. In the canonical mapping the user-defined type's attributes are mapped to XML elements.

Any type attributes with names starting with “@” are mapped to an attribute of the preceding element.User-defined types can be used to get nesting within the result XML document.

Using the same example as given in the `DBMS_XMLGEN` section ("DBMS_XMLGEN Example 4: Generating Complex XML #2 - Inputting User Defined Types To Get Nesting in XML Documents" on page 5-53), you can generate a hierarchical XML for the employee, department example as follows:

```
SELECT SYS_XMLGEN(
  dept_t(deptno,dname,
        CAST(MULTISET(
            select empno, ename
            from emp e
            where e.deptno = d.deptno) AS emplist_t))).getClobVal()
     AS deptxml
FROM dept d;
```

The MULTISET operator treats the result of the subset of employees working in the department as a list and the CAST around it, cast’s it to the appropriate collection type. You then create a department instance around it and call SYS_XMLGEN() to create the XML for the object instance.

The result is:

```
<?xml version="1.0"?>
<ROW DEPTNO="100">
  <DNAME>Sports</DNAME>
  <EMPLIST>
    <EMP_T EMPNO="200">
      <ENAME>John</ENAME>
    <EMP_T>
    <EMP_T>
      <ENAME>Jack</ENAME>
    </EMP_T>
 </EMPLIST>
</ROW>
```

per row of the department. The default name “ROW” is present because the function cannot deduce the name of the input operand directly.

The difference between the SYS_XMLGEN and the DBMS_XMLGEN is apparent from this example:

- SYS_XMLGEN works inside SQL queries and operates on the expressions and columns within the row
- DBMS_XMLGEN works on the entire result set

SYS_XMLGEN Example 3: Converting XMLType Instance

If you pass an XML document into `SYS_XMLGEN()`, `SYS_XMLGEN` encloses the document (or fragment) with an element, whose tag name is the default “ROW”, or the name passed in through the formatting object. This functionality can be used to turn document fragments into well formed documents.

For example, the extract operation on the following document, can return a fragment. If you extract out the EMPNO elements from the following document:

```
<DOCUMENT>
  <EMPLOYEE>
    <ENAME>John</ENAME>
    <EMPNO>200</EMPNO>
  </EMPLOYEE>
  <EMPLOYEE>
    <ENAME>Jack</ENAME>
    <EMPNO>400</EMPNO>
  </EMPLOYEE>
  <EMPLOYEE>
    <ENAME>Joseph</ENAME>
    <EMPNO>300</EMPNO>
  </EMPLOYEE>
</DOCUMENT>
```

Using the following statement:

```
select e.xmldoc.extract('/DOCUMENT/EMPLOYEE/ENAME')
   from po_xml_tab e;
```

you get a document fragment such as the following:

```
<ENAME>John</ENAME>
<ENAME>Jack</ENAME>
<ENAME>Joseph</ENAME>
```

You can make this fragment a valid XML document, by calling `SYS_XMLGEN()` to put an enclosing element around the document, as follows:

```
select SYS_XMLGEN(e.xmldoc.extract('/DOCUMENT/EMPLOYEE/ENAME')).getclobval()
   from po_xml_tab e;
```

This places an element “ROW” around the result, as follows:

```
<?xml version="1.0"?>
<ROW>
  <ENAME>John</ENAME>
  <ENAME>Jack</ENAME>
  <ENAME>Joseph</ENAME>
</ROW>
```

Note: If the input was a column, then the column name would have been used as default. You can override the enclosing element name using the formatting object that can be passed in as an additional argument to the function.

SYS_XMLGEN() Example 4: Using SYS_XMLGEN() with Object Views

```
-- create Purchase Order object type
CREATE OR REPLACE TYPE PO_typ AUTHID CURRENT_USER AS OBJECT (
  PONO                 NUMBER,
  Customer             Customer_typ,
  OrderDate            DATE,
  ShipDate             TIMESTAMP,
  LineItems_ntab       LineItems_ntabtyp,
  ShipToAddr           Address_typ
 )
/

--Purchase order view
CREATE OR REPLACE VIEW PO OF PO_typ
  WITH OBJECT IDENTIFIER (PONO)
   AS SELECT P.PONo,
             Customer_typ(P.Custno,C.CustName,C.Address,C.PhoneList),
             P.OrderDate,
             P.ShipDate,
             CAST( MULTISET(
                    SELECT LineItem_typ( L.LineItemNo,
                                  StockItem_typ(L.StockNo,S.Price,S.TaxRate),
                                            L.Quantity, L.Discount)
                     FROM LineItems_tab L, Stock_tab S
                     WHERE L.PONo = P.PONo and S.StockNo=L.StockNo )
                 AS LineItems_ntabtyp),
         Address_typ(P.ToStreet,P.ToCity, P.ToState, P.ToZip)
        FROM PO_tab P, Customer C
        WHERE P.CustNo=C.custNo;

-------------------------------------------------------
-- Use SYS_XMLGEN() to generate PO in XML format
-------------------------------------------------------
set long 20000
set pages 100
SELECT SYS_XMLGEN(value(p),
               sys.xmlgenformatType.createFormat('PurchaseOrder')).getClobVal()
```

```
PO
FROM po p
WHERE p.pono=1001;
```

This returns the Purchase Order in XML format:

```
<?xml version="1.0"?>
<PurchaseOrder>
 <PONO>1001</PONO>
 <CUSTOMER>
  <CUSTNO>1</CUSTNO>
  <CUSTNAME>Jean Nance</CUSTNAME>
  <ADDRESS>
   <STREET>2 Avocet Drive</STREET>
   <CITY>Redwood Shores</CITY>
   <STATE>CA</STATE>
   <ZIP>95054</ZIP>
  </ADDRESS>
  <PHONELIST>
   <VARCHAR2>415-555-1212</VARCHAR2>
  </PHONELIST>
 </CUSTOMER>
 <ORDERDATE>10-APR-97</ORDERDATE>
 <SHIPDATE>10-MAY-97 12.00.00.000000 AM</SHIPDATE>
 <LINEITEMS_NTAB>
  <LINEITEM_TYP LineItemNo="1">
   <ITEM StockNo="1534">
    <PRICE>2234</PRICE>
    <TAXRATE>2</TAXRATE>
   </ITEM>
   <QUANTITY>12</QUANTITY>
   <DISCOUNT>0</DISCOUNT>
  </LINEITEM_TYP>
  <LINEITEM_TYP LineItemNo="2">
   <ITEM StockNo="1535">
    <PRICE>3456.23</PRICE>
    <TAXRATE>2</TAXRATE>
   </ITEM>
   <QUANTITY>10</QUANTITY>
   <DISCOUNT>10</DISCOUNT>
  </LINEITEM_TYP>
 </LINEITEMS_NTAB>
 <SHIPTOADDR/>
</PurchaseOrder>
```

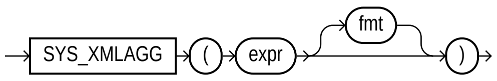
SYS_XMLAGG

SYS_XMLAGG aggregates all input documents and produces a single XML document. It aggregates (concatenates) fragments. SYS_XMLAGG takes in an XMLType as argument, and aggregates (or concatenates) all XML documents in rows into a single document per group. Use SYS_XMLAGG() for either of the following tasks:

- Aggregate fragments together
- Aggregate related XML data

In Figure 5–4 shows how SYS_XMLAGG function aggregates all XML documents or fragments, represented by *expr,* and produces a single XML document. It adds a new enclosing element with a default name ROWSET. To format the XML document differently, specify *fmt*, which is an instance of the SYS.XMLGenFormatType object.

Figure 5–4 SYS_XMLAGG Syntax



For example:

```
SQL> SELECT SYS_XMLAGG(SYS_XMLGEN(last_name)
             2  ,      SYS.XMLGENFORMATTYPE.createFormat
             3         ('EmployeeGroup')).getClobVal()
             4  FROM employees
             5  GROUP BY department_id;
```

This generates the following XML document:

```
<EmployeeGroup>
     <last_name>Scott</last_name>
     <last_name>Mary<last_name>
</EmployeeGroup >
<EmployeeGroup >
     <last_name>Jack</last_name>
     <last_name>John>/last_name>
</EmployeeGroup >
```

SYS_XMLAGG Example 1: Aggregating XML from Relational Data

Consider the SELECT statement:

```
SELECT SYS_XMLAGG(SYS_XMLGEN(ename)).getClobVal() xml_val
FROM scott.emp
GROUP BY deptno;
```

This returns the following XML document:

```
xml_val
-------------
<ROWSET>
  <ENAME>John</ENAME>
  <ENAME>Jack</ENAME>
  <ENAME>Joseph</ENAME>
</ROWSET>

<ROWSET>
  <ENAME>Scott</ENAME>
  <ENAME>Adams</ENAME>
</ROWSET>
```

2 rows selected

Here, you grouped all the employees belonging to a particular department and aggregated all the XML documents produced by the SYS_XMLGEN function. In the previous SQL statement, if you wanted to enclose the result of each group in an EMPLOYEE tag, use the following statement:

```
select sys_xmlagg(sys_xmlgen(ename),
    sys.xmlgenformattype.createformat('EMPLOYEE')).getClobVal() xmlval
          from scott.emp
          group by deptno);
```

This returns the following:

```
xml_val
-------------
<EMPLOYEE>
 <ENAME>John</ENAME>
  <ENAME>Jack</ENAME>
  <ENAME>Joseph</ENAME>
</EMPLOYEE>

<EMPLOYEE>
  <ENAME>Scott</ENAME>
  <ENAME>Adams</ENAME>
</EMPLOYEE>

2 rows selected
```

SYS_XMLAGG Example 2: Aggregating XMLType Instances Stored in Tables

You can also aggregate XMLType instances that are stored in tables or selected out from functions. Assuming that you have a table defined as follows:

```
CREATE TABLE po_tab
(
  pono  number primary key,
  orderdate date,
  poxml sys.XMLType;
);

insert into po_Tab values (100,'10-11-2000',
   '<?xml version="1.0"?><PO pono="100"><PONAME>Po_1</PONAME></PO>');
insert into po_Tab values (200,'10-23-1999',
   '<?xml version="1.0"?><PO pono="200"><PONAME>Po_2</PONAME></PO>');
```

You can now aggregate the purchase orders into a single purchase order using the SYS_XMLAGG function as follows:

```
select SYS_XMLAGG(poxml,sys.xmlgenformattype.createformat('POSET'))
from po_Tab;
```

This produces a single XML document of the form:

```
<?xml version="1.0"?>
<POSET>
  <PO pono="100">
    <PONAME>Po_1</PONAME>
  </PO>
  <PO pono="200">
    <PONAME>Po_2</PONAME>
  </PO>
</POSET>
```

SYS_XMLAGG Example 3: Aggregating XMLType Fragments

The Extract() function in XMLType, allows you to extract fragments of XML documents. You can also aggregate these fragments together using the SYS_XMLAGG function. For example, from the previous example, if you extract out the

PONAME elements alone, you can aggregate those together using the SYS_XMLAGG function as follows:

```
select SYS_XMLAGG(p.po_xml.extract('//PONAME')).getclobval()
from po_tab p;
```

This produces the following XML document:

```
<?xml version="1.0"?>
<ROWSET>
  <PONAME>Po_1</PONAME>
  <PONAME>Po_2</PONAME>
</ROWSET>
```

SYS_XMLAGG Example 4: Aggregating all Purchase Orders into One XML Document

```
set long 20000
set pages 200
SELECT SYS_XMLAGG(SYS_XMLGEN(value(p),
             sys.xmlgenformatType.createFormat('PurchaseOrder'))).getClobVal()
PO
FROM po p;
```

This returns all Purchase Orders in one XML Document, namely that enclosed in the ROWSET element:

```
<?xml version="1.0"?>
<ROWSET>
<PurchaseOrder>
  <PONO>1001</PONO>
  <CUSTOMER>
    <CUSTNO>1</CUSTNO>
    <CUSTNAME>Jean Nance</CUSTNAME>
    <ADDRESS>
      <STREET>2 Avocet Drive</STREET>
      <CITY>Redwood Shores</CITY>
      <STATE>CA</STATE>
      <ZIP>95054</ZIP>
    </ADDRESS>
    <PHONELIST>
      <VARCHAR2>415-555-1212</VARCHAR2>
    </PHONELIST>
  </CUSTOMER>
  <ORDERDATE>10-APR-97</ORDERDATE>
```

```
    <SHIPDATE>10-MAY-97 12.00.00.000000 AM</SHIPDATE>
    <LINEITEMS_NTAB>
      <LINEITEM_TYP LineItemNo="1">
        <ITEM StockNo="1534">
          <PRICE>2234</PRICE>
          <TAXRATE>2</TAXRATE>
        </ITEM>
        <QUANTITY>12</QUANTITY>
        <DISCOUNT>0</DISCOUNT>
      </LINEITEM_TYP>
      <LINEITEM_TYP LineItemNo="2">
        <ITEM StockNo="1535">
          <PRICE>3456.23</PRICE>
          <TAXRATE>2</TAXRATE>
        </ITEM>
        <QUANTITY>10</QUANTITY>
        <DISCOUNT>10</DISCOUNT>
      </LINEITEM_TYP>
    </LINEITEMS_NTAB>
    <SHIPTOADDR/>
  </PurchaseOrder>
  <PurchaseOrder>
    <PONO>2001</PONO>
    <CUSTOMER>
      <CUSTNO>2</CUSTNO>
      <CUSTNAME>John Nike</CUSTNAME>
      <ADDRESS>
        <STREET>323 College Drive</STREET>
        <CITY>Edison</CITY>
        <STATE>NJ</STATE>
        <ZIP>08820</ZIP>
      </ADDRESS>
      <PHONELIST>
        <VARCHAR2>609-555-1212</VARCHAR2>
        <VARCHAR2>201-555-1212</VARCHAR2>
      </PHONELIST>
    </CUSTOMER>
    <ORDERDATE>20-APR-97</ORDERDATE>
    <SHIPDATE>20-MAY-97 12.00.00.000000 AM</SHIPDATE>
    <LINEITEMS_NTAB>
      <LINEITEM_TYP LineItemNo="1">
        <ITEM StockNo="1004">
          <PRICE>6750</PRICE>
          <TAXRATE>2</TAXRATE>
        </ITEM>
        <QUANTITY>1</QUANTITY>
        <DISCOUNT>0</DISCOUNT>
      </LINEITEM_TYP>
      <LINEITEM_TYP LineItemNo="2">
        <ITEM StockNo="1011">
          <PRICE>4500.23</PRICE>
          <TAXRATE>2</TAXRATE>
        </ITEM>
        <QUANTITY>2</QUANTITY>
        <DISCOUNT>1</DISCOUNT>
      </LINEITEM_TYP>
    </LINEITEMS_NTAB>
    <SHIPTOADDR>
      <STREET>55 Madison Ave</STREET>
      <CITY>Madison</CITY>
      <STATE>WI</STATE>
      <ZIP>53715</ZIP>
    </SHIPTOADDR>
  </PurchaseOrder>
  </ROWSET>
```

Other Aggregation Methods

ROLLUP and CUBE

Oracle provides powerful functionality for OLAP operations such as CUBE and ROLLUP. SYS_XMLAGG function also works in these cases. You can, for example, create different XML documents based on the ROLLUP or CUBE operation.

WINDOWING Function

Oracle provides windowing functions that can be used to compute cumulative, moving, and centered aggregates. SYS_XMLAGG can also be used here to create documents based on rank and partition.

TABLE Functions

The previous sections talked about the new functions and operators that Oracle has introduced that can help query the XML instances using a XPath-like syntax. However, you also need to be able to explode the XML into simple relational or object-relational data so that you can insert that into tables or query using standard relational SQL statements. You can do this using a powerful mechanism called TABLE functions.

Table functions are new in Oracle9i. They can be used to model any arbitrary data (internal to the database or from an external source) as a collection of SQL rows. Table functions are executed pipelined and in parallel for improved performance. You can use Table functions to break XML into SQL rows. These can then be consumed by regular SQL queries and inserted into regular relational or object-relational tables.

With Oracle8*i* you could have a function returning a collection and use it in the FROM clause in the SELECT statement. However, the function would have to materialize the entire collection before it can be consumed by the outer query block.

With TABLE functions, these are both pipelined and parallel. Thus the function need not instantiate the whole collection in memory and instead pipe the results to the outer query block. The result is a faster response time and lower memory usage.

> **See Also:** *Oracle9i Application Developer's Guide - Fundamentals,* Table Functions.

Using Table Functions with XML

With XML, you can use these TABLE functions, to break the XML into SQL rows that can be queried by regular SQL queries and put into regular relational or object relational tables. Since they are parallel and piped, the performance of such an operation is vastly improved.

You can define a function for instance that takes an `XMLType` or a CLOB and returns a well known collection type. The function, for example, can use the XML parser available with Oracle9*i* to perform SAX parsing and return the results, or use the `extract()` function to extract pieces of the XML document and return it.

Table Functions Example 1: Exploding the PO to Store in a Relational Table

Assuming that you have the purchase order document explained in earlier sections and you need to explode it to store it in relational table containing the purchase order details, you first create a type to describe the structure of the result,

```
create type poRow_type as object
(
  poname varchar2(20),
  postreet varchar2(20),
  pocity varchar2(20),
  postate char(2),
  pozip char(10)
);
/
```

```
create type poRow_list as TABLE of poRow_type;
/
```

Now, you can either create an ODCI implementation type to implement the TABLE interface, or use native PL/SQL.

> **See Also:** *Oracle9i Application Developer's Guide - Fundamentals,* Table Functions, for details on what the interface definitions are and an example of the body,...

Assuming that you have created the body of the implementation type in PL/SQL, by creating the function itself, you can define the TABLE function as follows:

```
create function poExplode_func (arg IN sys.XMLType) return poRow_list
pipelined is
  out_rec poRow_type;
  poxml sys.XMLType;
  i binary_integer := 1;
  argnew sys.XMLType := arg;
begin

  loop

   -- extract the i'th purchase order!
   poxml := argnew.extract('//PO['||i||']');
   exit when poxml is null;

   -- extract the required attributes..!!!
   out_rec.poname := poxml.extract('/PONAME/text()').getStringVal();
   out_rec.postreet := poxml.extract('/POADDR/STREET/text()').getStringVal();
   out_rec.pocity := poxml.extract('/POADDR/CITY/text()').getStringVal();
   out_rec.postate := poxml.extract('/POADDR/STATE/text()').getStringVal();
   out_rec.pozip := poxml.extract('/POADDR/ZIP/text()').getStringVal();
   PIPE ROW(out_rec);

  i := i+1;

  end loop;
  return;
end;
/
```

You can use this function in the FROM list, and the interfaces defined in the Imp_t would be automatically called to get the values in a pipelined fashion as follows:

```
select *
   from TABLE( CAST(
      poExplode_func(
       sys.XMLType.createXML(
         '<?xml version="1.0"?>
          <POLIST>
           <PO>
            <PONAME>Po_1</PONAME>
            <POADDR>
              <STREET>100 Main Street</STREET>
              <CITY>Sunnyvale</CITY>
              <STATE>CA</STATE>
              <ZIP>94086</ZIP>
            </POADDR>
           </PO>
           <PO>
            <PONAME>Po_2</PONAME>
            <POADDR>
              <STREET>200 First Street</STREET>
              <CITY>Oaksdale</CITY>
              <STATE>CA</STATE>
              <ZIP>95043</ZIP>
            </POADDR>
           </PO>
          </POLIST>')
   ) AS poRow_list));
```

Note: IN the foregoing example, XMLType static constructor was used to construct the XML document. You can also use bind variables or select list subqueries to get the value.

The SQL statement returns the following values:

```
PONAME    POSTREET        POCITY    POSTATE   POZIP
------------------------------------------------------------
Po_1     100 Main Street  Sunnyvale   CA       94086
Po_2     200 First Street Oaksdale   CA       95043
```

which can then be inserted into relational tables or queried with SQL.

Frequently Asked Questions (FAQs): XMLType

Is Replication and Materialized Views (MV) Supported by XMLType?

Question Are there any issues regarding using `XMLType` with replication and materialized views?

Answer Replication treats `XMLType` as another user-defined type. It should work as other user-defined types. dbms_defer_query and user-defined conflict resolution routines do not support `XMLType` until a forthcoming release. So, no, replication and MV are not fully supported by `XMLType` in this release.

How Can I Update an XML Tag in a Database Record?

Question Can I update an XML tag within a record of a database table? Also, can I create indexes based on XML tags?

Answer In this release Oracle offers `XMLType` with a CLOB storage. Updatability is at the level of a single document, so you must replace the whole document.

`XMLType` can be indexed using Oracle Text (*inter*Media). This kind of index is best for locating documents that match certain XML search criteria, but if your applications are going to want to select out data like the “quantity” and the “price” as numerical values to operate on (for example, by some graphing or data warehousing software), then storing data-oriented XML as real tables and columns will give the best fit. You can also use functional indexes to speed up certain well-known XPath expressions.

See Also:

- Chapter 8, "Searching XML Data with Oracle Text"
- *Oracle Text Application Developer’s Guide*
- *Oracle Text Reference*

The book “Building Oracle XML Applications”, by Steve Muench (O’Reilly), covers Oracle8i with examples.

Does XMLType Support the Enforcing of Business Rules Such as Attribute Constraints?

Question Does the XML datatype in Oracle9i, provide the ability to enforce business rules or constraints as an attribute of an element within the data? For example:

```
<Address>
  <Street type=string> </Street>
  <City type=string> </City>
  <State type=string size=2> </State>
  <Zip type=number size=5> </Zip>
</Address>
```

Answer With Oracle9*i*, you can use the trigger mechanism to enforce any constraints. Oracle9i currently only supports storage as a CLOB and no constraint checks are inherently available. With forthcoming releases we may offer XML schema compliance and you would be able to create columns conforming to schemas, and so on. This would enable you to have any constraint that the schema enforces.

How Do I Create XML Documents with the Appropriate Encoding for Japanese?

Question I need to use `SYS_XMLGEN()` to create documents in Japanese, on Oracle9*i*. The database character set is EUC_JP, but creating XML with `SYS_XMLGEN()`, `SYS_XMLAGG()` and `DBMS_XMLGEN()` produces documents with the XML declaration:

```
<?xml version="1.0"?>
```

Can I create XML documents with the appropriate declaration, such as:

```
<?xml version="1.0" encoding="EUC_JP"?>
```

Answer In Oracle9*i*, you cannot generate XML output with an encoding tag. If you have data in binary datatype, then the conversion will fail if it is not convertible to the database character set.

Note that the encoding declaration does not constitute a part of the document per-se. It is an identifier to help processors identify its encoding.

What is the Best Way to Store XML in a Database?

Question What is the best way to store XML in a database? Can I store XML data in an NCLOB? Or is it preferable to store it in a BLOB and manipulate it within the application only?

Answer The best way to store XML in Oracle9*i* is to use the `XMLType`. Oracle currently allows only CLOB storage natively, but in forthcoming releases Oracle may allow native storage in NCLOBs, BLOBs, etc.

For Oracle9i Release 1 (9.0.1), you can store the XML as:

- `XMLType` - the preferred way. This helps the server to know that the data is XML. You can do XML based querying and indexing.
- BLOBs - This helps you store the XML document intact in the same encoding as the original document. The burden is on the user to deal with all the encoding issues.
- NCLOBs - Storing XML as NCLOBs will allow you to SQL operations on the data, as well as do Context searches. Context search is supported only if the database charset is a proper super-set or convertible set of the NCHAR, that is, the NCLOB must be convertible to the database char set without loss of data.