Ready, Set, XML!
Using Oracle XML Data

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Session Objectives

- Understand how Oracle supports XML data
- Know how to use the XMLtype for both structured and unstructured XML
- Use XML-related functions to retrieve relational data in XML form
- Create XML views of relational data
- Understand how Oracle uses registered XML schemas
- Know how WebDAV may be used with Oracle data

Oracle XML DB

- Oracle's XML support is provided as XML DB:
  - W3C (Worldwide Web Consortium) XML compliance
  - XMLType is an Oracle-defined datatype storing XML data
    - Unstructured (CLOB underneath)
    - Structured ("Shredded" into relational columns and rows)
    - Binary XMLType (new with Oracle 11g)
  - The XML parser is part of the database
  - Oracle provides several XML-oriented SQL functions to support XML, some support the emerging ISO/ANSI SQLX initiative
  - Check the reference manual for complete information: "XML DB Developer's Guide"

XML DB Features, page 1

- XMLType — XML document stored as CLOB (Character Large Object), or "shredded" and stored as structured XML
- DOM Fidelity — Structured XML is stored without disrupting DOM (Document Object Model) hierarchy
- XML Schema — Both “structured” and “unstructured” documents may use XML Schemas to constrain XML input
- XML Piecewise — Allows use of XPath syntax to update specific elements and attributes without rewriting document
- XPath Search — Allows use of XPath syntax to focus queries

XML DB Features, page 2

• XML Indexes	Support quicker XPath searches
• SQLX Operators	New ANSI/ISO SQLX functions
• XQuery	XML Query
• XSL Transformations	Use XSLT to transform XML documents via SQL
• XML Views	Views of XML documents, document fragments, and relational data
• Java Bean Interface	API providing access to structured XML data via Java Beans
• XML Repository	XML content stored in a directory-like hierarchy

XMLType Datatype

- XMLType may be used to represent a document or document fragment in SQL
- XMLType has several built-in member functions to operate on XML content
- XMLType may be used in PL/SQL as variables, return values, and parameters
- XMLType APIs are provided for both PL/SQL and Java programming
- Beginning with Oracle9i Release 2 XMLType is also supported on the client via FTP, HTTP, and WebDav

XMLType Functions

- XMLType member functions include:
  - createXML() — Create XMLType instance
  - existsNode() — Checks if XPath can find valid nodes
  - extract() — Uses XPath to return XML fragment
  - isFragment() — Checks if document is a fragment
  - getClobVal() — Gets document as a CLOB
  - getStringVal() — Gets value as a string
  - getNumberVal() — Gets numeric value as a number
  - isSchemaBased — Returns 1 if schema based (0 if not)
  - isSchemaValid — True if XMLType is valid
  - schemaValidate — Validates XMLType using Schema
  - Transform — Apply XSL Stylesheet to XMLType
  - XMLType — Constructs an XMLType instance from CLOB, VARCHAR2 or object

Oracle URLs/URIs

- URL (Uniform Resource Locator), address of a complete document or specific location within a document
- URI (Uniform Resource Identifier), URLs with additional information
- Oracle supports three datatypes for URIs
  - HttpUriType — URL beginning with “http://”
  - DBUriType — URI points to a column, row, or set of rows in the database – object methods retrieve data linked using DBUriType
  - XDBUriType — URI points to an XML document known to the Oracle XML DB Repository – object methods retrieve all or part of XML documents (resources) represented by XDBUriType

ISO-ANSI SQL/XML (SQLX)

- SQL/XML is an ISO-ANSI working draft for XML-Related Specifications (aka. SQLX)
- SQLX defines how SQL may be used with XML
- SQLX functions are used to generate XML from existing relational (and object relational) tables
- SQLX standard functions supported by Oracle:
  - XMLAgg()
  - XMLAttribute()
  - XMLCast ()
  - XMLComment ()
  - XMLConcat()
  - XMLElement()
  - XMLExists ()
  - XMLForest()
  - XMLParse ()
  - XMLPI ()
  - XMLQuery ()
  - XMLSerialize ()

SQL/XML Functions, 1

- XMLAgg(xmlTypeObject orderbyclause)
  - Creates an aggregate forest of XML elements from a collection of XML elements
  - xmlTypeObject represents the set of xmlType data to be aggregated
  - If specified, ORDER BY clause dictates sequence of aggregation (Note: no comma)
- XMLCast(expression as dataType)
  - Converts SQL expression's return as specified datatype
- XMLComment(expression)
  - Creates XML comment using specified expression
- XMLConcat(xmlType,xmlType,…xmlType)
  - Concatenates a series of XMLType objects (opposite of XMLElement)
- XMLElement(elementName,elementValue)
  - Creates series of XML fragments using specified element name and values as attributes sometimes using the XMLAttributes clause
- XMLExists(xmlQuery)
  - Returns TRUE if xmlQuery returns non-null result

SQL/XML Functions, 2

- XMLForest(expression)
  - Creates a set of XML elements (forest) using fragments from a list of arguments/parameters
- XMLParse(doctype,expression)
  - Parses and generates document using expression
- XMLPI(piName,piValue)
  - Inserts a Processing Instruction (PI) as directed
- XMLQuery(xQueryExpression)
  - Returns result of XQuery specified
- XMLSerialize(expression)
  - Returns string or LOB containing results of expression

Oracle SQL/XML Extensions

- XMLCdata
  - Generate cdata section from specified expression
- XMLColAttVal
  - Oracle SQLX extension creates series of XML fragments using an element name of "column" and column names and values as attributes
- XMLDiff
  - Compare two XML documents and return difference(s) as a document
- XMLPATCH
  - Patches XMLType using second XMLType
- XMLRoot
  - Generate XML identification line (PI)
- XMLSequence
  - Creates Varray of XMLType instances
- SYS_XMLGEN
  - Convert specified database row and column into an XML document
- SYS_XMLAGG
  - Generate single XML document from aggregate of XML data specified by "exp"

Other XML Functions

- APPENDCHILDXML
- DELETEXML
- DEPTH
- EXTRACT (XML)
- EXISTSNODE
- EXTRACTVALUE
- INSERTCHILDXML
- INSERTXMLBEFORE
- PATH
- SYS_DBURIGEN
- SYS_XMLAGG
- SYS_XMLGEN
- UPDATEXML
- XMLTransform

SYS_XMLGEN

- Uses a single input expression representing a particular row/column (scalar value or user-defined type)
  - A single XML element representing scalar values is returned
  - XML elements representing each of a user-defined type's data items is returned
  - Returns an instance of SYS.XMLType data that is an XML document
- The example below uses getStringVal since XMLType data returns as CLOB

```
select sys_xmlgen(ename).getStringVal() Name
     from emp
     where job = 'ANALYST'
NAME
--------------------------------------------------
<?xml version="1.0"?>
 <ENAME>FORD</ENAME>
<?xml version="1.0"?>
 <ENAME>SCOTT</ENAME>
```

SYS_XMLAGG

- SYS_XMLAGG aggregates all XML documents (or fragments) in an expression to produce a single document
  - ROWSET is the default tag name used
  - SYS.XMLGenFormatType may be used to change a tag name
- The example below uses the SYS_XMLGEN function to generate an XML document
  (example uses getClobVal to add XML PI)

```
select sys_xmlagg(SYS_XMLGEN(Ename)).getClobVal() emps
          from emp
          where deptno = 10
EMPS
--------------------------------------------------
<?xml version="1.0"?>
<ROWSET>
<ENAME>KING</ENAME>
<ENAME>CLARK</ENAME>
<ENAME>MILLER</ENAME>
</ROWSET>
```

Most-Used XML Functions, 1

- XMLElement is used to define Elements

```
XMLElement("MyElementName",valueExp)
```

  - MyElementName may be any valid XML name
  - valueExp may be a literal, column name, or expression providing the value for the element (May be nested)
- XMLAttributes is used to define Element Attributes; it should be used inside XMLElement and precede any SubElements for the chosen Element

```
XMLAttributes("MyAttributeName",valueExp)
```

  - MyAttributeName may be any valid XML name
  - valueExp may be a literal, column name, or expression providing the value for the element

Most-Used XML Functions, 2

- XMLForest works like nested XMLElements

```
XMLForest(valExp1,valExp2 AS "MyElement2")
```

  - valExp1 may be a literal, column name, or expression providing the value for the element
  - valExp2 may be a literal, column name, or expression providing the value for the element
  - MyElement2 may be any valid XML name
- XMLAgg aggregates calls to XMLElement, XMLAttribute, and XMLForest (and others) to create an XML document
- Column name used if Element and/or Attribute not explicitly named

XMLElement

- XMLELEMENT(name,exp) Generates an XML element using name and exp as data:

```
select xmlelement("employee",
       xmlelement("empid",empno),
       xmlelement("empname",ename)) myxml
    from emp

<employee> <empid>7369</empid>
    <empname>SMITH</empname> </employee>
<employee> <empid>7499</empid>
    <empname>ALLEN</empname> </employee>
<employee> <empid>7521</empid>
    <empname>WARD</empname> </employee>
<employee> <empid>7566</empid>
    <empname>JONES</empname> </employee>
<employee> <empid>7654</empid>
    <empname>MARTIN</empname> </employee>
```

XMLAttributes

- Generates XML attributes using an expression list:

```
select xmlelement("employee",
       xmlelement("emp", xmlattributes(empno as "empno",
                         ename as "ename")),
       xmlelement("job",job),
       xmlelement("hiredate",hiredate),
       xmlelement("pay", xmlattributes(nvl(sal,0) "sal",
                         nvl(comm,0) as "comm"))
       ) as myxml
from emp;
<employee>
  <emp empno="7782" ename="CLARK"/>
  <job>MANAGER</job>
  <hiredate>09-JUN-81</hiredate>
  <pay sal="2450" comm="0"/>
</employee>
*** More like the above ***
```

XMLForest

- XMLForest is similar to using XMLElement several times

```
select xmlelement("employee",
       xmlelement("emp", xmlattributes(empno as "empno",
                                       ename as "ename")),
       xmlforest(job,hiredate,sal,deptno)
       ) as myxml
from emp;

<employee>
  <emp empno="7839" ename="KING"/>
  <JOB>PRESIDENT</JOB>
  <HIREDATE>17-NOV-81</HIREDATE>
  <SAL>5000</SAL>
  <DEPTNO>10</DEPTNO>
</employee>
*** More like the above ***
```

XMLConcat

- XMLConcat concatenates XML data without adding higher-level elements

```
SELECT XMLConcat( XMLElement("empno",empno),
                  XMLElement("empname",ename),
                  XMLElement("hiredate",hiredate),

   XMLElement("salary",to_char(sal,'99,999.99')))
FROM emp;

<empno>7839</empno>
<empname>KING</empname>
<hiredate>17-NOV-81</hiredate>
<salary>5,000.00</salary>
*** More like the above ***
```

XMLAgg

- XMLAgg is used when a GROUP BY is aggregating the SQL data

```
SELECT XMLELEMENT("Department",
       XMLAGG(XMLForest(deptno,empno,ename,sal)))
FROM emp
GROUP BY deptno;

<Department>
  <DEPTNO>20</DEPTNO>
  <EMPNO>7566</EMPNO>
  <ENAME>JONES</ENAME>
  <SAL>2975</SAL>
  *** more dept 20 rows ***
  <DEPTNO>20</DEPTNO>
  <EMPNO>7902</EMPNO>
  <ENAME>FORD</ENAME>
  <SAL>3000</SAL>
</Department>
*** More like the above ***
```

Putting them Together

```
select xmlelement("employee",
      xmlagg(xmlelement("emp",xmlattributes(empno as "empno",
                     ename as "ename"),
                     xmlelement("job",job),
                     xmlelement("hiredate",hiredate),
                     xmlelement("pay",
                     xmlattributes(nvl(sal,0) as "sal",
                     nvl(comm,0) as "comm")))))
   from emp;
<employee>
   <emp empno="7839" ename="O&apos;BRIAN">
      <job>PRESIDENT</job>
      <hiredate>17-NOV-81</hiredate>
      <pay sal="5000" comm="0"/>
   </emp>
   <emp empno="7698" ename="BLAKE">
      <job>MANAGER</job>
*** More like above ***
</employee>
```

DBMS_XMLGEN

- DBMS_XMLGEN package creates XML documents from an SQL query
- DBMS_XMLGEN function setMaxRows may be used to control the maximum number of rows fetched
- DBMS_XMLGEN function setSkippedRows may be used to control the number of rows to be fetched
- Additional functions/procedures are provided to allow changing the default root element name from ROWSET to a chosen value and to change or omit the ROW identifier
- C language program
- First available with Oracle8i (8.1.6 and later)

dbms_xmlgen Functions/Procedures

- newContext() Creates new context handle
- setRowTag() Set root element name (default=ROWSET)
- setRowSetTag Set row element name (default=ROW)
- getXML() Use query to get XML document
- getNumRowsProcessed() Gets the number of SQL rows in last getXML call
- setMaxRows() Set max. rows to be fetched each time
- setSkipRows() Set number of rows to skip before generating XML (default = 0)
- setConvertSpecialChars() "Escape" special characters convert() Converts XML as "escaped"/"unescaped"
- useItemTagsForColl() Defines a collection column name appended by _ITEM
- restartQUERY() Restarts query at the beginning
- closeContext() Closes context and releases all resources

DBMS_XMLGEN, 1

- DBMS_XMLGEN may be used to process a query as follows

```
CREATE OR REPLACE FUNCTION getAllEmps
RETURN clob
IS
   mySql VARCHAR2(500);
BEGIN
   mySql := 'select ename,job,empno,sal,deptno '
               || ' from emp order by ename,empno ';
   RETURN dbms_xmlgen.getxml(mySql);
END;
select getAllEmps from dual;
<?xml version="1.0"?>
<ROWSET>
 <ROW>
  <ENAME>ADAMS</ENAME>
  <JOB>CLERK</JOB>
  <EMPNO>7876</EMPNO>
  <SAL>1100</SAL>
  <DEPTNO>20</DEPTNO>
 </ROW>
 ...
 </ROWSET>
```

DBMS_XMLGEN, 2

```
CREATE OR REPLACE FUNCTION getEmpData (inEmpno in varchar2)
RETURN clob
IS
   mySql VARCHAR2(500);
BEGIN
   mySql := 'select ename,job,empno,sal,deptno '
               || ' from emp where empno = ' || inEmpno
               || ' order by ename,empno ';
   RETURN dbms_xmlgen.getxml(mySql);
END;
select getEmpData(7788) from dual;

<?xml version="1.0"?>
<ROWSET>
 <ROW>
  <ENAME>SCOTT</ENAME>
  <JOB>ANALYST</JOB>
  <EMPNO>7788</EMPNO>
  <SAL>3000</SAL>
  <DEPTNO>20</DEPTNO>
 </ROW>
</ROWSET>
```

DBMS_XMLGEN, 3

```
CREATE OR REPLACE FUNCTION getEmpData2
RETURN clob
IS
 mySql dbms_xmlgen.ctxHandle;
BEGIN
 mySql := dbms_xmlgen.newContext('select ename,job,empno,sal,deptno '
       || ' from emp '
       || ' order by ename,empno ');

 dbms_xmlgen.setRowsetTag(mySql,'personnelData');
 dbms_xmlgen.setRowTag(mySql,'employee');

 return dbms_xmlgen.getxml(mySql);
END;

select getEmpData2 from dual;
<?xml version="1.0"?>
<personnelData>
 <employee>
  <ENAME>ADAMS</ENAME>
  <JOB>CLERK</JOB>
  <EMPNO>7876</EMPNO>
  <SAL>1100</SAL>
  <DEPTNO>20</DEPTNO>
 </employee>
```

DBMS_XMLQUERY

- Java program to create XML from an SQL query
- Like DBMS_XMLGEN, but, not as fast (use DBMS_XMLQUERY)

DBMS_XMLQUERY Procedures/Functions

- **closeContext() Closes query context**
- **getDTD() Generate DTD**
- **getNumRowsProcessed() Gets number of rows processed**
- **getXML() Generate the XML document**
- **newContext() Creates a query context**
- **removeXSLTParam() Removes a stylesheet parameter**
- **setBindValue() Sets value for bind name**
- **setDateFormat() Sets format of generated dates in the XML**
- **setEncodingTag() Set XML encoding instructions**
- **setMaxRows() Sets maximum number of rows to be converted to XML**
- **setRowIdAttrName() Sets name of id attribute**
- **setRowIdAttrValue() Specifies column to provide row id attribute**
- **setRowTag() Sets element name for each row**
- **setRowsetTag() Sets root element tag name**
- **setSkipRows() Sets the number of rows to skip**
- **setStylesheetHeader() Sets stylesheet header**
- **setTagCase() Specify case of generated XML tags**
- **setXSLT() Registers stylesheet to be applied to XML**
- **setXSLTParam() Sets value of stylesheet parameter**
- **useNullAttributeIndicator() Whether or not to indicate null**

dbms_xmlquery Usage

```
CREATE OR REPLACE FUNCTION getAllEmpsXQ
RETURN clob
IS
   mySql VARCHAR2(500);
   mySqlCtx DBMS_XMLQuery.ctxType;
   returnXML CLOB;
BEGIN
   mySql := 'select ename,job,empno empid,sal,deptno '
                    || ' from emp order by ename,empno ';
   mySqlCtx := DBMS_XMLQuery.newContext(mySql);
   dbms_xmlquery.setRowIdAttrName(mySqlCtx,null);
   dbms_xmlquery.setRowsetTag(mySqlCtx,'personnelData');
   dbms_xmlquery.setRowTag(mySqlCtx,'employee');
   returnXML := DBMS_XMLQuery.getXML(mySqlCtx);
   DBMS_XMLQuery.closeContext(mySqlCtx);
   RETURN returnXML;
END;
select getAllEmpsXQ from dual;
```

dbms_xmlquery Output

```
<?xml version = '1.0'?>
<personnelData>
   <employee>
      <ENAME>ADAMS</ENAME>
      <JOB>CLERK</JOB>
      <EMPID>7876</EMPID>
      <SAL>1100</SAL>
      <DEPTNO>20</DEPTNO>
   </employee>
   <employee>
      <ENAME>ALLEN</ENAME>
      <JOB>SALESMAN</JOB>
      <EMPID>7499</EMPID>
      <SAL>1600</SAL>
      <DEPTNO>30</DEPTNO>
   </employee>
   *** more ***
</personnelData>
```

XML Schema Support

- The W3C (World-Wide Web Consortium) XML Schema standard provides a middle ground between data modeling and document modeling
- XML schemas may be used to automatically create tables and types, or, to validate updates and inserts
- XML schemas may be used as the basis for XMLType tables and columns (but, schemas are ***not*** required to store XMLType data)
- XML schemas must be registered in the database where they are stored as CLOBs
- Once registered, XML schemas may be referenced using URL notation
- Registered XML schemas may be used to map XML documents to structured or unstructured database storage

More on XML Schema

- Beginning with Oracle9i Release 2 some of the XML schema related activity permitted includes:
  - XMLType objects may be built based upon XML schema
  - XMLType objects may be validated using XML schema
  - Tables may be created based upon XML schema automatically creating storage structures
    (does not require specific column definition)
  - XML schemas may registered in the database using DBMS_XMLSCHEMA package
  - Registered schemas may be shared
  - Schema registration may create Java beans and default tables
  - Schemas allow pre-parsing of incoming XML documents and their direction to the appropriate tables
  - XML documents and instances may be validated using XMLType's XMLIsSchemaValid() method
  - extractValue is used to extract part of the XML document

Schema Validation

- XML Schemas are powerful, but, do not provide some features we take for granted in the database such as UNIQUE key and FOREIGN key constraints
- By default, Oracle9i does not completely validate documents as they are inserted into the database; restriction facets such as minLength, maxLength, and patterns are ignored
  (11g and 10g add more-complete validation)

  Schema validation may be enabled for individual schemas via Check Constraints or Triggers

DBMS_XMLSCHEMA

- Oracle9i added the DBMS_XMLSchema package, Oracle 10g enhanced it
- DBMS_XMLSchema provides procedures used to manager schemas in the XDB repository
  - COMPILESCHEMA — Recompile an already registered schema
  - COPYEVOLVE — Evolve registered schema(s)
  - DELETESCHEMA — Remove schema from the database
  - GENERATEBEAN — Generate the Java bean code corresponding to a registered schema
  - GENERATESCHEMA — Generate XML schema from an Oracle type
  - GENERATESCHEMAS — Generate several XML schemas from an Oracle type
  - REGISTERSCHEMA — Register schema in repository
  - REGISTERURI — Register XMLSchema specified by URI

registerSchema Syntax

```
PROCEDURE registerSchema(
   schemaURL IN varchar2,
   schemaDoc IN SYS.URIType,
   local IN BOOLEAN := TRUE,
   genTypes IN BOOLEAN := TRUE,
   genBean IN BOOLEAN := FALSE,
   force IN BOOLEAN := FALSE,
   owner IN VARCHAR2 := null);
```

- schemaURL — URL to be used within Oracle for schema
- schemaDoc — Schema (varchar, bfile, blob, clob, XMLtype, URItype
- local — true, register as /sys/schemas/<username>/...
false, register as /sys/schemas/PUBLIC/... (default = true)
- genTypes — true, generate object types (default = true)
- genBean — true, generate Java beans (default = false)
- genTables — true, generate default tables (default = true)
- force — true, do not raise registration errors probably building invalid schema object (default = false)
- owner — User who owns schema object
(default = user registering schema)
- csid — Character set of schema, if 0 current rule for "text/xml"
(no default)

Registering Schema

- Schemas must be created and tested (use an appropriate XML editor), then, register them with DBMS_XMLSCHEMA

```
begin
  dbms_xmlschema.registerschema('myBooks.xsd',
    '<?xml version="1.0" encoding="UTF-8"?>
     <xs:schema
        xmlns:xs="http://www.w3.org/2001/XMLSchema"
                  elementFormDefault="qualified">
       <xs:element name="myBooks">
           <xs:complexType>
              <xs:sequence>
                 <xs:element ref="book"
                    maxOccurs="unbounded"/>
       **** rest of schema definition ****
     </xs:schema>',true,true,false,false);
end;
/
```

10g Schema Annotations

- Oracle 10g adds add schema annotations providing information to the XDB schema compiler

```
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
   xmlns:xdb="http://xmlns.oracle.com/xdb" version="1.0"
   xdb:storeVarrayAsTable="true">
   <xs:element name="PurchaseOrder"
   type="PurchaseOrderType"
   xdb:defaultTable="PURCHASEORDER" />
   <xsd:complexType name="PurchaseOrderType"
        xdb:SQLType="XDBPO_TYPE">
```

  - Namespace **"http://xmlns.oracle.com/xdb"** is required
  - Attributes include:
    - storeVarrayAsTable — Direct database to store as a table
    - defaultTable — Names table representing Schema's data
    - SQLType — Defines SQL type (number, varray, etc...) of related database column
    - SQLName — Name used for SQL attribute
    - SQLSchema — Names registered schema

DBMS_XMLSCHEMA Dictionary

• ALL_XML_SCHEMAS	Schemas available to user
• ALL_XML_TABLES	XMLType tables available to user
• ALL_XML_TAB_COLS	XMLType table columns in tables available to user
• ALL_XML_VIEWS	XMLType views available to user
• ALL_XML_VIEW_COLS	XMLType view columns in views available to user

Schema with XMLType Tables

- To create a table using the schema type the following

```
create table myBooksType of xmltype
   xmlschema "myBooks.xsd" element "myBooks";
```

Schema with XMLType Columns

- To create an XMLType column using the schema definition

```
create table myBooks
 (id number,
  books xmltype)
  xmltype column books
     xmlschema "myBooks.xsd" Element "myBooks"
```

Oracle 10g CopyEvolve

- Oracle 10g added the ability to evolve registered schemas so that existing XML data remains valid
- **Careful! Backup all schemas and documents before executing COPYEVOLVE, it deletes all conforming documents**
- COPYEVOLVE is very busy, it:
  - Copies XMLType tables to temporary storage tables
  - Drops old tables
  - Deletes old schemas
  - Registers new schemas
  - Creates new XMLType tables
  - Populates new tables with data from temporary tables (constraint, triggers, indexes are lost)
  - Drops temporary storage tables

11g In-Place Schema Evolution

- Oracle 11g adds the capability of In-Place schema evolution
- In-Place Schema Evolution ***does not*** require copying, deleting, and inserting existing data making it faster than copy-based evolution
- In-Place Schema Evolution is restricted to cases where:
  - Storage model is not changing
  - Existing documents are valid using the new schema
- Different PL/SQL procedures are used for each:
  - DBMS_XMLSCHEMA.copyEvolve (Copy-Based)
  - DBMS_XMLSCHEMA.inPlaceEvolve (In-Place)

Unstructured XML Data

- XMLType data stored without a schema is “unstructured” and stored as CLOB

```
CREATE TABLE my_books OF XMLTYPE;

CREATE TABLE my_books ( books XMLTYPE );
```

Unstructured Insert

- Data inserted into an unstructured XMLType table or column is stored in CLOB form

```
INSERT INTO my_books
VALUES
  (XMLTYPE('
     <book>
          <name>Learning XML</name>
          <author>Eric T. Ray</author>
          <publisher>O&apos;Reilly</publisher>
          <isbn>0-596-00046-4</isbn>
     </book>
  '));
```

Insert from File

- It is also possible to insert (both structured and unstructured) XML using an input file

```
insert into my_books
values
(
  XMLType
  (
    bfilename('MYXDB','myBooks.xml'),
    nls_charset_id('AL32UTF8')
  )
)
```

PL/SQL XML INSERT

```
CREATE or REPLACE PROCEDURE insertPurchaseOrderXMLOrder IS
   PurchaseOrderXML CLOB; -- CLOB to hold XML
BEGIN
   PurchaseOrderXML :=
        <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
        <PurchaseOrder>
               <POID>1234</POID>
               <Date>2003-0401</Date>
               <CustomerID>AA1234></CustomerID>
               <Company>King Training Resources</Company>
                <!-- other elements -->
        </PurchaseOrder>';
  -- Insert the Purchase Order XML into an XMLType column
   INSERT INTO purchaseOrderTable (purchaseOrder)
        VALUES (XMLTYPE(PurchaseOrderXML));
EXCEPTION
   WHEN OTHERS THEN
        raise_application_error(-20101,
        'Error loading purchaseOrderTable, SQLCODE='||SQLERRM);
END insertPurchaseOrderXMLOrder;
```

Unstructured Update

- Unstructured Updates look like this

```
update my_books xstuff
  set books = xmltype('
 <book>
      <name>Learning XML</name>
      <author>Eric T. Ray</author>
      <publisher>O Reilly</publisher>
      <isbn>0-596-00046-4</isbn>
   </book>')
 where
  xstuff.books.extract('/myBooks/book/text()').getStringVal()
                          = 'Wiley'
```

Unstructured Delete

- Unstructured Delete may also use XPath notation to identify parts of the document to be deleted

```
delete from my_books xstuff
where
xstuff.books.extract('/myBooks/book/text()').getStringV
   al() = 'Wiley'
```

Structured XML Data

- XMLType data stored using a schema is “structured” and is taken apart (shredded) into relational objects

```
CREATE TABLE my_books OF XMLTYPE
   XMLSCHEMA 'myBooks.xsd'
   ELEMENT 'myBooks';

CREATE TABLE my_books (
       info XMLTYPE, desc VARCHAR2(100))
      XMLTYPE COLUMN info STORE AS OBJECT RELATIONAL
   XMLSCHEMA 'myBooks.xsd'
   ELEMENT 'myBooks';

CREATE TABLE my_books (
      info XMLTYPE, desc VARCHAR2(100) )
     XMLTYPE COLUMN info STORE AS CLOB
   XMLSCHEMA 'myBooks.xsd'
   ELEMENT 'myBooks';
```

Insert using Schema

- When inserting data, XML document using schemas are validated

```
INSERT INTO myBooksType VALUES (
  xmltype.createxml('<?xml version="1.0"?>
    <myBooks xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:noNamespaceSchemaLocation="myBooks.xsd">
      <book>
        <name>Definitive XML Schema</name>
        <author>Prescilla Walmsley</author>
        <publisher>Prentice-Hall</publisher>
        <isbn>0-13-0655667-8</isbn>
     </book>
     <book>
        <name>Definitive XSLT and XPATH</name>
        <author>G. Ken Holman</author>
        <publisher>Prentice-Hall</publisher>
        <isbn>0-13-065196-6</isbn>
     </book>
</myBooks>
'));
```

Selecting Using XPath

- XPath notation may be used to select sets of data or particular rows

```
select value(xml)
  from myBookstype xml
  where existsnode(value(xml),
      '/myBooks/book[publisher="OReilly"]') = 1
```

```
select extract(object_value,'/PurchaseOrder/Reference')
  aref
from oe.PurchaseOrder
where extract(object_value,'/PurchaseOrder/Requestor')
  like '%Walsh%'
```

Update Using XPath

- XPath may be used to alter portions of the structured XML document (piece-wise update)
  - Oracle 9i provided UpdateXML()
  - Oracle 10G R2 added InsertXML(), AppendChildXML(), InsertXMLBefore(), DeleteXML()

```
update myBookstype xstuff
  set value(xstuff) =
    updateXML(value(xstuff),
          '/myBooks/book/publisher/text()','Shannon')
      where existsnode(value(xstuff),
            '/myBooks/book[publisher="Wiley"]') = 1
```

Delete Using XPath

- Delete may also use XPath notation to identify portions of the XML document to be deleted

```
delete myBookstype xstuff
  where existsnode(value(xstuff),
     '/myBooks/book[publisher="Wiley"]') = 1
```

Structured Storage Review

- XML document is “shredded” into database objects
- Documents must conform to a registered XMLSchema; XML DB will use the XML Schema to generate SQL
- Structured Storage has several advantages:
  - Memory management is better than with CLOB
  - Storage requirements are reduced
  - Indexing is easier with structured data
  - Partial or in-place updates are possible
- Adding and retrieving XML documents to the database is slower when using Structured Storage

Binary XML

- Oracle continues its XML leadership in Oracle 11g
- Biggest change is the addition of a new “binary” XMLType
  - “binary xml” is a third method for storing XML data in the database
  - “structured” and “unstructured” XMLType still supported
  - Oracle 11g’s XML processors includes a binary XML encoder, decoder, and token manager
  - XML 1.0 text may be parsed via SAX events with or without a corresponding schema into “binary” XML form
  - “binary” XMLType allows optimization of some XML applications by reducing memory and CPU expense

11g Binary XMLType Pros

- XMLType data is stored in a binary format (known as post-parse)
- Binary XML is:
  - Smaller
  - Already-parsed
  - XML schema-aware
    (but does not require XML schema)

BINARY XML Storage

- When creating table/column of XMLType the type of storage may be specified

```
CREATE TABLE MYSTUFF OF XMLTYPE
  XMLTYPE STORE AS BINARY XML
/
```

XMLTypes Compared

	Structured	Unstructured	Binary
Throughput	Slower	Fast	Fast
Size	Excellent	Poor	Good
Flexible Data	Match schema	Any	Any
Mult. Schemas	No	No	Yes
Updates	Piecewise	Entire doc.	Piecewise (SecureFile only)
XPath Query	Excellent	Poor	Good
Insert Validation	Partial	Partial (if schema-based)	Full
Index	B-tree, Function-based, Oracle-text	XMLIndex, function-based, Oracle-text	XMLIndex, function-based, Oracle-text

XML DB Components

- XMLType — Data type defining the column or table as XML data and including methods to allow operations on the XML such as XSL transformations and validation via XML Schema
- XMLSchema — Complete XML Schemas may be registered with XML DB to validate documents and to define how documents are stored by Oracle
- XML DB Repository — Provides mechanism for associated URIs with XPath notation to access XML data; supports interaction with HTTP, FTP, WebDAV clients
- SQL/XML — XML DB includes many operators that are part of the emerging SQL/XML standard

Viewing Folders

- The server's Http server may be used to access the directory structure

What is WebDAV?

- WebDAV is an IETF (www.ietf.org) standard set of HTTP extensions allowing an HTTP Server to serve files to a WebDAV-enabled client
- Any WebDAV-enabled product can read and update XML content stored in the XML DB Repository
- Since both Microsoft Office (Office XP and beyond) and Oracle support WebDAV, they work together automatically
- Some other WebDAV-enabled products: Microsoft Internet Explorer, Altova XMLSpy, Macromedia MX and others
- XML's promise of portable data is greatly facilitated by WebDAV

Running Oracle's XDB Demo

- Go to http://technet.oracle.com

  If you don't already belong:
  - No cost (other than an email address and occasional spam)
  - Most trial software available for download
  - Many white papers and demos

- Look under "XML" for the "XDBBasicDemo"
  - Download it
  - Download other software: XML editor, FTP package (not required, but makes installation of demo easier)
  - Try WebDAV by following the well-laid-out instructions

Indexing XML Content

- XML data may be indexed to increase efficiency like other Oracle tables
- Unstructured XML data (CLOB storage)
  - XML & text aware indexing and searching with Oracle Text
- Structured XML data (Object-Relational storage)
  - Automatic query rewrite enables all existing indexes types

```
create index book_author on myBooks
   (books.extract('/myBooks/book/author.text()').getStringVal())
```

11g XMLIndex

- Oracle 11g introduces a new index type for XMLType called XMLIndex
- XMLIndex can improve performance of XPath-based predicates and fragment extraction
- XMLIndex is a (logical) domain index consisting of underlying physical table(s) and secondary indexes (replaces CTXSYS.CTXXPath; Oracle recommends replacing any CTXXPath indexes with XMLIndex)
- Supported by PL/SQL DBMS_XMLINDEX package

XML Publisher

- XML Publisher is a powerful report generation tool allowing creation of standardized reports containing Oracle (and other) data quickly and easily (replacement for SQL*Reports?)
- XML Publisher supports:
  - Creating Reports and Report Standardization
  - Report, Data, and Translation Templates
  - Support for regular files, XML files, and database data
  - Online Report Editor, Query Builder, and Analyzer
  - Simple Charts & Formatting Options
  - Row, Column, and Cell formatting
  - Number and Date formatting (e.g internationalization)
  - Advanced reporting via XSL, SQL, and XSL-FO (including PDF)
- Originally intended to support Oracle' various ERP tools XML Publisher is now available as a separate product

XQuery

- XQuery is an XML query and processing language represented in manner similar to XML
- Some find XQuery programs easier to understand and maintain than XSLT
- XQuery language is small and powerful
- XQuery language is a W3C (World Wide Web Consortium) project in working draft form
- XQuery is part of ISO/ANSI SQL 2005
- XQuery may well become the normal way of accessing SQL data in the future
- XQuery supports XML Schema

XQuery Expressions - FLWOR

- Everything in XQuery is an “expression”
- Every expression returns a new value
- FLWOR expressions include:
  - For — Range of values (like SQL FROM)
  - Let — Define/set variables used by For
  - Where — Filter conditions (like SQL WHERE)
  - Order-by — Ordering (like SQL ORDER BY)
  - Return — Output definition (like SQL SELECT)
- SQL*Plus now supports direct XQuery use

XMLQuery & XMLTable

- The Oracle (ISO) XMLQuery function
  - Uses XQuery to one read or more XML documents
  - Return is an XML document
  - XMLQuery is usually used in a Select list
- Oracle (ISO) XMLTable Function
  - XMLTable() is used in the From clause of an SQL Expression

Example XMLQuery

```
SELECT XMLQuery('for $i
   in ora:view("OE","WAREHOUSES")/ROW
   return <Warehouse id="{$i/WAREHOUSE_ID}">
    <Location>
     {for $j in ora:view("HR", "LOCATIONS")/ROW
       where $j/LOCATION_ID eq $i/LOCATION_ID
       return ($j/STREET_ADDRESS,
               $j/CITY, $j/STATE_PROVINCE)}
    </Location>
  </Warehouse>'
  RETURNING CONTENT) FROM DUAL;
```

Example XMLTable

```
SELECT mystuff.COLUMN_VALUE AS OrderTotal
   FROM oe.purchaseorder,
      XMLTable(
       'for $i in /PurchaseOrder
        where $i/User = "AWALSH"
        return
        <OrderTotal>
                {$i/Reference}
          <Total>
           {fn:sum(for $j in $i/LineItems/LineItem/Part
           return ($j/@Quantity*$j/@UnitPrice))}
          </Total>
        </OrderTotal>'
    PASSING OBJECT_VALUE
) mystuff;
```

SQL*Plus XQuery

- SQLPlus now supports direct XQuery

```
XQuery(
      'for $i in ora:view("OE", "WAREHOUSES")/ROW
        return
         <Warehouse id="{$i/WAREHOUSE_ID}">
           <Location>
             {for $j in ora:view("HR", "LOCATIONS")/ROW
               where $j/LOCATION_ID eq $i/LOCATION_ID
               return ($j/STREET_ADDRESS, $j/CITY,
                       $j/STATE_PROVINCE)}
           </Location>
         </Warehouse>')
/
```

10g R1 XML Enhancements

- Export/Import support
- Schema evolution via DBMS_XMLSCHEMA.CopyEvolve
- C and C++ APIs allow XML modification
- DBMS_XMLGEN allows turning off "pretty print"
- Hierarchical queries (CONNECT) via DBMS_XMLGEN.newContextFromHierarchy
- DBMS_AQ support for XMLType data
- SQL*Loader support for both shredded and unshredded data
- Globalization support

10g R2 XML Enhancements

- XMLType in Java, C, C++ (Ent. XML Developers Kit)
- XSLT 2.0 XPath support
- XQuery XMLQUERY and XMLTABLE functions
- InsertXML(), AppendChildXML(), InsertXMLBefore(), DeleteXML() SQL functions added to UpdateXML()
- SOAP 1.2 support in C/C++
- SQL/XML 2003 standard support
- DBMS_XMLDOM, DBMS_XMLPARSER and DBMS_XSLPROCESSOR replace deprecated XMLDOM, XMLPARSER and XSL_PROCESSOR packages
- XML DB HTTPS support

11g XML Enhancements, 1

- New Binary XMLType storage model
- XMLIndex Index type to improve Xpath location
- XMLTypeOCT (XMLType Ordered Collection Tables)
- Supports both WebDAV and XML DB privileges
- Web Services Oracle queries with SQL or XQuery
- In-Place XML Schema Evolution
- Recursive XML Schemas
- XLink and XInclude support
- XQuery 1.0 Compliance
- SQL/XML Compliance

11g XML Enhancements, 2

- Large XML Nodes in PL/SQL, Java, and C
- Java XML APIs shared for XML DB and Oracle XDK
- XMLType support by Oracle Streams
- XMLType supported by Oracle Data Pump
- Oracle XDK Pull-Parser API
- XML-Update Performance improvements
- XQuery and SQL/XML Performance improvements
- XSLT Performance Enhancements

Wrapping it all Up

- XML DB provides several valuable tools for working with XML data
- XML may be produced from existing relational tables using XML-oriented functions and PL/SQL packages
- XML may be stored in the database in three ways:
  - Unstructured (entire XML document in one CLOB)
  - Structured (XML document uses schema to store data in object-relational database objects
  - Binary (may use schema, but not required)
- XML data may be retrieved, inserted, updated and deleted like other database data
- WebDAV provides a direct interface to several other products


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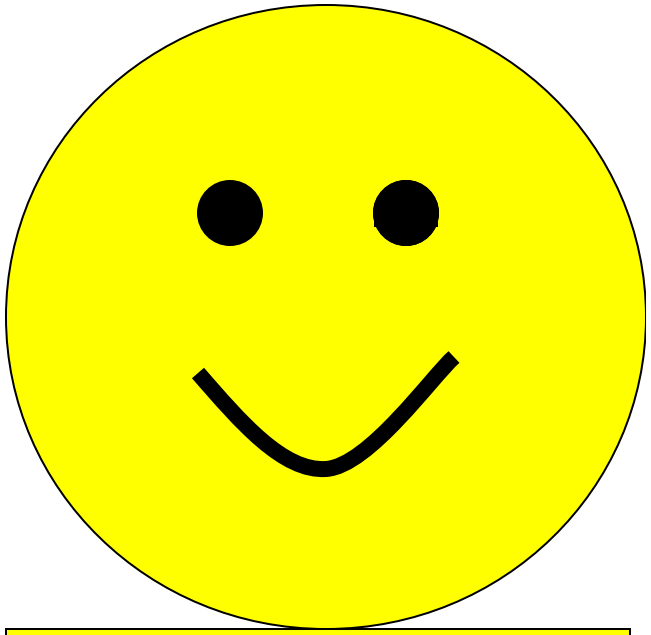

Thanks for your attention!

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