An Introduction to Oracle XML DB in Oracle Database 12c Release 2

Mark D Drake
Manager, Product Management
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Agenda

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7. XML Schema
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Introduction to XML DB
Oracle’s XML Vision

• Enable a single source of truth for XML
• Provide the best platform for managing all your XML
  – Flexibility to allow optimal processing of data-centric and content-centric XML
  – Deliver Oracle’s commitment to Reliability, Security, Availability and Scalability
• Drive and implement key XML Standards
• Support SQL-centric, XML-centric and document-centric development paradigms
• Support XML in Database and Application Server
XMLType and XQuery
XMLType

• Standard data type, makes database XML aware
  – Use as Table, Column, Variable, Argument or Return Value

• Abstraction for managing XML
  – Enforces XML content model and XML fidelity
  – Enables XML schema validation
  – Multiple persistence and indexing options

• Query and update operations performed using XQuery

• All application logic is independent of persistence model
Using XMLType

create table INVOICES of XMLTYPE;

create table PURCHASEORDERS (  
    PO_NUMBER NUMBER(4),  
    PO_DETAILS XMLTYPE 
)  
XMLTYPE column PO_DETAILS  
XMLSCHEMA "http://schemas.example.com/PurchaseOrder.xsd"  
ELEMENT “PurchaseOrder“  
STORE AS OBJECT RELATIONAL;
XQuery

• W3C standard for generating, querying and updating XML
  – Natural query language for XML content
  – Evolved from XPath and XSLT
  – Analogous to SQL in the relational world

• Iterative rather than Set-Based

• Basic construct is the FLWOR clause
  – for, let where, order by, return

• XQuery operations result in a sequence consisting of zero or more nodes
XQuery FLWOR example

for $l in $PO/PurchaseOrder/LineItems/LineItem
return $l/Part/@Description

<XQuery>
  <PurchaseOrder DateCreated="2011-01-31">
    ...
    <LineItems>
      <LineItem ItemNumber="1">
        <Part Description="Octopus">31398750123</Part>
        <Quantity>3.0</Quantity>
      </LineItem>
      .....<LineItem ItemNumber="5">
        <Part Description="King Ralph">18713810168</Part>
        <Quantity>7.0</Quantity>
      </LineItem>
    </LineItems>
  </PurchaseOrder>
</XQuery>
XQuery fn:collection: Working with lots of XML

- Used to access a collection of documents
  - Allows an XQuery to operate on a set of XML documents
- Collection sources include
  - The contents of a folder
  - XMLType tables or columns
  - Relational Tables via a conical mapping scheme
- Protocol “oradb:” causes the components of the path should be interpreted as a Schema, Table, Column
  - Column is optional

```
for $doc in fn:collection(“oradb:/OE/PURCHASEORDER”) return $doc
```
XQuery : Where and Order by clause

let $USER := “SKING”
for $doc in fn:collection(“oradb:/OE/PURCHASEORDER”) 
  where $doc/PurchaseOrder[User = $USER] 
  order by $doc/PurchaseOrder/Reference 
return $doc/PurchaseOrder/Reference

• Where clause controls which documents or nodes are processed
  – Enables the use of predicates
• Order by clause controls the ordering of nodes
Executing XQuery in SQL*Plus

SQL> XQUERY
let $USER := "SKING"
for $doc in fn:collection("oradb:/OE/PURCHASEORDER")
where $doc/PurchaseOrder[User = $USER]
order by $doc/PurchaseOrder/Reference
return $doc/PurchaseOrder/Reference
/

• If XQuery statement ends with ‘;’ use empty comment ( : :) to prevent semi-colon being interpreted by SQL.
Executing XQuery using XMLTable

- Converts the sequence returned by XQuery into a relational result set
- JDBC / OCI programs
- Tools that do not yet provide native XQuery support
  - SQL*Developer, APEX SQL Workbench
- This is what the SQL*PLUS XQUERY command does under the covers

```sql
select *
from XMLTABLE
(
  'for $doc in fn:collection("oradb:/OE/PURCHASEORDER")
  return $doc/PurchaseOrder/Reference'
)
```
XQuery in Database Native Web Services

```
<ENV:Envelope
    xmlns:ENV="http://schemas.xmlsoap.org/soap/envelope/
    xmlns:ENC="http://schemas.xmlsoap.org/soap/encoding/
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema">
<ENV:Body>
    <m:query xmlns:m="http://xmlns.oracle.com/orawsv">
        <m:query_text type="XQUERY"> for $doc in fn:collection("oradb:/OE/PURCHASEORDER")
            return $doc/PurchaseOrder/Reference </m:query_text>
        <m:pretty_print>true</m:pretty_print>
    </m:query>
</ENV:Body>
</ENV:Envelope>
```

- WSDL location : http://dbserver:port/orawsv?wsdl
JCR-225 or XQJ

- Native XQuery API for Java
- XQJ is to XQuery what JDBC is to SQL
- Reference implementation by Oracle XMLDB

```java
import javax.xml.xquery.*
XQDataSource dataSource = new oracle.xml.xquery.OXQDataSource();
XQConnection connection = dataSource.getConnection();
XQExpression expression = connection.createExpression();
XQResultSequence result = expression.executeQuery("for $doc in fn:collection("oradb:/OE/PURCHASEORDER") return $doc/PurchaseOrder/Reference");
result.writeSequence(System.out, null);
result.close();
```
Loading XML
**SQL Loader**

- Load files from a local file system
- `Filelist.dat` contains a list of the files to be loaded

```sql
load data
in file 'filelist.dat'
append
into table PURCHASEORDER
xmltype(XMLDATA)
(
    filename filler char(120),
    XMLDATA lobfile(filename) terminated by eof
)
```

```
C:\purchaseOrders\ABANDA-20020405224101614PST.xml
C:\purchaseOrders\ABANDA-20020406224701221PDT.xml
...
```
BFILE Constructor

create or replace directory XMLDIR as 'c:\myxmlfiles';

insert into PURCHASEORDER values (XMLTYPE (BFILENAME('XMLDIR', 'SKING-20021009123335560PDT.xml'),NLS_CHARSET_ID('AL32UTF8')));

• Directory XMLDIR references a directory in a file system local to the database server
• Must specify the character set encoding of the file being loaded.
public boolean doInsert(String filename) throws SQLException, FileNotFoundException {

    String statementText = "insert into PURCHASEORDER values (:1)";
    Connection conn = getConnection();
    OracleCallableStatement statement =
        (OracleCallableStatement) conn.prepareStatement(statementText);

    FileInputStream is = new FileInputStream(filename);
    XMLType xml = XMLType.createXML(this.getConnection(), is);
    statement.setObject(1, xml);
    boolean result = statement.execute();

    statement.close();
    conn.commit();
    return result;
}
The XML DB repository and protocols

- Allows content to be loaded directly into the database using FTP, HTTP and WebDAV
XML Generation
Generating XML from relational data

- SQL/XML makes it easy to generate XML from relational data
  - Result set generated by SQL Query consists of one or more XML documents

- XQuery enables template-based generation of XML from relational tables
  - Use fn:collection() to generate a canonical XML representation of relational data that can be transformed using XQuery

- XMLType views enable persistent XML centric access to relational content
Generating XML using SQL/XML

• **XMLElement()**
  – Generates an Element with simple or complex content
    • Simple Content derived from a scalar column or constant
    • Complex content derived from XMLType columns or generated using nested SQL/XML operators

• **XMLAttributes()**
  – Adds attributes to an element

• **XMLAgg()**
  – Generates an XML Fragment
  – Aggregation operator used to process the results of a nested sub-query
Example: Using SQL/XML

```sql
SELECT xmlElement ("Department",
    xmlAttributes (d.DEPTNO as "Id"),
    xmlElement("Name", d.DNAME),
    xmlElement("Employees", (SELECT xmlAgg(
        xmlElement("Employee",
            xmlForest(
                e.ENAME as "Name",
                e.HIRE_DATE as "StartDate"
            )
        )
    )
    FROM EMP e
    WHERE e.DEPTNO = d.DEPTNO
) )
) AS XML
FROM DEPT d
```
XML and SQL Integration
XMLExists() XQuery Predicates

- Use in SQL where clause to filter rows based on an XQuery expression
- Bind variables are supplied via the “Passing” clause

```
SQL> select OBJECT_VALUE "XML"
  2  from PURCHASEORDER
  3  where XMLExists (  
  4   '$_PO/PurchaseOrder[Reference=$REF]'
  5   passing OBJECT_VALUE as "PO",
  6   'SKING-20021009123336131PDT' as "REF"
  7  );

XML

<PurchaseOrder>
  <Reference>SKING-20021009123336131PDT</Reference>
  ...
</PurchaseOrder>
```
XMLQuery() Fragment access

SQL> select XMLQUERY(
1    '$PO/PurchaseOrder/ShippingInstructions'
2    passing OBJECT_VALUE as "PO"
3    returning content) XML
4  from PURCHASEORDER
5  where XMLEXISTS(
6    '$PO/PurchaseOrder[Reference=$REF]'
7    passing OBJECT_VALUE as "PO", 'SKING-20021009123336131PDT' as "REF"));

XML

<ShippingInstructions>
  <name>Steven A. King</name>
  ...
</ShippingInstructions>

- Use in SQL where clause to extract a fragment from each document in a result set.
- Bind variables are supplied via the “Passing” clause
XMLTable() : Relational Views of XML

• The “COLUMNS” clause extends XMLTable, allowing the creation of in-line relational views of XML content

• Enables SQL operations on XML content
  – Views allow Non-XML aware tools access to XML content

• Collection hierarchy managed using chained XMLTable operations
  – Repeating elements passed down the chain as XMLType fragments
XMLTable Columns Clause

```sql
SQL> select m.REFERENCE, l.LINENO, l.QUANTITY
2    from PURCHASEORDER,
3       XMLTable(
4          '$PO/PurchaseOrder' passing OBJECT_VALUE as "PO"
5          COLUMNS
6              REFERENCE VARCHAR2(32) PATH 'Reference',
7              LINEITEM_FRAGMENT XMLTYPE PATH 'LineItems/LineItem'
8        ) m,
9       XMLTable(
10          '$LI/LineItem' passing m.LINEITEM_FRAGMENT as "Li"
11        COLUMNS
12            LINENO NUMBER(4) PATH '@ItemNumber',
13            UPC NUMBER(14) PATH 'Part/text()',
14            QUANTITY NUMBER(5) PATH 'Quantity'
15      )
16    where l.UPC = '24543000457';
```

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>LINENO</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>AKHOO-20100418162507692PDT</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>PVARGAS-20101114171322653PST</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>JTAYLOR-20100518182653281PDT</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>
XQuery-Update support

Standards-compliant update of XML content

- http://www.w3.org/TR/xquery-update-10/
- Declaratively modify and transform XML content
  - Replace, Delete, Insert, Rename
- Database supports the copy / modify form of XQuery-Update
- Operations are re-written into partial-updates where possible
- XQuery update support is also enabled starting with patchset 11.2.0.3.0
XQuery-Update support

- Combine an XMLQuery operator containing an XQuery-Update expression with a SQL Update statement
  - The XQuery-Update supplies the new value for the XMLType

```xml
update TABLE
  set XML_COLUMN = xmlQUERY(
    'copy $NEWXML := $XML modify (  
      let $TARGET := $NEWXML/rootElement/targetElement  
      return replace node $TARGET with $NEWCONTENT  
    )  
    return $NEWXML'
  
  passing XML_COLUMN as "XML", V_NEW_CONTENT as " NEWCONTENT "  
  returning content
  )

where ...
```
XQuery-Update support

```
copy $NEWPO := $PO modify {
    let $ROOT := $NEWPO/PurchaseOrder
    let $SHIPINST := $ROOT/ShippingInstructions
    return {
        replace value of node $ROOT/User with $NEWUSER,
        replace node $ROOT/Requestor with element Requestor {$NEWNAME},
        delete node $SHIPINST/address,
        insert node element street {$STREET} as last into $SHIPINST,
        insert node element city {$CITY} as last into $SHIPINST,
        insert node element zipcode {$ZIPCODE} as last into $SHIPINST
    }
}
return $NEWPO
```

- Select target nodes using For or Let clauses
- Specify modifications in the return clause
XQuery-Update usage

• Updating XML stored in the Oracle Database

• XML Data Masking
  – Use an XMLType view based on XQuery-Update to remove or mask content from an XML document

• Updating xml is supported using Oracle specific operators in older releases of the database
  – UpdateXML(), DeleteXML(), insertChildXML() etc
  – Legacy Oracle specific operators are deprecated in Oracle Database 12c
XQuery-FullText support

Standards compliant Full-Text search of XML content

- XQFT [http://www.w3.org/TR/xpath-full-text-10/](http://www.w3.org/TR/xpath-full-text-10/)
- Declarative full text search in XML content
  - contains text, stemming, windowing
  - Logical full text operators: ftor, ftand, ftMildNot
- The XQuery contains() operator is limited to ‘string within string’ searches
- Available starting with Oracle Database 12.1.0.1.0
XQuery-FullText support

```
select PURCHASEORDER_XML
from PURCHASEORDERS
where XMLExists(
    '$P/PurchaseOrder/ShippingInstructions/Address/street[. contains text ($PHRASE)]'
    passing PURCHASEORDER_XML as "P", 'sport' as "PHRASE"
);
```

- Use with XMLExists() operator to perform Full-Text filtering
- Use with XMLQuery() and XMLTable() to perform Full Text based fragment extraction
- Support for Document, Fragment, Element and Attribute level operations
- Document and Fragment level operations target all descendant nodes
XQuery-FullText support

Common operations

- Use Stemming to search for different forms a word

```xquery
$PO/PurchaseOrder/ShippingInstructions/Address/street[. contains text {$WORD} using stemming]
```

- Use FT logical operators to search for multiple words

```xquery
'$PO/PurchaseOrder/ShippingInstructions/Address[. contains text {$WORD1} ftand {$WORD2}]
```

- Use Windowing to specify the distance between words

```xquery
$P/PurchaseOrder/ShippingInstructions/Address[. contains text {$WORD1} ftand {$WORD2} window 6 words]
```
XQuery-FullText Indexing

• XQuery-FullText operations are optimized by XML aware Full-Text (Context) index

• Based on existing Oracle Text (Context) Technology

• Proven Full-Text search capabilities

• Fully Namespace Aware

• Use XQuery Full-Text rather than SQL’s contains() operator when working with XML content

• The oracle xpath extension ora:contains() is deprecated starting with Oracle Database 12c
XQuery-FullText Index Creation

BEGIN
  CTX_DDL.CREATE_SECTION_GROUP('XQFT','PATH_SECTION_GROUP');
  CTX_DDL.SET_SEC_GRP_ATTR('XQFT','XML_ENABLE','T');
  CTX_DDL.create_preference('STORAGE_PREFS', 'BASIC_STORAGE');
  CTX_DDL.set_attribute('STORAGE_PREFS',
    'D_TABLE_CLAUSE', 'LOB(DOC) STORE AS SECUREFILE (COMPRESS MEDIUM CACHE)');
  CTX_DDL.set_attribute('STORAGE_PREFS',
    'I_TABLE_CLAUSE', 'LOB(TOKEN_INFO) STORE AS SECUREFILE (NOCOMPRESS CACHE)');
END;
/

CREATE INDEX PURCHASEORDER_XQFT_IDX
  ON PURCHASEORDER(OBJECT_VALUE)
  INDEXTYPE IS CTXSYS.CONTEXT
  PARAMETERS(
    'storage STORAGE_PREFS'|
    section group XQFT'
  )
/

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Other SQL/XML Operators

• XMLCast()
  – Used with XMLQuery() operator
  – Converts XML scalars into SQL scalars

• XMLTransform()
  – XSL based transformation

• XMLNamespaces()
  – Namespace management

• SchemaValidate()
  – XMLType method for validating document against an XML Schema
XML Storage and Indexing
Binary Persistence

- Stores post-parse representation of XML on disc
  - Reduced storage requirements
  - Tags are tokenized, content stored in native representation
- Optimized for streaming, indexing and fragment extraction.
- Single representation used on disc, in-memory and on-wire
  - No parsing / serialization overhead once XML is ingested
- Partial update
- Schema-less and XML Schema aware versions

SQL> create table PURCHASEORDER of XMLTYPE
2> XMLTYPE store as SECUREFILE BINARY XML;
Oracle Binary XML

Database

Application Server

Web Cache

Clients

SQL, PL/SQL

XQuery

XQuery, Java, ‘C’

Oracle Binary XML

Binary XML

Binary XML

Binary XML

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Client Side Encoding

• Enable client side encoding by executing the methods `setPicklePreference()` and `setMetadataConn()` on the XMLType object before performing the Insert
  – Specify `XMLType.XMLTYPE_PICKLE_AS_BINXML` when invoking `setPicklePreference()` to force client side encoding.

• Client side encoding is only supported with XMLType.
  – Currently it is not available when using the JDBC 4.0 SQLXML class

```java
XMLType xml = new XMLType(connection, is);
xml.setPicklePreference(XMLType.XMLTYPE_PICKLE_AS_BINXML);
xml.setMetadataConn(connection);
statement.setObject(1, xml);
boolean result = statement.execute();
```
Client Side Encoding

• Allows the overhead of parsing and encoding the XML to be moved from the database to the client
  – Reduction in overall Network Traffic
  – Reduction in Database CPU usage
  – Increase in Client CPU usage (no free lunch)

• Most effective when many similar documents will be inserted using a single database connection

• Recommended when constructing XMLType from InputStream.

• Avoid when constructing XMLType directly from XMLDocument
Client Side Encoding: Bytes sent to Server

- 50% reduction in bytes sent to server
- Complete Works of Shakespeare
- 36 Files, 9,067,913 bytes
- High content to Tag ratio
Client Side Encoding: Bytes sent to Server

- 2x bytes read from server
- Client needs token table to encode XML
- Less than 0.001% of content

Bytes Sent to Client

<table>
<thead>
<tr>
<th>Client Side Encoding</th>
<th>Bytes Sent to Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disabled</td>
<td>4000</td>
</tr>
<tr>
<td>Enabled</td>
<td>8000</td>
</tr>
</tbody>
</table>
Client Side Encoding : CPU Usage

- 85% reduction in DB CPU
- 8x increase in Client CPU
- 5% reduction in elapsed time
- Significant improvement in scalability
XML Index: Unstructured Index

- Requires no knowledge of the structure of the XML being indexed or the search criteria
- All elements and attributes in the XML are indexed
  - Name / Value pair model
- Optimizes searching and fragment extraction
- Accelerates path and path-with-predicate searching
- Supports type-aware searches
- Synchronous and Asynchronous indexing modes

```
SQL> create index PURCHASEORDER_XML_IDX
2  on PURCHASEORDER (OBJECT_VALUE)
3  indextype is XDB.XMLINDEX;
```
Path Subsetting

- Indexing all nodes can be expensive
  - DML Performance & Space Usage
- Path sub-setting allows control over which nodes are indexed
- Trade off retrieval performance, DML performance and space usage

SQL> create index PURCHASEORDER_XML_IDX
    2 on PURCHASEORDER (OBJECT_VALUE)
    3     indextype is XDB.XMLINDEX
    4     parameters ( 'paths ( 'include ( 
    5                     /PurchaseOrder/Reference 
    6                      /PurchaseOrder/LineItems//* ))' 
    7                     )
    8 );
Structured XML Index

- Indexes “Islands of Structure”
  - Requires some knowledge of the XML being indexed and the kind of queries that will be performed
- Specific leaf-level nodes projected into relational tables
  - Table for each island, leaf node values stored as columns
- Data type aware
- Based on XMLTable syntax()
- Optimizes all SQL/XML operators
  - XMLQuery(), XMLTable() and XMLExists()
SQL> call DBMS_XMLINDEX.registerParameter(
   2   'PO_SXI_PARAMETERS',
   3   'GROUP  PO_LINEITEM
   4      xmlTable PO_INDEX_MASTER
   5     '/PurchaseOrder'
   6    COLUMNS
   7       REFERENCE    varchar2(30)       PATH "Reference",
   8       LINEITEM     xmlType            PATH "LineItems/LineItem"
   9      VIRTUAL XMLTABLE    PO_INDEX_LINEITEM
   10     '/LineItem"
   11    PASSING lineitem
   12   COLUMNS
   13      ITEMNO       number(38)         PATH "@ItemNumber",
   14      UPC          number(14)         PATH "Part/text()",
   15      DESCRIPTION  varchar2(256)      PATH "Part/@Description"
   16   =');
XML Schema
XMLSchema

• WC3 Standard for defining the structure and content of an XML document
  – An XML Schema is an XML document

• Used for validation purposes
  – Parsers like Oracle XDK, XERCES or Microsoft’s MSXML
  – XML Editors like XMetal, Oxygene or Microsoft Word 2K7

• Created using tools like Altova’s XML Spy or Oracle’s JDeveloper
XML Schema and Binary XML

- Increased storage efficiency for Binary XML
  - Simple types mapped to native formats
  - Pre-generated token tables
- Improves streaming XPath and XML Index operations
  - Leverages cardinality and location information
- Schema validation part of Binary XML encoding process

```sql
DBMS_XMLSCHEMA.registerSchema (  
    SCHEMAURL => 'http://www.example.com/xsd/purchaseOrder.xsd',  
    SCHEMADOC => xmlType(bfilename('XMLDIR','po.xsd'), nls_charset_id('AL32UTF8')),  
    GENTYPES => FALSE,  
    GENTABLES => FALSE,  
    OPTIONS => DBMS_XMLSCHEMA.REGISTER_BINARYXML )
```
Object-Relational Storage

XML Schema defines an XML object Model,

XML Schema compilation
  – SQL object model generated from the XML object model
  – Object-relational tables created to provide efficient storage for SQL objects.

Object Relational storage enables
  – Lossless, bi-directional mapping between XML object model and SQL object model
  – XQuery execution via re-write into SQL operations on the underlying tables

DBMS_XMLSCHEMA.registerSchema (  
  SCHEMAURL => 'http://www.example.com/xsd/purchaseOrder.xsd',  
  SCHEMADOC => xmlType(bfilename('XMLDIR','po.xsd'), nls_charset_id('AL32UTF8')),  
  GENTYPES => TRUE,  
  GENTABLES => TRUE )
Object Relational Persistence

• Suitable for highly structured XML use-cases
  • XML collection hierarchy persisted as master/details relationships using nested tables
  • Simple recursive structures handled automatically using out-of-line tables

• Near-relational performance for
  – Leaf level access and update
  – Collection manipulation (insert, delete)

• Indexing via B-Tree and Bitmap indexes

• Significant reductions in storage Vs serialized form

• Some overhead incurred for document-level storage and retrieval operations
XML DB Repository
Oracle XML DB Repository

• Organize and access content as files in folders rather than rows in tables
  – Manages XML and non-XML content
  – Native support for HTTP, FTP and WebDAV protocols
  – Content accessible using standard desktop Tools

• Enables document-centric development paradigm
  – Path based access to content
  – Queries based on location

• Hierarchical Index
  – Patented, high performance folder-traversal operations and queries
Oracle DB repository Features

• Document Level Security
  – Highly granular access control
  – Database and application defined principles with custom authentication schemes

• Standards compliant
  – File / Foldering model : IETF WebDav standard
  – Security : DavACL
  – Protocols : HTTP, HTTPS, WebDAV

• Application Development
  – JCR Provider
  – SQL API and Views
  – Database Native Web Services
Oracle DB repository XML features

- Schema based XML content automatically stored in user tables specified during schema registration
- Enables URL centric standards like XLink and XInclude
- Special handling for office productivity documents
- Support for virtual documents
  - Based on XMLType views
  - Content generated when document is opened
Content Management Features

• Access control
  – Grant / Revoke permissions on a document by document basis

• Versioning
  – Simple linear versioning model with Check-In and Check Out

• Comprehensive event model
  – Associate code with operations on files and folders

• Standard and user defined Metadata
  – Manage metadata independently from content
  – Java content management system API
Database Native Web Services
Database-native Web Services

  – Any package method, function or procedure can be accessed as a SOAP end-point
• Leverages the Oracle XML DB HTTP Server
  – No additional infrastructure required
• Automatic generation of WSDL
  – URL to Package, Function or Procedure mapping scheme
• Uses XML DB infrastructure for processing request and generating response
• Includes ‘SQL Query’ and ‘XQuery’ Services
Summary
XML DB Summary

• **XMLType**
  – XML storage and indexing

• **XQuery, XML Schema, XSLT**
  – XML centric development

• **SQL/XML**
  – XML publishing

• **XMLDB repository**
  – XML specific content management

• **Standards** compliant
  – Strict adherence and conformance
Integrated Cloud
Applications & Platform Services