Managing XML Content with XML DB: Getting the Best Bang for the Buck

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Agenda

• XQuery, SQL/XML Best Practices & Guidelines
• Structured Storage Guidelines
• Binary XML with XMLIndex Storage Guidelines
• Q & A
XQuery, SQL/XML
Best Practices
Using XMLQuery(), XMLExists()

SELECT XMLQuery(‘…’ passing T.doc RETURNING CONTENT)
FROM table T
WHERE XMLExists(‘…’ passing T.doc)

• Use XMLExists() to search
  • Typical database task to locating matching documents
  • XQuery expression must be index friendly to obtain good performance
  • Split complex XQuery expressions into index friendly and index unfriendly expressions joined by “AND”

• Use XMLQuery() to transform resulting documents
  • Typically runs on matching documents (much smaller set)
  • Can contain complex expressions and still obtain good performance
Performing XML DML operations

UPDATE Table t SET t.doc = DELETEXML(…)
WHERE XMLEXists(‘…’ passing t.doc)

- Use XMLEXists() to identify documents being updated
  - As before, XQuery expression should take advantage of indexes to obtain good performance
- Use XPaths in DML operator to identify portion of document to update
- Piece-wise update operations are optimized
  - For Structured Storage, many operations rewritten to directly update relational columns
  - For Binary Storage, updates evaluated in streaming fashion and only updated portion changed on disk
Use `XMLTable()` for relational access

- XML documents are hierarchical
  - Can contain many master-detail relationships
- Projecting out relational columns a common requirement

```sql
SELECT li.description, li.lineitem
FROM purchaseorder T, XMLTable("$p/PurchaseOrder/LineItems/LinItem" PASSING T.X AS "p"
  COLUMNS lineitem NUMBER PATH '@ItemNumber',
  description VARCHAR2(30) PATH 'Description',
  partid NUMBER PATH 'Part/@Id',
  unitprice NUMBER PATH 'Part/@UnitPrice',
  quantity NUMBER PATH 'Part/@Quantity') li
WHERE li.unitprice > 30 and li.quantity < 20);
```
Use XMLTable() for relational access

- XQuery expressions should be storage/index friendly for good performance
- For structured storage, expressions should map down to relational columns for best performance
- For Binary XML storage with XMLIndex, expressions should be indexed
  - In particular, expression in predicates (WHERE clause)
- Multi level master-detail can be achieved by chaining multiple XMLTable clauses
Use XMLCast() for ORDER BY, GROUP BY

```
SELECT XMLCAST(XMLQUERY("$p/PurchaseOrder/@poDate"
    PASSING T.X
RETURNING CONTENT) AS DATE), COUNT(*)
FROM purchaseorder T
WHERE ...
GROUP BY XMLCAST(XMLQUERY("$p/PurchaseOrder/@poDate"
    PASSING T.X RETURNING CONTENT) AS DATE)
```

- If ordering or grouping multiple XPaths, use them in an XMLTable clause
- XMLTable allows expressions to be encapsulated in views for further BI analysis
XQuery on PL/SQL variable

DECLARE
    v_x XMLType;
    NumAcc NUMBER;
BEGIN
    v_x := XMLType(...); /* initialize xmltype variable */
    SELECT /*+ NO_XML_QUERY_REWRITE */
        XMLCAST(XMLQUERY('declare default element namespace
    "http://custacc";for $cust in $cadoc/Customer return
    fn:count($cust/Addresses/Address)'
    PASSING v_x AS "cadoc" RETURNING CONTENT) AS NUMBER)
    INTO NumAcc
    FROM DUAL;
END;

• Hint allows efficient DOM based evaluation
• XMLExists() can be used similarly
Datatype considerations

• XQuery specifies xs:untypedAtomic for non-schema documents
  • Different for schema-based documents
  • Can lead to confusing semantics
• Use explicit casting in XQuery and PASSING clause for numeric comparisons
  
  $po/purchaseOrder[xs:decimal(@id)=$id]
  PASSING T.X AS "po", CAST(:1 AS NUMBER) as "id"

• For non-numeric datatypes, XQuery can automatically cast to appropriate type of RHS
  
  $po/purchaseOrder[@podate =xs:date($d)]
Accessing XML DB repository

- Repository data can be accessed using fn:doc and fn:collection
- Approach 1: Use SQL/XML and RESOURCE_VIEW

```sql
SELECT XMLQuery(…)
FROM RESOURCE_VIEW rv, purchaseorder p
WHERE ref(p) = XMLCast(XMLQuery('declare default element namespace "http://xmlns.oracle.com/xdb/XDBResource.xsd"; (: :) fn:data
  (/Resource/XMLRef) PASSING rv.RES RETURNING CONTENT) AS REF XMLType) AND
  equals_path(rv.RES, '/home/mydocs/podocs/1924.xml') = 1;
```

- Approach 2: Use XQuery pragma

```xml
for $doc in (#ora:defaultTable PURCHASEORDER #)
  {fn:doc("/home/mydocs/podocs/1924.xml")} …
```
XMLQuery() vs XMLTable() for top level XQuery

- Two variants for top level XQuery
  - SELECT * FROM XMLTable()
  - SELECT XMLQuery() FROM DUAL

- All rewrite optimizations are performed and appropriate indexes are leveraged

- Difference in semantics though:
  - XMLTable() construct produces many rows (one for each result item)
  - Avoids materializing large sequences and maps better to SQL’s iterator model
  - XMLQuery() produces 1 row (the entire result sequence)
Structured Object
Relational Storage
Best Practices

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Default tables, Nested tables & Indexes

• Use annotation xdb:defaultTable
• Allows your tables to be recognized in the explain plan output
• Nested tables can be named using the VARRAY STORE AS clause
• If tables already created, use DBMS_XMLSCHEMA_MANAGE RENAMECOLLECTIONTABLE procedure
• Create B-tree indexes on underlying relational tables and columns
Indexing predicates

- Create Indexes on XPaths used in predicates (WHERE clause)
- Using the XPath directly (approach 1):

```sql
CREATE INDEX po_reference_ix ON purchaseorder
(XMLCast(XMLQuery ('$p/PurchaseOrder/Reference'
PASSING po.OBJECT_VALUE AS "p" RETURNING CONTENT)
AS VARCHAR2(128)));
```

- If function based index created, use approach 2 to obtain name of indexed column and then create index

```sql
select XDB.DBMS_MANAGE_XMLSTORAGE.xpath2TabColMapping('PURCHASEORDER_TAB',NULL,'/ipo:purchaseOrder/ Reference ','"http://www.example.com/IPO" as "ipo"') from dual;
```
Indexing predicates

- Create indexes on collection tables
- Composite index
  - The column in the collection table corresponding to XML attribute or element that needs to be indexed
  - The NESTED_TABLE_ID column

```
WHERE
XMLExists('p/PurchaseOrder/LinItems/LinItem/Part[@Id="717951002372"]'

SELECT XDB.DBMS_MANAGE_XMLSTORAGE.xpath2TabColMapping('PURCHASEORDER_TAB', NULL, '/ipo:purchaseOrder/items/item/Part/Id', "http://www.example.com/IPO" as "ipo")
FROM dual

CREATE INDEX xxx ON tab_name (col_name, NESTED_TABLE_ID)
```
Loading large documents

- Large XML documents are loaded without building complete DOM in memory
- Pipelined storage directly into collection tables as document is scanned
- Can handle arbitrarily large documents (proven to many GB size)
- Use FTP PUT or CreateResource() for optimal performance
  - Ensure that xdb:defaultTable is specified correctly for root element in schema document
  - Ensure all collections are mapped to tables (default)
- Can also use SQL Insert statement (11gR2)
Configuring large document load

- Configuration file /xdbconfig.xml has parameters that control the amount of memory used by the loading operation.
- Can tune the memory usage and performance of a load (or retrieval) operation by varying:
  - `xdbcore-loadableunit-size` – indicates the maximum size to which a **loadable unit** (partition) can grow in Kilobytes. Default is 16 KB.
  - `xdbcore-xobmem-bound` – indicates the maximum size in kilobytes that a document is allowed to occupy in memory. Default is 1024 KB.

```sql
DECLARE
  v_cfg XMLType;
BEGIN
  SELECT updateXML(DBMS_XDB.cfg_get(),
                   '/xdbconfig/sysconfig/xdbcore-loadableunit-size/text()',
                   '65536',
                   '/xdbconfig/sysconfig/xdbcore-xobmem-bound/text()',
                   '1024')
    INTO v_cfg FROM DUAL;
  DBMS_XDB.cfg_update(v_cfg);
  COMMIT;
END;
/
```
Binary XML Storage with XMLIndex
Best Practices
Binary XML Streaming evaluation

• Multiple XPaths evaluated in a single streaming access over XML document
• Automatically used for XMLExists(), XMLQuery() and XMLTable() constructs
• Execution plan shows “XPATH EVALUATION”
• Reverse axes should be converted by user to more optimal forward axes
  
  \[
  \$p/PurchaseOrder/*/a[@id=”abc1”]/..
  \rightarrow
  \$p/PurchaseOrder/*[a/@id=”abc1”]
  \]

• Avoid descendant and wildcard axes if exact XPaths can be used.
  • Especially for large documents to avoid scanning unnecessary portions
Binary XML DML considerations

- For DML heavy workloads, enable caching on writes of underlying LOB column
- Use securefile for Binary XML storage if:
  - Documents are very large
  - Piece-wise updates form an important part of the workload
  - XMLIndex has been created on the XML column
XMLIndex considerations

• Query paradigm can determine choice of index
• XMLIndex (structured component)
  • Ideal for scalar value lookups
  • Speeding up queries on islands of structure
  • Author, Date, Title fields for example
  • Captures the “attributes” of an “entity” together using E/R Model
• XMLIndex (unstructured component)
  • Can handle wide variety of queries
  • Scalar value lookups and fragment identification/retrieval
  • Can index desired sub-trees including hierarchies
XMLIndex considerations

- Queries suited to XMLIndex (structured component)
  - Applications with stable XPaths
  - Query hierarchy is expressable as XMLTable constructs
  - Key value search having data types (dates, numbers)

- Queries suited to XMLIndex (unstructured component)
  - Applications with ad-hoc queries
  - Exact list of paths cannot be predicted (path subsetting required)
  - Queries requiring hierarchy computations

- XMLIndex can have both components
  - Mix of either class of queries
Structured XMLIndex guidelines

• Use Structured XMLIndex in place of multiple functional indexes
  • All expressions can be accessed and populated efficiently
• Index and Query datatypes should correspond
• Use structured XMLIndex for relational paradigm over XML data
  • Relational views can be defined over XML using XMLTable()
  • XMLTable() construct can be efficiently indexed
• Create secondary indexes for predicates
Structured XMLIndex guidelines

- Split up fragment extraction from document identification
  - Fragment extraction in SELECT list using XMLQuery()
  - Can efficiently use Binary XML streaming evaluation
  - Document identification in WHERE clause using XMLExists()
  - Can use structured XMLIndex

- Use SQL ORDER BY instead of XQuery “order by”
  - Project out ordering keys as columns in XMLTable()
  - Use them in SQL ORDER BY clause
  - Better match for picking up structured XMLIndex
Unstructured XMLIndex guidelines

- Consists of path table (path, value pairs) and secondary indexes (PIKEY, VALUE)
- Execution plan should show usage of unstructured XMLIndex
  - The Path table name should appear
  - One of the secondary indexes should be used
- Drop PIKEY index if only simple XPath filtering is needed
  - Instead create PATHID index directly on PATHID column
- Create datatype aware secondary indexes
  - CreateNumberIndex and CreateDateIndex
Path subsetting considerations

- Path subsetting reduces index size
  - Faster population
  - Faster queries
- The explain plan output should be used to verify that path subsetted index is being picked
- Ensure paths used in predicates are indexed
- Exclude paths that are better evaluated by Binary XML streaming evaluation
Using SQL/XML for Text Searches

• Example query:
  SELECT XMLQuery()
  FROM DocTable
  WHERE XMLExists()
  AND CONTAINS()

• Create XMLIndex on DocTable with optional paths (structured or unstructured)
• Create Text Index on DocTable with desired settings
• Optimizer uses appropriate combination of indexes
Text Search Considerations

- Queries
  - Use SQL operator CONTAINS

- Path restriction
  - If complete document need not be indexed, use custom data source
  - Use INPATH inside CONTAINS for path restricted search (PATH_SECTION_GROUP)
  - Keywords can also be matched inside a particular complex element (XML_SECTION_GROUP with tags)

- Disk space usage
  - Optimal space usage since keywords are present only in text index
  - XML structure and values only in XMLIndex
Organizing Documents

• Documents can be stored in binary XML table
• Can be queried using XQuery
• In addition, XML DB repository can be used if:
  • Documents need to be organized and searched using a hierarchical file/folder metaphor
  • Documents need to be accessed using path/URL based protocols like FTP, HTTP, WebDaV etc.
  • Document lifecycle needs to be managed using Content Management models:
    • Security policies using ACLs
    • Simple versioning
Organizing Schema-based Documents

- Documents conforming to XML schema controlled by xdb:defaultTable annotation
- Automatically route document to binary XML table
  - Using DBMS_XDB.CreateResource
  - Using Protocols

DocSchema.xsd
<element name="DocRoot" xdb:defaultTable="DOC_TAB"…>

Doc.xml
<DocRoot xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="DocSchema.xsd" >
  ….
Organizing Schema-less Documents

- Document metadata in XML DB repository
- Document contents in user’s binary XML table
- 2 ways of creating hierarchy
  - Using repository events
    - User’s PLSQL or Java code
    - Triggered during repository create operations
    - Can store content in desired binary XML table
  - XML DB repository stores “REF” to content
- Staging table with path, document key
  - Can store content in desired binary XML table using regular options like SQL-Loader etc.
  - XML DB repository stores “REF” to content
Oracle XML DB DEMOgrounds Booths

• Come by our DEMOgrounds booths to have one-on-one conversation with our team members
  • Moscone West: W-41, W-44, and W-61
Tuesday Sessions

S317480: Managing XML Content with Oracle XML: Getting the Best Bang for the Buck
Moscone South, Rm 200
2:00 PM – 3:00 PM

S317428: ProQuest Use Case
Moscone South, Rm 200
5:00 PM – 6:00 PM
Wednesday Sessions

S317650: S&P Use Case
Hotel Nikko, Nikko Ballroom I
10:00 AM – 11:00 AM

S319105: Interfacing with Your Database via Oracle XML DB
Hotel Nikko/Bay View
11:30 AM – 12:30 PM

S317648: PolarLake Use Case, XDK, and XQJ
Hotel Nikko Nikko Ballroom I
1:00 PM – 2:00 PM
Thursday Sessions

S317504: Waters Use Case and Structured XML Index
Moscone South, Rm 200
10:30 AM – 11:30 AM

S317528: Working with Complex XML Schemas: Not as Hard as You Might Think
Hotel Nikko Nikko Ballroom I
2:00 PM – 3:00 PM

S317657: XBRL Expert Panel - Using Oracle Database as an XBRL Repository
Hotel Nikko Nikko Ballroom I
3:30 PM – 4:30 PM