Building PHP Applications with Berkeley DBXML

George Schlossnagle

2005-08-04

OSCON

What is DBXML?

Sleepycat DB4 + Document Parser + Query Engine

- Embeddable engine
- Robust storage engine for XML documents
- Fast, indexed searching

DB4

- Berkeley DB4 is a high-performance, enterprise-grade embedded database engine
- Support for:
  - Transactions
  - Locking
  - Online Backups
  - Support for XA and Replication
  - Data Agnostic

DB4 Concepts: Db4

- A Berkeley DB4 database.
- Supports:
  - key/value lookup
  - cursor support
  - multiple storage mechanism
  - supports alternative indexes and joins via secondary databases
  - platform-independent storage

DB4 Concepts: DbEnv

- A Database Environment that encapsulates one or more DBs, and provides:
  - Nested transactions
  - Replication Support
  - Write-ahead logging
  - Multiple databases per file

DB4 Concepts: Db4Txn

- Standard transaction semantics
- Nested transactions for decomposing large transactions into smaller components.

DBXML Concepts

DBXML Concepts: XmlContainer

- A collection of XML documents
- One-to-one correspondence to a db4 database
- Indexes are bound to this container

DBXML Concepts: Indexes

- Indexes are critical for query performance against collections.
- Indexes are defined on a container.
- Indexes can be defined for equality, presence or substring.
- Indexes can be on node content, attributes, or metadata.

DBXML Concepts: XmlManager

- A factory object that manages XmlContainers.
- Optionally bound to a db4 environment context

DBXML Concepts: XmlDocument

- An XML Document (whoda thunk?)
- Lives in a XmlContainer
- Documents are uniquely named within their container.

DBXML: Under the Hood

- Xerces (XML parsing and handling)
- Pathan (XPath parsing and evaluation, built on Xerces)
- XQuery (XQuery implementation built on Pathan)
- Limitations for PHP:
  - PHP's native XML handling is libxml2 based
  - Passing to other XML extensions requires conversion

DBXML Concepts: XQuery

- A W3C Draft Recommendation.
- XQuery is an XML query language built as an extension on XPath 2.0.
- Queries can span:
  - A document
  - A collection of documents in an XmlContainer
  - Multiple collections of documents.

DBXML Concepts: Path Expressions (I)

/ A documents root
/Foo Foo nodes under the root node
/Foo/Bar Bar nodes that are a child to Foo
/*/Bar Bar nodes under any node under the root node
//* Shorthand for all nodes in the document
. The current node
.. The current node's parent
/Foo/@baz The baz attribute of Foo
//Foo All Foo nodes, anywhere
//myns:Foo All Foo nodes in the namespace aliased to 'myns'

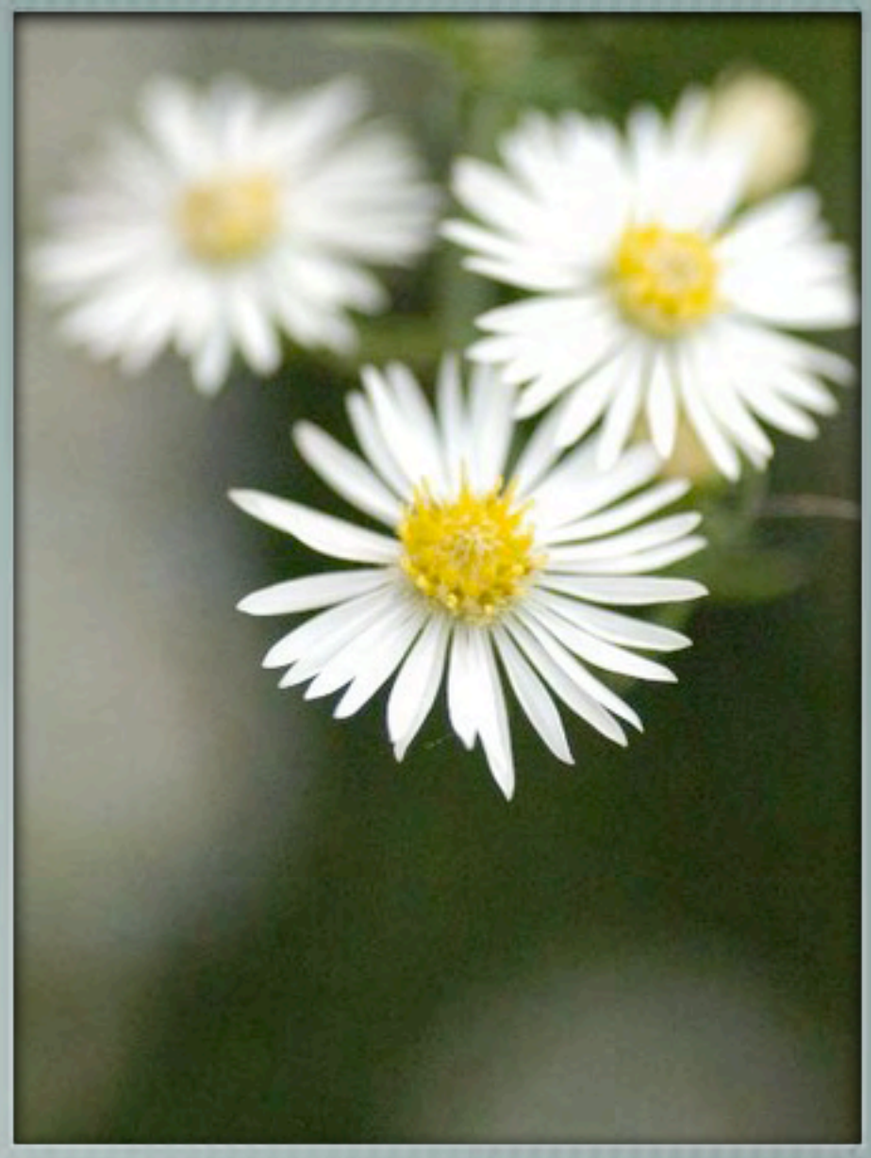
DBXML Concepts: Path Expressions (II)

```
//Foo[@bar = 'baz']
/Foo[@number > 100 and @number < 200]
//Foo[../@bar = 'baz']
//Foo[count(./Bar) > 1]

doc("my.dbxml/doc.xml")/Foo
doc("file:/var/tmp/doc.xml")/Foo
collection("my.dbxml")/Foo
```

FLWOR Power!

- XQuery Query Structure
  - FOR
  - LET
  - WHERE
  - ORDER BY
  - RETURN



DBXML Concepts: FLOWR in Action

```
<results>
 {
 let $con := collection("books.dbxml")
 for $book in $con/Item
 let $t := $book/ItemAttributes/Title
 let $p := $book/ItemAttributes/ListPrice/Amount
 let $prettyprice := $book/ItemAttributes/ListPrice/FormattedPrice
 where count($book/ItemAttributes/Author) > 1
 order by $p ascending
 return
  <result>
   <title>{$t}</title>
   <price>{$prettyprice}</price>
  </result>
 }
</results>
```

XQuery UDFs

```
declare function local:summary($books as element(Item)*)
   as element(results)*
{
   for $d in distinct-values($items/Publisher)
   let $e := $books[Publisher = $d]
   return
      <results>
        <publisher>{$d}</publisher>
        <bookcnt> {count($e)} </bookcnt>
        <pagecount> {sum($e/NumberOfPages)} </pagecount>
      </results>
};


local:summary(collection("books.dbxml")//Item/[Author = "Herman Melville"])
```

DBXML Concepts: Index Types

- Uniqueness = (unique)?
- Path Types = (node | edge)?
- Node Types = (element | attribute | metadata)
- Key = (equality | presence | substring)
- Type = (string | boolean | date | ...)
- Examples:
  - node-element-equality-string
  - node-attribute-equality-floats
  - node-element-substring-string
  - metadata-equality-string

DBXML in Practice

Where To Get It

- Go to: http://www.sleepycat.com
- Berkeley DBXML Package contains all you need
- PHP Components:
  - db-4.3.x/mod_db4 - An Apache (1.3) module for coordinating recovery and providing environment caching.
  - db-4.3.x/php_db4 - A PHP wrapper for DB4
  - dbxml/src/php - A PHP wrapper for DBXML
- Read the READMEs!

DBXML Defined Classes

class XmlManager {}
class XmlContainer {}
class XmlData {}
class XmlDocument {}
class XmlIndexSpecification {}
class XmlModify {}
class XmlQueryContext {}
class XmlQueryExpression {}
class XmlResults {}
class XmlValue {}
class XmlUpdateContext {}
class XmlTransaction {}
class XmlInputStream {}
class XmlStatistics {}

Creating a Container and Adding Some Data

```
$book_name = 'book1';
$book_content = '<book><title>Knowledge Discovery in Databases.</title></book>';
```

```
$mgr = new XmlManager(null);
if(file_exists("test.dbxml")) {
    $mgr->openContainer("test.dbxml");
} else {
    $con = $mgr->createContainer("test.dbxml");
}
$con->putDocument($book_name, $book_content);
```

Extracting Data From a Container

```
$mgr = new XmlManager(null);
$con = $mgr->openContainer("test.dbxml");
$results = $mgr->query("collection('test.dbxml')/book");

$results->reset();
while($results->hasNext())
{
    $val = $results->next();
    $doc = $val->asDocument();
    print $doc->getName()." = ".$val->asString()."\n";
}
```

Querying with Namespaces

```
$mgr = new XmlManager(null);
$con = $mgr->openContainer("test.dbxml");
$qc = $mgr->createQueryContext();
$qc->setNamespace("books2", "http://foo.bar.com/books.dtd");

$query = $mgr->query("collection('test.dbxml')/*[books2:title='Knowledge Discovery in Databases.']", $qc);
$results->reset();
while($results->hasNext())
{
    $val = $results->next();
    $doc = $val->asDocument();
    print $doc->getName()." = ".$val->asString()."\n";
}
```

Adding Indexes to a Container

```
$mgr = new XmlManager(null);
$ns = ‘’;
$node = ‘title’;
$con = $mgr->createContainer("test.dbxml");
$con->addIndex($ns, $node, "node-element-equality-string");
```

Reflecting Indexes

```
$mgr = new XmlManager();
$con = $mgr->openContainer("test.dbxml");
$con->addIndex("", "title", "node-element-equality-string, edge-element-equality-string");
$indexes = $con->getIndexSpecification();
foreach($indexes->getIndexes() as $a) {
    var_dump($a);
}
```

Using Prepared Queries

```
$qc = $mgr->createQueryContext();
$qc->setVariableValue("title", "");
$query = $mgr->prepare("collection('test.dbxml')//*[title=\$title]", $qc);
foreach($titles as $title) {
  $qc->setVariableValue("title", "Knowledge Discovery in Databases.");
  $results = $query->execute($qc);
  // ...
}
```

Query Local Documents

```
$mgr = new XmlManager(null);
$results = $mgr->query("doc('file:./14.xml')/book");
```

```
$results->reset();
while($results->hasNext())
{
    $val = $results->next();
    $doc = $val->asDocument();
    print $doc->getName()." = ".$val->asString()."\n";
}
```

Performing DML on Documents (I)

```
$mgr = new XmlManager();
$qc = $mgr->createQueryContext();
$uc = $mgr->createUpdateContext();
$mod = $mgr->createModify();

$select = $mgr->prepare("/book/title", $qc);
$mod->addAppendStep($select, XmlModify_Element, "foo", "bar");

$retdoc = $mgr->query("collection('test.dbxml')/book");
$mod->execute($retdoc, $qc, $uc);
```

Performing DML on Documents (II)

```
$mgr = new XmlManager();
$qc = $mgr->createQueryContext();
$uc = $mgr->createUpdateContext();
$mod = $mgr->createModify();

$select = $mgr->prepare("/book/title", $qc);
$mod->addUpdateStep($select, "bar");
$retdoc = $mgr->query("collection('test.dbxml')/book");
$mod->execute($retdoc, $qc, $uc);
```

Managing Containers

```
$mgr = new XmlManager();
$con = $mgr->createContainer("test1.dbxml");
$mgr->renameContainer("test1.dbxml", "test2.dbxml");
```

```
$con = $mgr->openContainer("test2.dbxml");
$mgr->removeContainer("test2.dbxml");
```

Using DbEnvs

```
$env = new Db4Env();
$env->open();
$mgr = new XmlManager($env);
$txn = $mgr->createTransaction();
$con = $mgr->createContainer($txn, "test.dbxml", DBXML_TRANSACTIONAL);
$doc = $mgr->createDocument();
$doc->setContent($book_content);
$doc->setName($book_name);
$con->putDocument($txn, $doc);
$txn->commit();
```

Transactions Spanning Multiple Containers

```
$env = new Db4Env();
$env->open();
$mgr = new XmlManager($env);
$txn = $mgr->createTransaction();
$con1 = $mgr->openContainer($txn, "test.dbxml");
$con2 = $mgr->openCContainer($txn, "test2.dbxml");
$con1->putDocument($txn, $book_name, $book_content);
$con2->putDocument($txn, $book_name, $book_content);
$txn->commit();
```

Join Collections in a Query

```
$query = '<html><body>
  <ul>
    {
    for $component in collection("components.dbxml")/component
    return
    <li>
     <b>Component number: {$component/@number/text()}</b><br/>
     {
       for $part-ref in $component/uses-part
       return
         for $part in collection("parts.dbxml")/part[@number = $part-ref cast as xs:decimal]
         return
           <p>{$part/description/text()}</p>
     }
    </li>
   }
  </ul>
</body></html>';
```

Future Bits

- Better PHP5 Support (iterators)
- High-Level wrappers (hide the gory details)
- DBXML 2.2 (Q4)
- DB-4.4 (Q4?)
- Apache 2 Support for mod_db4?

Thanks!

Questions?