# DB2 pureXML

| | |
|---|---|
| **Module ID** | 10116 |
| **Length** | 45 minutes |

**For questions about this presentation contact** askdata@ca.ibm.com

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# Module Information

- You should have completed or acquired the necessary knowledge for the following modules in order to complete this module:
  - DB2 Fundamentals

- After completing this module, you should be able to:
  - Explain the concept of:
    - XML storage in DB2
    - XQuery
    - XPath


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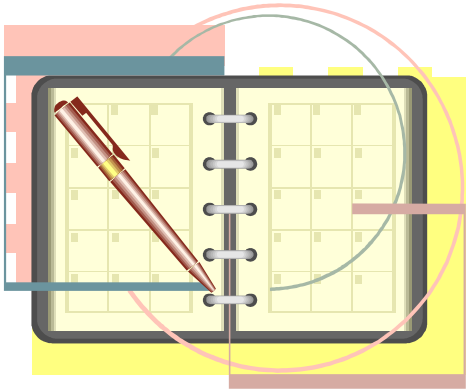
# Module Content

- **pureXML in DB2**
  - pureXML engine
  - XML storage
- **Basic Operations**
- **XQuery and SQL/XML**
- **XML Indexes in DB2**
- **Summary**

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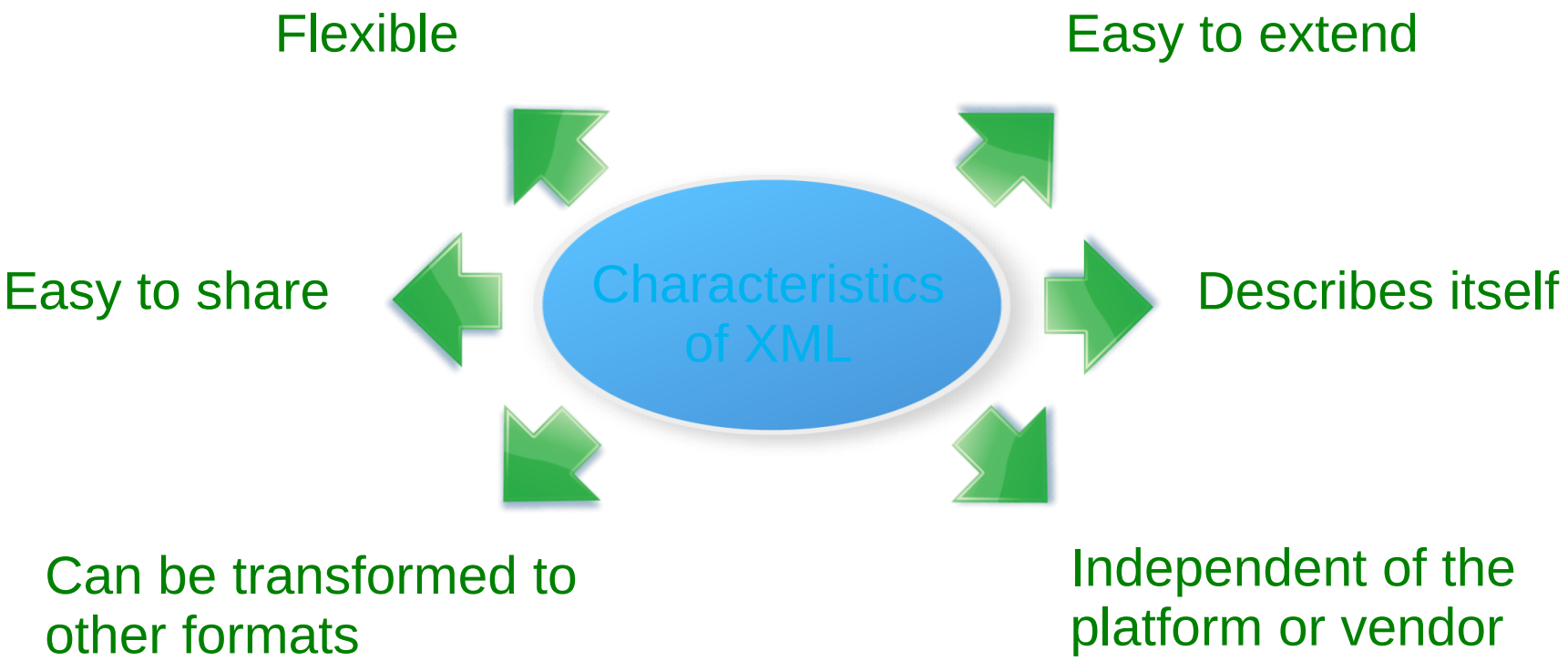
# What is XML?

- eXtensible Markup Language
  - XML is a language designed to describe data
- A hierarchical data model





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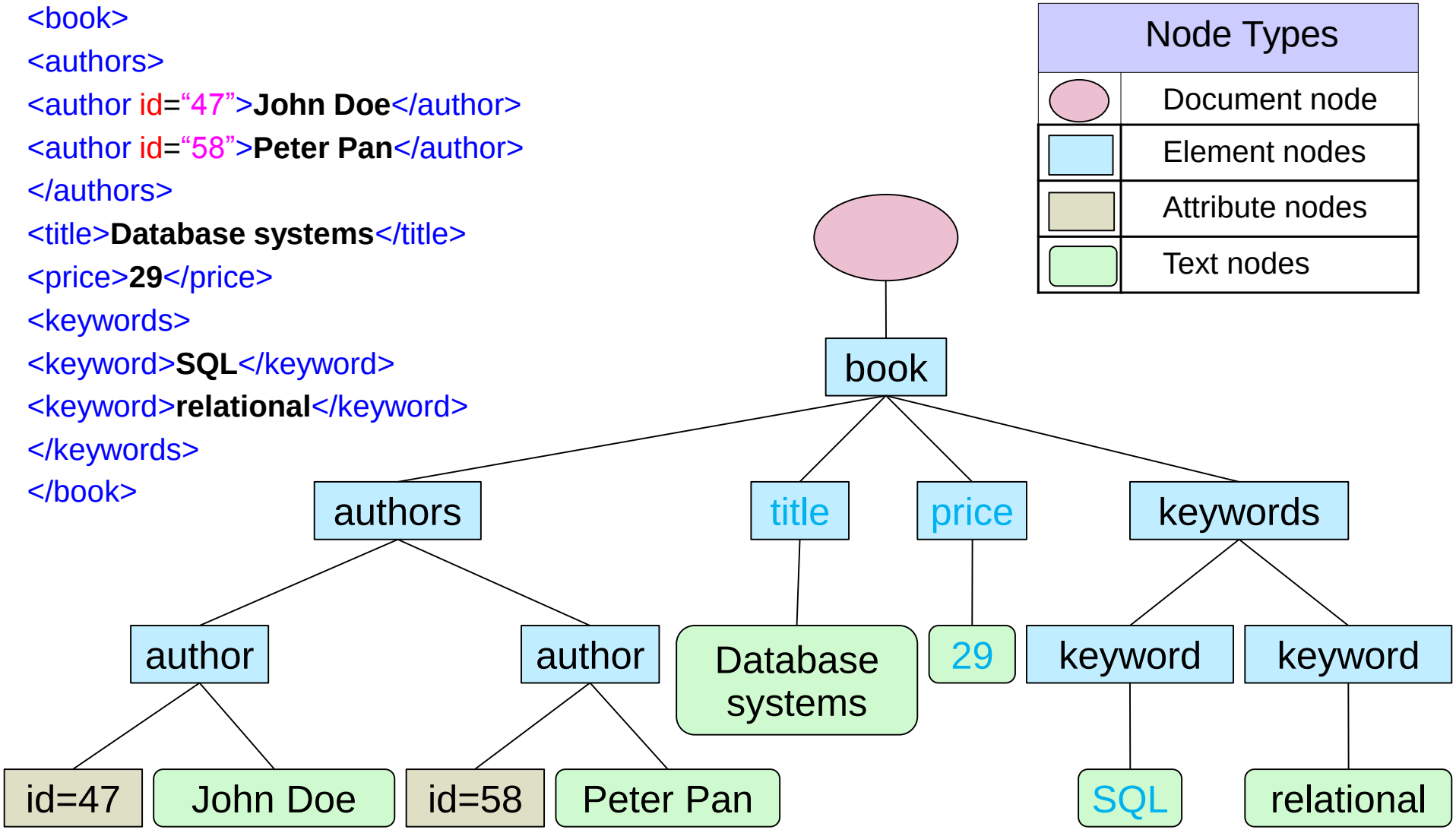
# The XML Data Model: Node Types

```
<book>
<authors>
<author id="47">John Doe</author>
<author id="58">Peter Pan</author>
</authors>
<title>Database systems</title>
<price>29</price>
<keywords>
<keyword>SQL</keyword>
<keyword>relational</keyword>
</keywords>
</book>
```





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# Relational Versus Hierarchical (XML) Model

| Relational | Hierarchical (XML) |
|---|---|
| Relational data is flat | XML data is nested. |
| Relational model is set oriented. Sets are unordered. | XML retrieves sequences (the order matters) |
| Relational data is structured. | XML data is semi-structured. |
| Relational data has a strong schema, unlikely to change often. | XML data has a flexible schema, appropriate for constant changes. |
| Use NULL for an unknown state. | NULLS don't exist. Don't add any XML element. |
| Based on the ANSI/ISO industry standards. | Based on the W3C industry standards. |

With DB2 you can store and process both.



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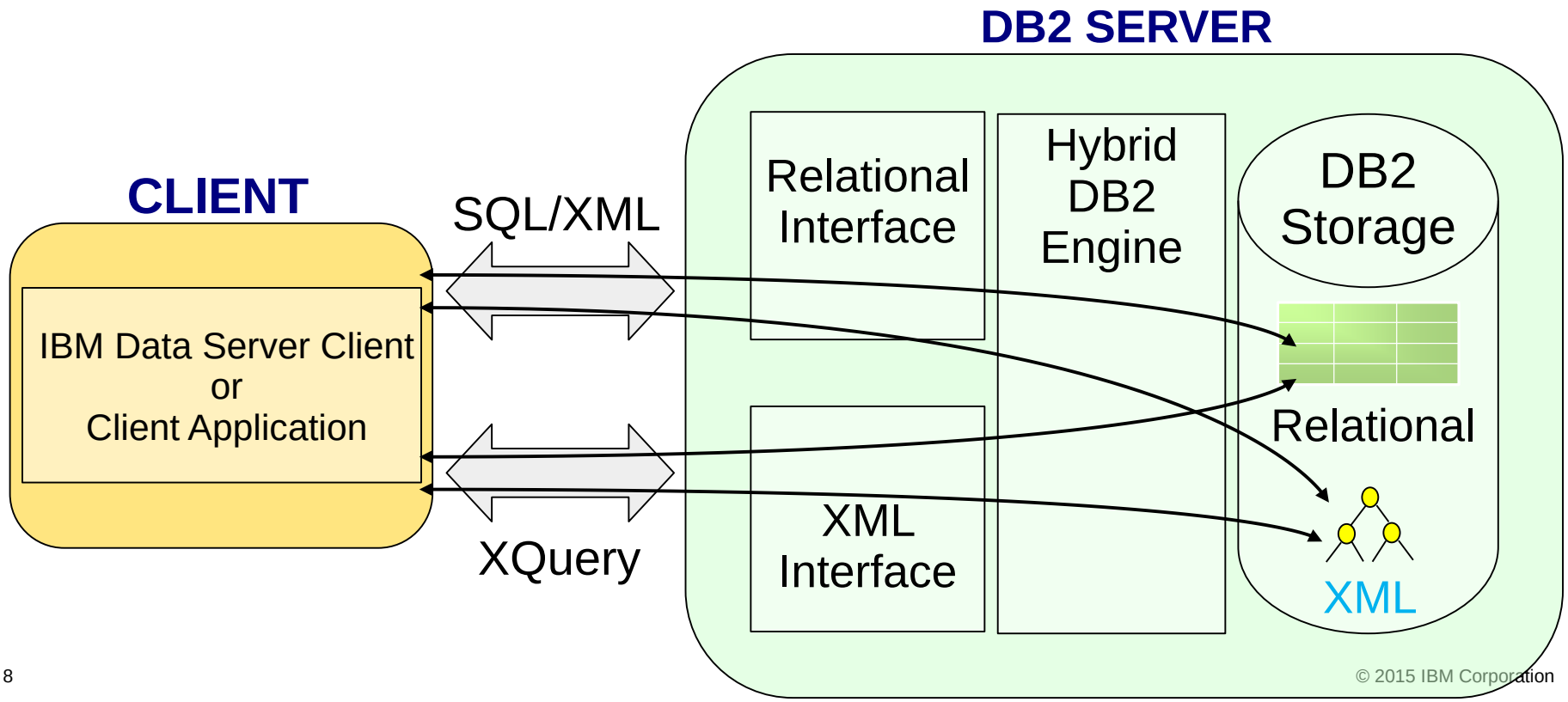
# The pureXML Engine

- Relational and XML data are stored differently, but closely linked
- XML Capabilities in all DB2 components
- Combine XML and relational data
- Binary XML format is supported for faster data transmission between Java application and DB2 server

**New in DB2 10**





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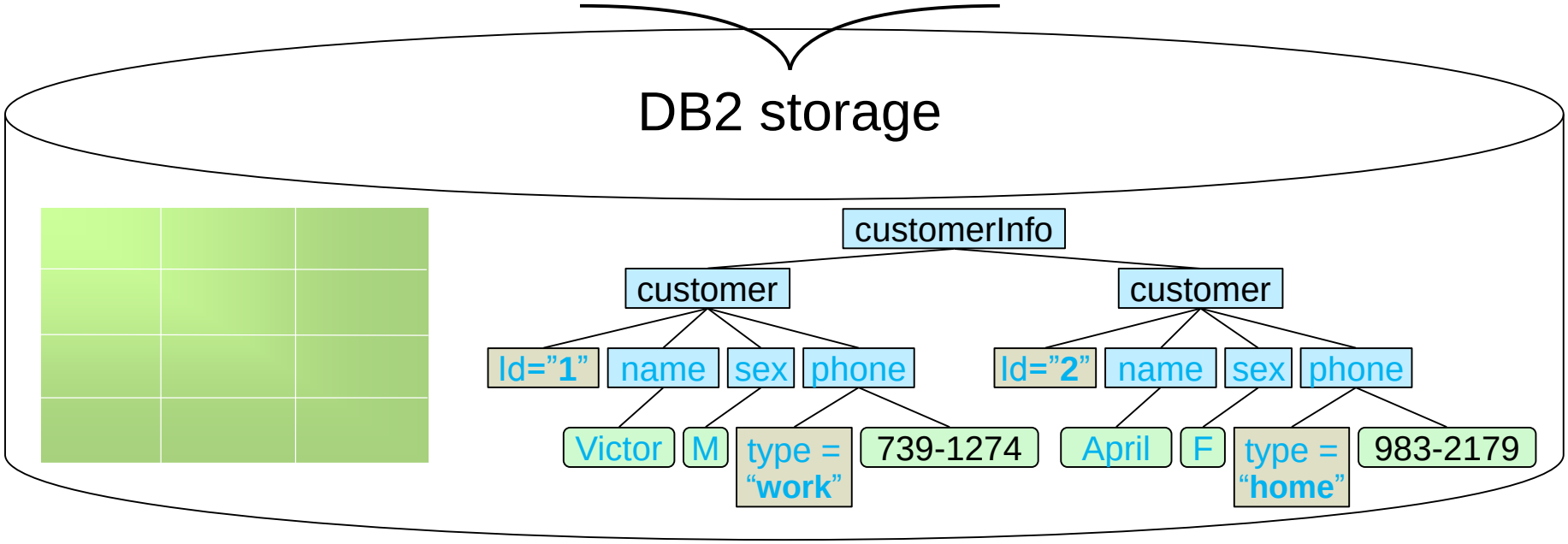
# pureXML Storage in DB2: XML Data Type

```
CREATE TABLE dept (deptID VARCHAR(30), ..., custDoc XML)
```

| deptID | ... | custDoc |
|---|---|---|
| A001 | .. | |
| A002 | .. | |





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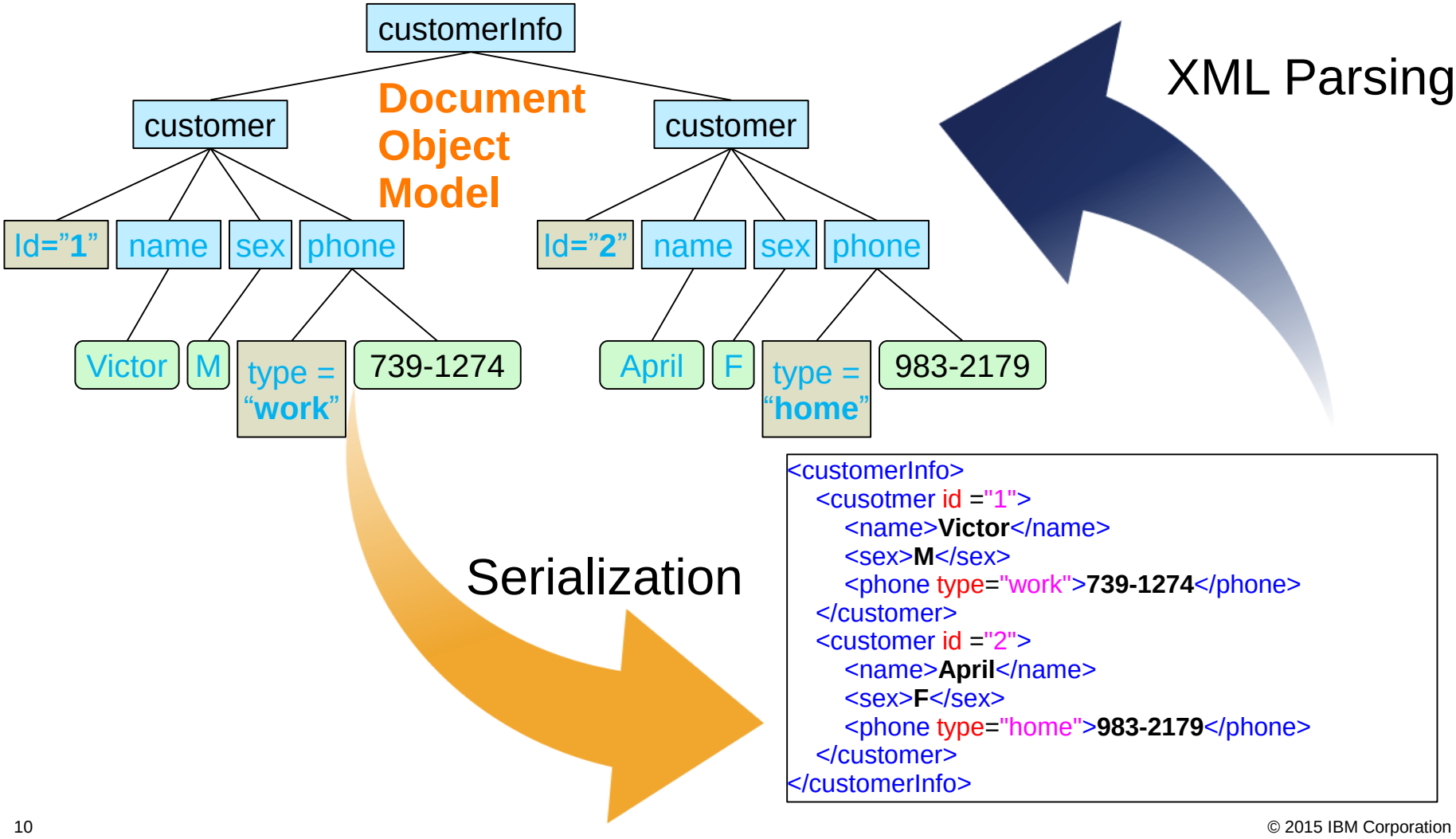
# Storage as XML Document Tree

- Documents are stored in parsed representation





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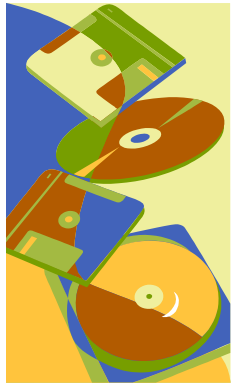
# Storing XML: Native XML Storage

- Relational columns are stored in relational format (tables)
- Values of XML columns are stored natively (XML documents in parsed hierarchical format), encoded in UTF-8
- XML values are stored:
  - In the pureXML storage area (by default). A descriptor points from row to XML storage
  - Or inlined in row, if enabled for XML document smaller than 32KB.
- No XML parsing for query evaluation!
- XML data can be compressed



**New in DB2 10**



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# How to get Data In?

- Implicit XML parsing:
  - Inserting data of XML data type info a column

```
 INSERT INTO dept VALUES
('PR27', …, '<dept>…<emp>…</emp>…</dept>')
```

- Explicit XMLPARSE
  - Transform XML value from serialized (text) form into internal representation.
  - Tell system how to treat whitespaces (strip/preserve)
    - Default is 'Strip WHITESPACE'

```
 INSERT INTO dept VALUES ('PR27', xmlparse(document
'<a>...</a>'));
 INSERT INTO dept VALUES ('PR27',
    xmlparse(document '<a>...</a>' preserve whitespace));
```



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# Deleting XML Data

- DELETE
  - Will delete every XML document for a row

```
DELETE FROM dept WHERE deptID='A001'
```

  - You can also delete based on the XML content

```
DELETE FROM dept WHERE
    XMLEXISTS ('$d//phone[type="Home"]'
                passing INFO as "d")
```

- Note: Setting an XML column to NULL deletes the XML document

```
UPDATE dept SET custDoc = NULL WHERE deptID='A001'
```


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# Import

DEL file to import

```
import from /data/dept.del of del
XML from /data/xmlfiles
insert into dept
```

**/data/dept.del**

```
1000,"<XDS FIL='deptdoc.001.xml' />"
1001,"<XDS FIL='deptdoc.002.xml' />"
1002,"<XDS FIL='deptdoc.003.xml' />"
1003,"<XDS FIL='deptdoc.004.xml' />"
1004,"<XDS FIL='deptdoc.005.xml' />"
```

**/data/xmlfiles**

```
/data/xmlfiles/deptdoc.001.xml
/data/xmlfiles/deptdoc.002.xml
/data/xmlfiles/deptdoc.003.xml
/data/xmlfiles/deptdoc.004.xml
/data/xmlfiles/deptdoc.005.xml
```

Directory that includes the XML files that are referenced in the DEL file

**dept**

| | |
|---|---|
| 1000 | <dept><employee><name>John Doe</name><br><address><street>555 Bailey Ave</street><city>…</city><zip>95141</zip><br></address>…</employee></dept> |
| 1001 | <dept><employee><name>Kathy Smith</name> … |
| 1002 | <dept><employee><name>Jim Noodle …. |



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# Export

```
EXPORT TO /data/dept.del of DEL
XML TO /data/xmlfiles
XMLFILE deptdoc
MODIFIED BY XMLINSEPFILES
SELECT * FROM dept
```

- DEL file to output
- Directory to place XML files
- Base name for exported XML files
- Store each XML document in separate file (Optionally: Concatenate all XML documents in one large file.)
- What to export

**dept**

| | |
|---|---|
| 1000 | <dept><employee><name>John Doe</name><br><address><street>555 Bailey Ave</street><city>…</city><zip>95141</zip><br></address>…</employee></dept> |
| 1001 | <dept><employee><name>Kathy Smith</name> … |
| 1002 | <dept><employee><name>Jim Noodle …. |

**/data/dept.del**

```
1000,"<XDS FIL='deptdoc.001.xml' />"
1001,"<XDS FIL='deptdoc.002.xml' />"
1002,"<XDS FIL='deptdoc.003.xml' />"
1003,"<XDS FIL='deptdoc.004.xml' />"
1004,"<XDS FIL='deptdoc.005.xml' />"
```

**/data/xmlfiles**

```
/data/xmlfiles/deptdoc.001.xml
/data/xmlfiles/deptdoc.002.xml
/data/xmlfiles/deptdoc.003.xml
/data/xmlfiles/deptdoc.004.xml
/data/xmlfiles/deptdoc.001.xml
```


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# SQL/XML and XQuery

- XPath
  - Cornerstone for both XQuery and SQL/XML standard
  - Provides ability to navigate within XML documents
- XQuery
  - Query language for XML data
  - Can be embedded into SQL via SQL/XML standard
  - DB2 LUW : Can be used via XQuery interface
- SQL/XML
  - Provides functions to work with both XML and relational data at the same time.
  - Embed XPath and XQuery expressions into SQL to query XML data
  - Turn XML data into relational (table) form
  - Produce XML out of relational data
  - Enhanced XML casting in DB2 10
  - Improved XML query performance in DB2 10


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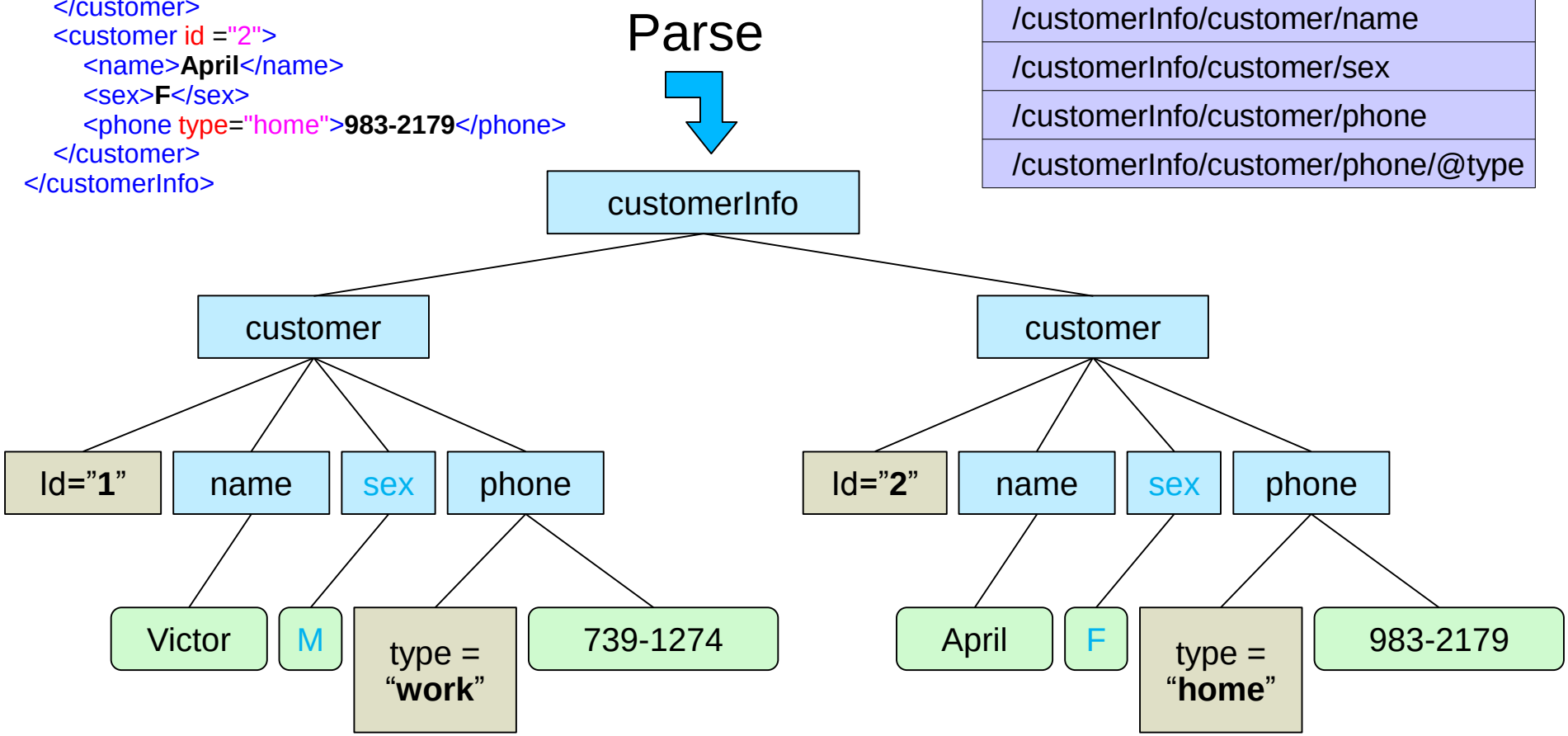
# XPath

```
<customerInfo>
   <customer id ="1">
      <name>Victor</name>
      <sex>M</sex>
      <phone type="work">739-1274</phone>
   </customer>
   <customer id ="2">
      <name>April</name>
      <sex>F</sex>
      <phone type="home">983-2179</phone>
   </customer>
</customerInfo>
```

| Path Table |
|---|
| / |
| /customerInfo |
| /customerInfo/customer/@id |
| /customerInfo/customer/name |
| /customerInfo/customer/sex |
| /customerInfo/customer/phone |
| /customerInfo/customer/phone/@type |





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# Some Common XPath Expressions

```
<customerInfo>
   <customer id ="1">
      <name>Victor</name>
      <sex>M</sex>
      <phone type="work">739-1274</phone>
   </customer>
   <customer id ="2">
      <name>April</name>
      <sex>F</sex>
      <phone type="home">983-2179</phone>
   </customer>
</customerInfo>
```

| | |
|---|---|
| **/** | Selects from the root node. |
| **//** | Selects nodes in the document from the current node that match the select. |
| **text()** | Specifies the text node under an element. |
| @ | Specifies an attribute. |
| ***** | Matches any element node. |
| @* | Matches any attribute node. |
| **[ … ]** | Predicates |

| XPath Expression | Result Description | Result |
|---|---|---|
| `/customerInfo/*/phone/text()` | Selects the text node under the **phone** element of **customerInfo** | **739-1274**<br>**983-2179** |
| `/customerInfo//phone/@type` | Selects the `type` attribute under the **phone** element of **customerInfo** | **work**<br>**home** |
| `/customerInfo/customer[1]/phone/text()` | Selects the **phone** element text node under the first **customer** of **customerInfo** | **739-1274** |
| `/customerInfo//phone[@type='home']` | Selects all **phone** elements under **cusomterInfo** which has an attribute named type with a value of 'home' | **<phone type = "home”>**<br>**983-2179**<br>**</phone>** |

# SQL/XML Functions

- XQuery can be invoked from SQL
  - **`XMLQUERY()`**
  - **`XMLTABLE()`**
  - **`XMLEXISTS()`**
- By executing XQuery expressions from within the SQL context, you can:
  - Operate on parts of stored XML documents instead of entire XML documents
  - Enable XML data to participate in SQL queries
  - Operate on both relational and XML data
  - Apply further SQL processing to the returned XML values


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# Query and Extract XML data

- XMLQUERY
  - Scalar function, applied once to each qualifying document
  - Evaluates an XPath (or XQuery) expression
  - Input arguments can be passed into the XQuery (e.g. column names, constants, parameter markers)
  - Returns a sequence of 0, 1 or multiple items from each document

***XMLCUSTOMER***

| CID | INFO |
|---|---|
| 1001 | |
| 1002 | |
| 1003 | |

```
SELECT
  XMLQUERY('$i/customerinfo/name'
  PASSING INFO AS "i")
FROM
  CUSTOMER
```

| 1 |
|---|
| <name>...</name> |
| <name>...</name> |
| ... |



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# Query and Extract XML Data

- XMLTABLE
  - Creates a temporary SQL table using XML data

***XMLCUSTOMER***

| CID | INFO |
|---|---|
| 1001 | |
| 1002 | |
| 1003 | |

```
SELECT T.*
FROM XMLTABLE(
    'db2-fn:xmlcolumn("XMLCUSTOMER.INFO")/customerinfo'
     COLUMNS "NAME" VARCHAR (20) PATH 'name',
             "STREET" VARCHAR (20) PATH 'addr/street',
             "CITY" VARCHAR (20) PATH 'addr/city'
) AS T
```

```
<customerinfo>
  <name>John Smith</name>
  <addr country="Canada">
    <street>Fourth</street>
    <city>Calgary</city>
    <prov-state>Alberta</prov-
state>
    <pcode-zip>M1T 2A9</pcode-zip>
  </addr>
  <phone type="work">
    963-289-4136
  </phone>
</customerinfo>
```

| NAME | STREET | CITY |
|---|---|---|
| Amir Malik | Young | Toronto |
| John Smith | Fourth | Calgary |
| … | … | … |



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# SQL/XQuery XML Data for SQL Developers

- XMLEXISTS
  - Predicate that tests if an XQuery expression returns a sequence

***XMLCUSTOMER***

| CID | INFO |
|---|---|
| 1001 | |
| 1002 | |
| 1003 | |

```
SELECT CID, INFO
FROM XMLCUSTOMER WHERE
XMLEXISTS(
    '$d/customerinfo[name = "John Smith"]'
    passing INFO as "d")
```

```
<customerinfo>
  <name>John Smith</name>
  <addr country="Canada">
    <street>Fourth</street>
    <city>Calgary</city>
    <prov-state>Alberta</prov-
state>
    <pcode-zip>M1T 2A9</pcode-zip>
  </addr>
  <phone type="work">
    963-289-4136
  </phone>
</customerinfo>
```

| CID | INFO |
|---|---|
| 1003 | |



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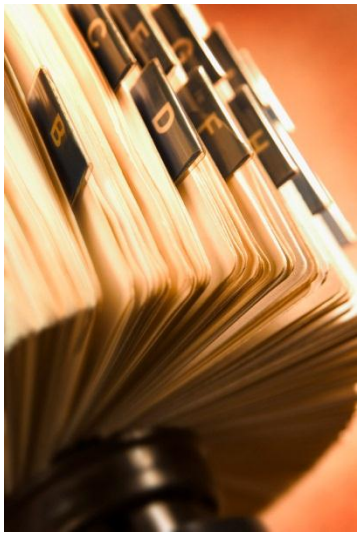
# Indexing

- Several data types supported
  - **VARCHAR** and **VARCHAR HASHED**
  - **DATE** and **TIMESTAMP**
  - **DOUBLE**, **DECIMAL**, **INTEGER**

**New in DB2 10**

- Nodes identified using XPath-like pattern
  - Navigation within documents similar to query
  - Supports functional XML indexes
    - **fn:exists()**
    - **fn:upper-case()**

**New in DB2 10**



```
CREATE INDEX custname_IX ON XMLCUSTOMER(INFO)
GENERATE KEY USING XMLPATTERN '/customerinfo/name'
AS SQL VARCHAR(60);

CREATE INDEX custname_IX ON XMLCUSTOMER(INFO)
GENERATE KEY USING XMLPATTERN
'/customerinfo/name/fn:upper-case(.)'
AS SQL VARCHAR(60);
```



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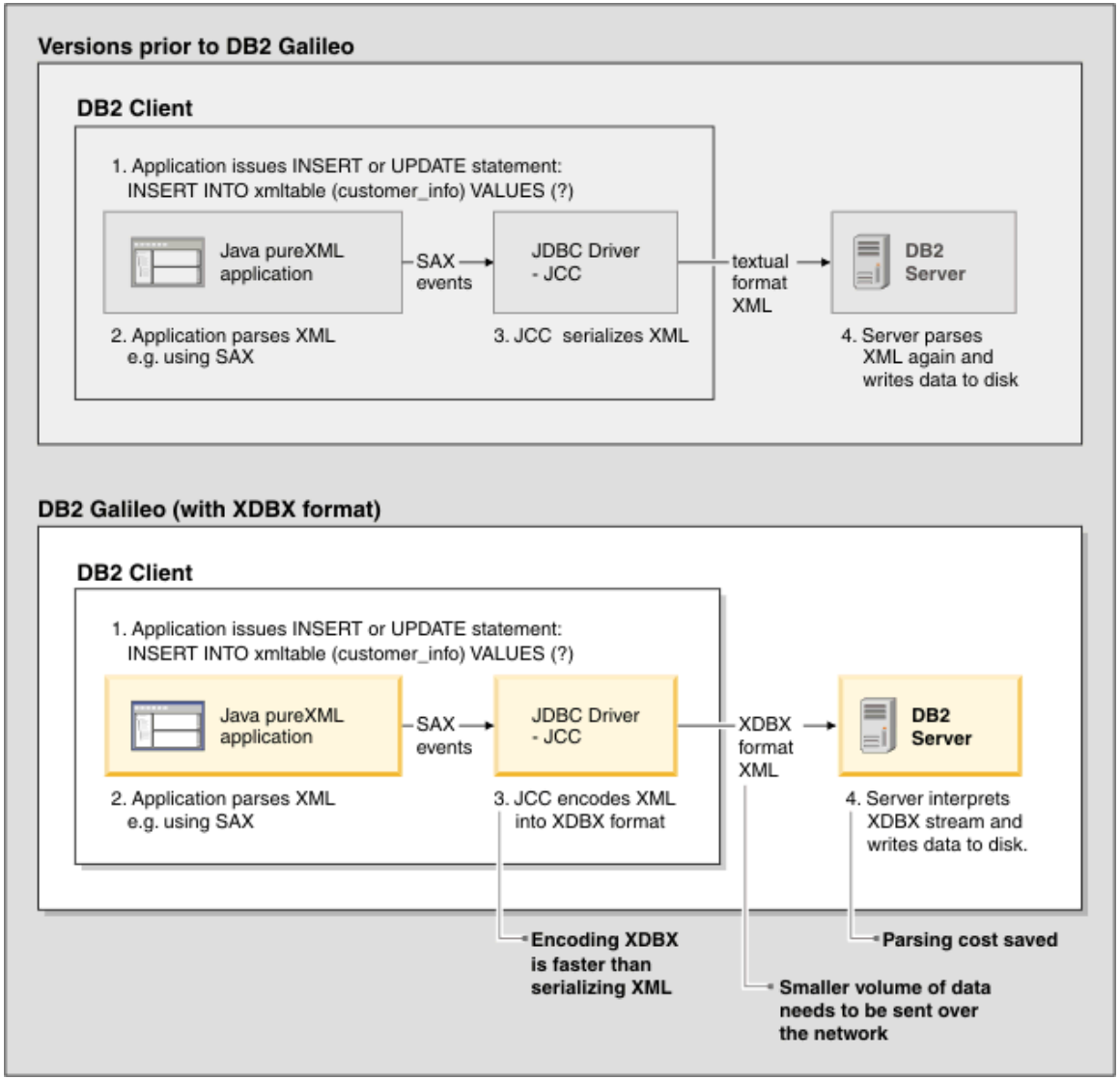
# Improved Insert/Query Performance with Binary XML Format

**New in DB2 10**

- Improve end to end performance of client/server applications using JDBC or SQLJ interfaces
- Avoid conversion between XML as text and internal format (client / server) by introducing XDBX
  - Already used in DB2 for z/OS
  - Simple to generate, simple to parse
  - Provides improved end to end performance
- Transparent to applications
- Storage and retrieval of binary XML data requires version 4.9 or later of the IBM Data Server Driver for JDBC and SQLJ





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# Summary

- Native XML hierarchical storage
  - No shredding, no CLOBs, no BLOBs required
  - Optimized for XPath and XQuery processing

- High performance
  - Superior indexing technology
  - No parsing of XML data at query runtime

- Fully integrated XML and relational processing
  - Seamlessly query various types of data at once
  - SQL/XML functions for combining SQL and XQuery
  - No internal translation of XQuery into SQL


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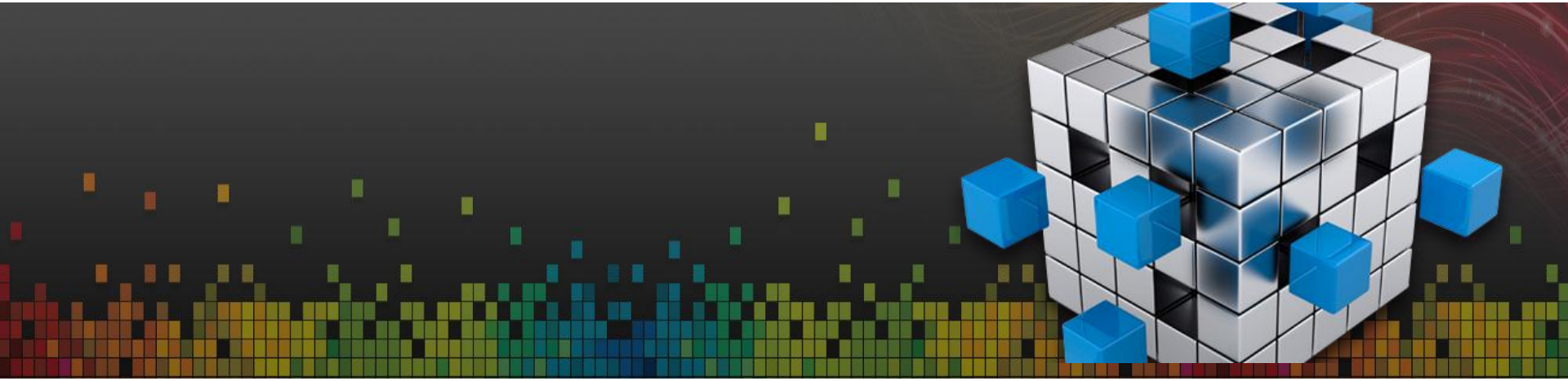
# The next steps…



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# The Next Steps…

- Complete the online quiz for this module
  - Log onto SKI, go to “My Learning” page, and select the “In Progress” tab.
  - Find the module and select the quiz
- Provide feedback on the module
  - Log onto SKI, go to “My Learning” page
  - Find the module and select the “Leave Feedback” button to leave your comments

# Questions?
# askdata@ca.ibm.com



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