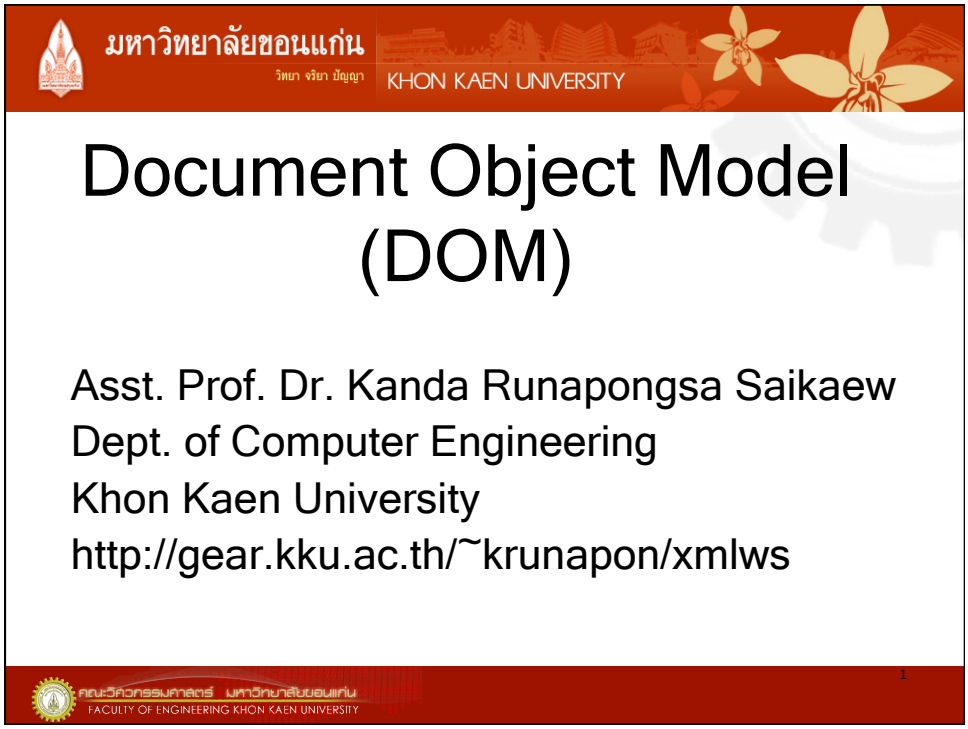
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KHON KAEN UNIVERSITY
Document Object Model (DOM)
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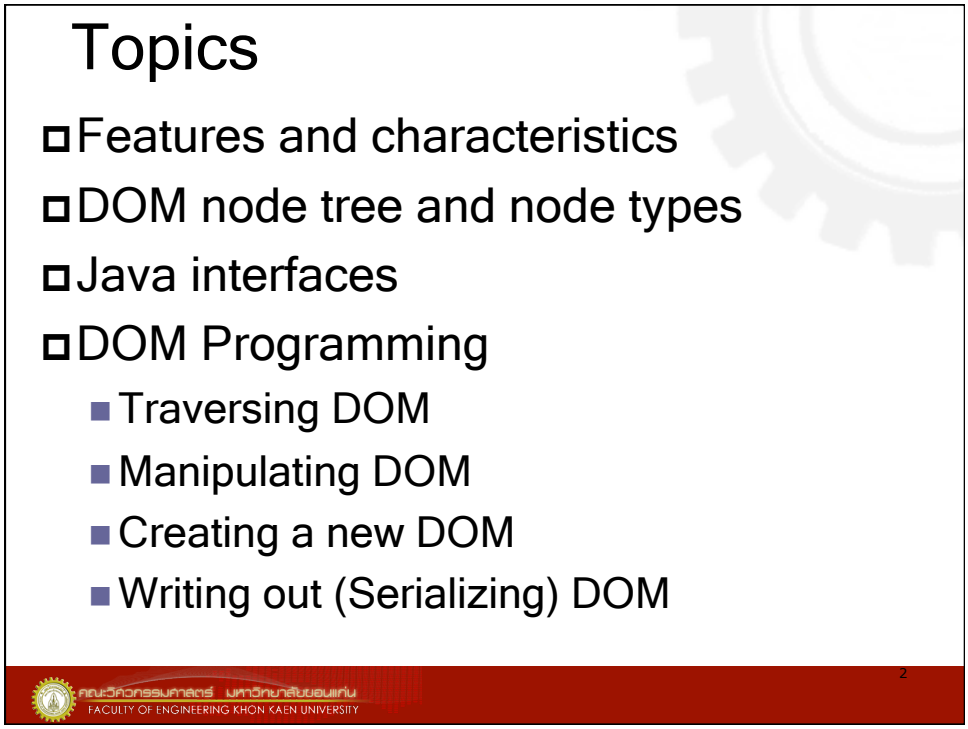
Topics
Features and characteristics
DOM node tree and node types
Java interfaces
DOM Programming
Traversing DOM
Manipulating DOM
Creating a new DOM
Writing out (Serializing) DOM
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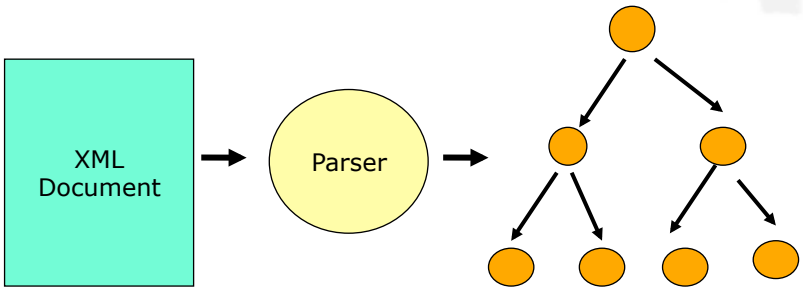
Document Object Model

- Define how XML and HTML documents are represented as objects in programs
- W3C Standard
- Defined in IDL; this language independent
- HTML as well as XML
- Writing as well as reading
- DOM focuses more on the document, SAX focuses more on the parser

DOM Characteristics

- Access XML document as a tree structure
- Composed of mostly element nodes and text nodes
- Can “walk” the tree back and forth
- Larger memory requirements
  - Fairly heavyweight to load and store
- Use it when for walking and modifying the tree

DOM in Action



DOM Tree and Nodes

- XML document is represented as a tree
- A tree is made of nodes
- There are 12 different node types
- Nodes may contain other nodes (depending on node type)
  - Parent node contains child nodes

Tree

- According to DOM, an XML document is a tree made up of nodes of several types
- The tree has a single root node, and all nodes in this tree except for root have a single parent node
- Each node has a list of child nodes
  - How to call a node that has the empty list of children?
    - A leaf node

Tree and Nodes

- There can also be nodes that are not part of the tree structure
  - Each attribute node belongs to one element node but is not considered to be a child of that element
- A full DOM document is composed of
  - A tree of nodes
  - Various nodes that are somehow associated with other nodes but are not themselves part of the tree

Tree Node Types (1/2)

- DOM divides nodes into twelve types, seven of which can potentially be part of a DOM tree
  - Document nodes
  - Element nodes
  - Text nodes
  - Attribute nodes

Tree Node Types (2/2)

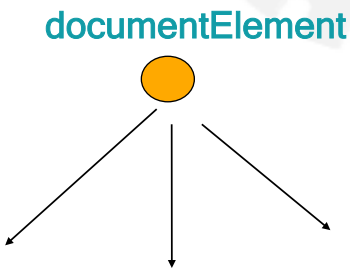
- Types of a node in DOM
  - Processing instruction nodes
  - Comment nodes
  - Document type nodes
  - Document fragment nodes
  - Notation nodes
  - CDATA section nodes
  - Entity nodes
  - Entity reference nodes

Tree Node Types Example

Node Type	Example
Document type	**<!DOCTYPE** nation SYSTEM “nation.dtd”>
Processing instruction	<?**xsl:stylesheet** version="1.0" xmlns:xsl= http://www.w3.org/1999/XSL/Transform?>
Element	**<nation** id=“th”>…**</nation**> **<name>**Thailand**</name>**
Attribute	**id=“th”**
Text	<name>**Thailand**</name>

Tree View of the XML Document

- documentElement is the root node of the tree
- documentElement has the type as Document node



DOM Tree Hierarchy

- A document node contains
  - One element node (root element node)
  - One or more processing instruction nodes
- An element node may contain
  - Other element nodes
  - One or more text nodes
  - One or more attribute nodes
- An attribute node contain
  - A text node

Tree Nodes (1/2)

- Besides its tree connections, each node has a local name, a namespace URI, and a prefix
  - Example:

```
<html xmlns:h="http://www.w3.org/tr/html">
  <h:booktitle/>
</html>
```

  - Local name: booktitle
  - Namespace URI: http://www.w3.org/tr/html
  - Prefix: h
  - Qualified name: h:booktitle

Tree Nodes (2/2)

- Though for several kinds of nodes, local name, namespace URI, and prefix may be null
  - For instance, these information of a comment are always be null

<!-- comment -->

  - Comment node does not have its name, its namespace URI, and its prefix

Tree Node Names

- For an element or attribute, the node name is the prefixed name
  - Example: <**h:booktitle**>
- For the notation or entities, the node name is the name of the thing
  - <!ENTITY **xml** “Extensible Markup Language”>
- For nodes without names such as text nodes, the node name is the value from the following list matching the node type
  - **#comment**

Tree Node Values

- Each node has a string value
- For text-ish things like text nodes and comments, this tends to be the text of the node
  - <name>**Thailand**</name>
- For attributes, it's normalized value of the attribute
  - <nation id="**th**">…</nation>
- For everything else, including elements and documents, the value is null

Example XML Document

```
<?xml version="1.0"?>
<nation id="th">
   <name>Thailand</name>
   <location>Southeast
Asia</location>
</nation>
```

- Document node
  - Element node "nation"
    - Text node
    - Element node "name"
      - Text node "Thailand"
    - Text node
    - Element "location"
      - Text node "Southeast Asia"
    - Text node
    - * Attribute node "id"
      - Text node "th"

Node Interface

- Primary data type in DOM
- Represents a single node in a DOM tree
- Every node is Node interface type
  - Since every node is a Node interface type, every node can be processed in the same way (polymorphism)
- Specialized interfaces contain additional or more convenient methods

Methods in Node Interface

- Most frequently used interface methods
  - public short getNodeType()
  - public String getNodeName()
  - public String getNodeValue()
  - public Node getParentNode()
  - public Node getPreviousSibling()
  - public Node getNextSibling()
  - public NamedNodeMap getAttributes()
  - public NodeList getChildNodes()

Node Interface (1/3)

```
public interface Node {
        // NodeTypes
        public static final short ELEMENT_NODE = 1;
        public static final short ATTRIBUTE_NODE = 2;
        public static final short TEXT_NODE = 3;
        public static final short CDATA_SECTION_NODE = 4;
        public static final short ENTITY_REFERENCE_NODE = 5;
        public static final short ENTITY_NODE = 6;
        public static final short
        PROCESSING_INSTRUCTION_NODE = 7;
        public static final short COMMENT_NODE = 8;
        public static final short DOCUMENT_NODE = 9;
        public static final short DOCUMENT_TYPE_NODE = 10;
        public static final short DOCUMENT_FRAGMENT_NODE = 11;
        public static final short NOTATION_NODE = 12;
```


Node Interface (2/3)

```
public String getNodeName();
public String getNodeValue() throws DOMException;
public void setNodeValue(String nodeValue) throws
DOMException;
public short getNodeType ();
public Node getParentNode();
public NodeList getChildNodes();
public Node getFirstChild();
public Node getLastChild();
public Node getPreviousSibling();
public Node getNextSibling();
public NamedNodeMap getAttributes();
public Document getOwnerDocument( ) ;
public Node insertBefore (Node newChild , Node refChild) throws
DOMException;
```

Node Interface (3/3)

```
public Node replaceChild(Node newChild, Node oldChild)
throws DOMException ;
public Node removeChild(Node oldChild) throws
DOMException;
public Node appendChild(Node newChild ) throws
DOMException;
public boolean hasChildNodes ();
public Node cloneNode(boolean deep);
public void normalize();
public boolean supports(String feature, String version);
public String getNamespaceURI ();
public String getPrefix ();
public void setPrefix (String prefix) throws DOMException;
public String getLocalName ();
}
```


NodeList Interface

- Represents a collection of nodes
- Return type of getChildNodes() method of Node interface

```
public interface NodeList {
   public Node item(int index);
   public int getLength();
}
```

NamedNodeMap Interface

- Represents a collection of nodes each of which can be identified by name
- Return type of getAttributes() method of Node interface
- Most frequently used methods
  - public Node item(int index);
  - public int getLength();
  - pubic Node getNamedItem(String name);
  - public Node removeNamedItem(String name) throws DOMException;

Document Node (1/2)

- Root node of DOM tree
- Represents entire document
- Child node types
  - One element node
  - Optional document type node
  - Optional instruction nodes
  - Optional comment nodes

Document Node (2/2)

- If the document contains any comments or processing instructions before or after the root element, then these will also be child nodes of the document node

```
<?xml version="1.0"?>
<!DOCTYPE nation SYSTEM "nation.dtd">
<nation>…</nation>
```

- The document node has the document type node as the first child and has the <nation> element as the second child

Document Interface Purpose

- Contains factory methods for creating other nodes
  - Elements, text nodes, comments, processing instructions, etc.
- Method to get the root element node of the input XML document
  - Element getDocumentElement()

Document Interface

public interface Document extends Node {

- Attr createAttrbute (String name)
- Attr createAttributeNS(String namespaceURI, String qName)
- CDATASection createCDATASection (String data)
- Comment createComment(String data)
- DocumentFragment createDocumentFragment ()
- Element createElement(String tagName)
- Element createElementNS(String namespaceURI , String qName)
- EntityReference createEntityReference(String name)
- ProcessingInstruction createProcessingInstruction (String target, String data)
- Text createTextNode(String data)
- DocumentType getDocType()
- Element getDocumentElement ()
- Element getElementById(String elementId)
- NodeList getElementsByTagName(String tagName)
- NodeList getElementsByTagNameNS(String namespaceURI, String localName)
- DOMImplementation getImplementation()
- Node importNode(Node importNode , boolean deep) }

Document Node Example

```
// Create an instance of a DOM parser and
// get the Document Object
DocumentBuilderFactory factory =
DocumentBuilderFactory.newInstance();
DocumentBuilder parser =
factory.newDocumentBuilder();

// xmlDoc is the root node of DOM tree
Document xmlDoc = parser.parse(filePath);

// obtain the root element of the document
Element rootElement =
xmlDoc.getDocumentElement();
```

Element Node

- Represents an element
  - Includes start tag, end tag, content
- Child node types
  - Element nodes
  - Attribute nodes
  - Processing instruction nodes
  - Comment nodes
  - Text nodes
  - CDATASection nodes
  - EntityReference nodes

Element Interface

```
public interface Element extends Node {
        public String getTagName ();
        public String getAttribute (String name);
        public void setAttribute (String name, String value) throws DOMException;
        public void removeAttribute(String name) throws DOMException ;
        public Attr getAttributeNode(String name);
        public Attr setAttributeNode (Attr newAttr ) throws DOMException;
        public Attr removeAttributeNode(Attr oldAttr) throws DOMException;
        public NodeList getElementsByTagName(String name);
        public String getAttributeNS(String namespaceURI, String localName);
        public void setAttributeNS(String namespaceURI, String qualifiedName,
String value) throws DOMException;
        public void removeAttributeNS(String namespaceURI , String
localName) throws DOMException;
        public Attr getAttributeNodeNS(String namespaceURI , String localName);
        public Attr setAttributeNodeNS(Attr newAttr ) throws DOMException ;
        public NodeList getElementsByTagNameNS(String namespaceURI ,
String localName);  }
```

Element Node

- Using methods of Node interface
  - Element name
    - getNodeName()
  - Attribute names and values
    - NamedNodeMap getAttributes()
  - Child elemenets
    - NodeList getChildNodes()

Element Node Example

```
if (node.getNodeType() == Node.ELEMENT_NODE) {
        NodeList nodeList = node.getChildNodes();
        for (int i = 0; i < nodeList.getLength(); i++)  {
                Node childNode = nodeList.item(i);
                if (childNode.hasAttributes()) {
                        NamedNodeMap attrMap =
        node.getAttributes();
                        for (int j = 0; j < attrMap.getLength(); j++)  {
                                Attr attribute = (Attr) attrMap.item(j);
                        System.out.println(attribute.getName()
                                        +"="+attribute.getValue());
                        }
                }
    }
}
```

Text Node

- Represents textual content of an element or attribute
- Contains only pure text, no markup
- A text node for each contiguous run of pure text
  - Element with no sub-elements
    - Text is represented in a single Text object
  - Element with sub-elements
    - Many Text objects
- Use getNodeValue() to return text

Attribute Node

- Represents an attribute
- Child node types
  - Text nodes
  - Entity reference nodes
- Node interface methods
  - getNodeName() returns name of attribute
  - getNodeValue() returns value of attribute

Attr Interface

```
public interface Attr extends Node {
        String getName();
        Element getOwnerElement();
        boolean getSpecified();
        String getValue() ;
        void setValue(String);
}
```


JAXP

- A thin and lightweight Java API for parsing and transforming XML documents
- Allows for pluggable parsers and transformers
- Allows parsing of XML document using
  - Event-driven (SAX 2.0)
  - Tree based (DOM Level 2)

DOM Programming Procedures

- Create a parser object
- Read or set properties
- Parse XML document and get Document object
- Perform operations
  - Traversing DOM
  - Manipulating DOM
  - Creating a new DOM
  - Writing out DOM

Create a Parser Object (Sample)

```
import javax.xml.parsers.*;
import java.io.File;
import org.w3c.dom.*;
public class JAXPChecker {
        …
        String documentName = argv[0];
        DocumentBuilderFactory factory =
        DocumentBuilderFactory.newInstance();
        try {
                DocumentBuilder builder =

        factory.newDocumentBuilder();
                Document doc = builder.parse( new
                        File(documentName));

        …
        }
```

Read or set builder properties

- For reading/setting
  - is/set Validating: validate the XML content during parse
  - is/set Coalescing: convert CDATA nodes to Text nodes and append it to the adjacent (if any) text node
  - is/set ExpandEntityReferences: expand entity reference nodes
  - is/set NamespaceAware: provide support for XML namespaces

Read/set builder properties (Sample)

```
import javax.xml.parsers.*;
import java.io.File;
import org.w3c.dom.*;
public class JAXPChecker {
        …
    DocumentBuilderFactory factory =
            DocumentBuilderFactory.newInstance();
    factory.setValidating(true);
    factory.setNamespaceAware(true);
    System.out.println("coalescing or not " +
        factory.isCoalescing());
```

Validating (Sample 1/2)

```
// Create a SchemaFactory capable of
// understanding W3C XML Schemas (WXS)
SchemaFactory schemaFactory =

   SchemaFactory.newInstance(      XMLConstants
   .W3C_XML_SCHEMA_NS_URI);

// Set the error handler to receive any
// error during Schema compilation
         schemaFactory.setErrorHandler(new
   MyErrorHandler());
```


Validating (Sample 2/2)

```
// Load a WXS schema, represented by a Schema instance
 Source schemaSource =
       new StreamSource(new File(xsdName));
 Schema schema =
schemaFactory.newSchema(schemaSource);

// Validate the XML file that refers to the schema instance
   Validator validator = schema.newValidator();
   validator.validate(new
         StreamSource(documentName));
```

Traversing DOM

- After we get document node, then we traverse DOM tree using methods
  - getChildNodes()
  - getFirstChild()
  - getLastChild()
  - getParentNode()
  - getNextSibling()
  - getPreviousSibling()

Traversing DOM Example

```
// note use of recursion
public void followNode(Node node) throws IOException {

  printer.writeNode(node);
  if (node.hasChildNodes()) {
    String name = node.getNodeName();
    int numChildren = node.getChildNodes().getLength();
    System.out.println("node " + name + " has " + numChildren
            + " children");
    Node firstChild = node.getFirstChild();
    followNode(firstChild);
  }
  Node nextNode = node.getNextSibling();
  if (nextNode != null) followNode(nextNode);

}
…
// Read the entire document into memory
 Node document = parser.parse(args[0]);
// Start processing from the root node of DOM tree
followNode(document);
```

Create an XML Document

- Create a new document node
- Use the document node to
  - Create element nodes
  - Create attribute nodes
  - Create text nodes
  - Link the relationships between those nodes
- Transform from DOM to an XML file

Create an XML Document (1/2)

```
// Create a new Document node
Document doc = builder.newDocument();
// Create various nodes
Element root = doc.createElement("profile");
        Element nameE = doc.createElement("name");
        Text nameT = doc.createTextNode("Kanda
Saikaew");
// Link relationships between created nodes
nameE.appendChild(nameT);
root.appendChild(nameE);
doc.appendChild(root);
```

Create an XML Document (2/2)

```
OutputStream os = new
FileOutputStream(xmlProfile);

TransformerFactory tf =
TransformerFactory.newInstance();

Transformer trans = tf.newTransformer();
        trans.transform(new
              DOMSource(doc),
              new StreamResult(os));
```


Create an XML Doc with Namespace

```
// default namespace
Element root = doc.createElementNS("http://www.kku.ac.th",
                "profile");
root.setAttribute("xmlns:xsi",                    "http://
www.w3.org/2001/XMLSchema-instance");
root.setAttribute("xsi:schemaLocation",   "http://www.kku.ac.th profile.xsd");
root.setAttribute("xmlns", "http://www.kku.ac.th");

// namespace with prefix
Element nameE = doc.createElementNS("http://gear.kku.ac.th", "name");
nameE.setAttribute("xmlns:coe", "http://gear.kku.ac.th");
nameE.setPrefix("coe");
```

Benefits of DOM

- Provides random-access manipulation of an XML file
  - Traverse from a node to its parent and its child very easily
- A DOM can be created from scratch or an existing file can be edited in memory
- Easy to develop a DOM parser
  - The developer does not need to design the model and the data structure for the model

Drawbacks of DOM

- Large documents could be problematic since the entire document is read into memory
- Performance could suffer using DOM with large document and/or limited memory availability
- No standard support for reading documents or writing DOM models out to files

Summary

- DOM Characteristics
  - DOM models XML document as a tree and keeps the tree in memory
- DOM node tree and node types
  - The root node of DOM tree is the document node which contains the root node of the input XML document
- DOM Programming
  - Traverse the document
  - Manipulate the document
  - Create the new document

References

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