


Lecture 12

Java XML & JSON, Reactive Streams Programming




presentation

Java Programming – Software App Development

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Agenda for Lecture 12





XML, XSD, X-Path / XSLT

XML & JSON Concepts



1. XML Concepts

XML Concepts:

« W3Schools Home

Next Chapter »



XML stands for eXtensible Markup Language.

XML is designed to transport and store data.

XML is important to know, and very easy to learn.

Start learning XML now!

XML Document Example

```
<?xml version="1.0" encoding="UTF-8"?>
<note>
  <to> Tove</to>
  <from>Jani</from>
  <heading>Reminder</heading>
  <body>Don't forget me this weekend!</body>
</note>
```

1. XML Concepts

XML Concepts:

What is XML?

- XML stands for EXtensible Markup Language
- XML is a markup language much like HTML
- XML was designed to carry data, not to display data
- XML tags are not predefined. You must define your own tags
- XML is designed to be self-descriptive
- XML is a W3C Recommendation

The Difference Between XML and HTML

XML is not a replacement for HTML.

XML and HTML were designed with different goals:

- XML was designed to transport and store data, with focus on what data is
- HTML was designed to display data, with focus on how data looks

HTML is about displaying information, while XML is about carrying information.

1. XML Concepts

XML Concepts:

XML Does Not DO Anything

Maybe it is a little hard to understand, but XML does not DO anything. XML was created to structure, store, and transport information.

The following example is a note to Tove, from Jani, stored as XML:

```
<note>
<to>Tove</to>
<from>Jani</from>
<heading>Reminder</heading>
<body>Don't forget me this weekend!</body>
</note>
```

The note above is quite self descriptive. It has sender and receiver information, it also has a heading and a message body.

But still, this XML document does not DO anything. It is just information wrapped in tags. Someone must write a piece of software to send, receive or display it.

With XML You Invent Your Own Tags

The tags in the example above (like <to> and <from>) are not defined in any XML standard. These tags are "invented" by the author of the XML document.

That is because the XML language has no predefined tags.

The tags used in HTML are predefined. HTML documents can only use tags defined in the HTML standard (like <p>, <h1>, etc.).

XML allows the author to define his/her own tags and his/her own document structure.

1. XML Concepts

XML Concepts – What about JSON?:

XML is Not a Replacement for HTML

XML is a complement to HTML.

It is important to understand that XML is not a replacement for HTML. In most web applications, XML is used to transport data, while HTML is used to format and display the data.

My best description of XML is this:

XML is a software- and hardware-independent tool for carrying information.

XML is a W3C Recommendation

XML became a W3C Recommendation on February 10, 1998.

XML is Everywhere

XML is now as important for the Web as HTML was to the foundation of the Web.

XML is the most common tool for data transmissions between all sorts of applications.

1. XML Concepts

XML Concepts:

XML Documents Form a Tree Structure

XML documents must contain a **root element**. This element is "the parent" of all other elements.

The elements in an XML document form a document tree. The tree starts at the root and branches to the lowest level of the tree.

All elements can have sub elements (child elements):

```
<root>
  <child>
    <subchild>.....</subchild>
  </child>
</root>
```

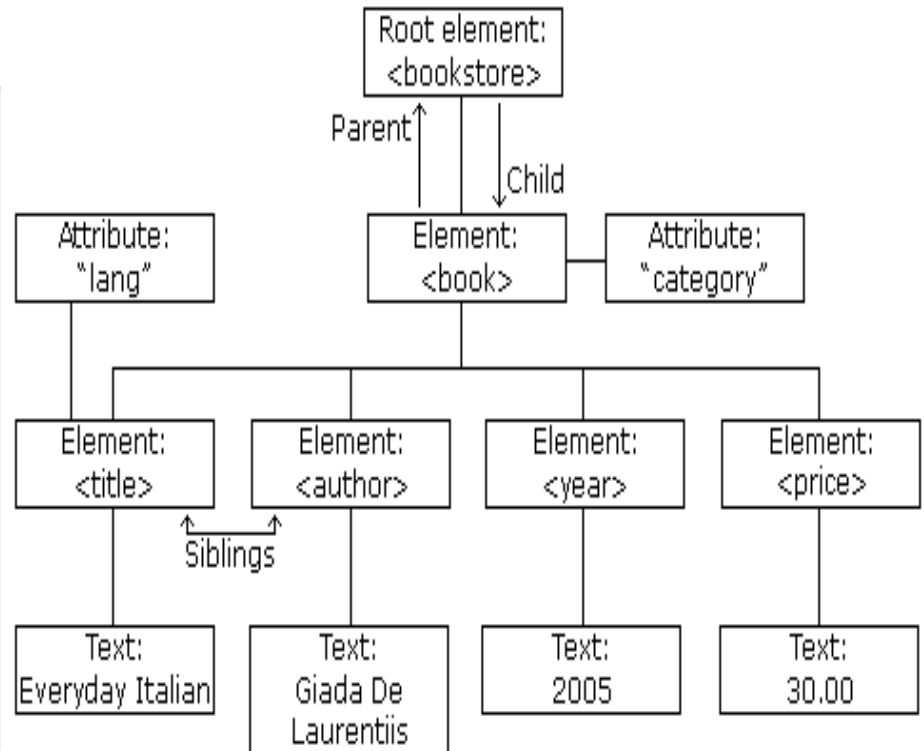
The terms parent, child, and sibling are used to describe the relationships between elements. Parent elements have children. Children on the same level are called siblings (brothers or sisters).

All elements can have text content and attributes (just like in HTML).

1. XML Concepts

XML Concepts:

```
<bookstore>
  <book category="COOKING">
    <title lang="en">Everyday Italian</title>
    <author>Giada De Laurentiis</author>
    <year>2005</year>
    <price>30.00</price>
  </book>
  <book category="CHILDREN">
    <title lang="en">Harry Potter</title>
    <author>J K. Rowling</author>
    <year>2005</year>
    <price>29.99</price>
  </book>
  <book category="WEB">
    <title lang="en">Learning XML</title>
    <author>Erik T. Ray</author>
    <year>2003</year>
    <price>39.95</price>
  </book>
</bookstore>
```



The root element in the example is `<bookstore>`. All `<book>` elements in the document are contained within `<bookstore>`.

The `<book>` element has 4 children: `<title>`, `<author>`, `<year>`, `<price>`.

1. XML Concepts

XML Concepts – Synthax:

All XML Elements Must Have a Closing Tag

In XML, it is illegal to omit the closing tag. All elements **must** have a closing tag:

```
<p>This is a paragraph.</p>  
<br />
```

XML Tags are Case Sensitive

XML tags are case sensitive. The tag <Letter> is different from the tag <letter>. Opening and closing tags must be written with the same case:

```
<Message>This is incorrect</message>  
<message>This is correct</message>
```

Note: "Opening and closing tags" are often referred to as "Start and end tags"

1. XML Concepts

XML Concepts – Synthax:

XML Elements Must be Properly Nested

In XML, all elements **must** be properly nested within each other:

```
<b><i>This text is bold and italic</i></b>
```

In the example above, "Properly nested" simply means that since the `<i>` element is opened inside the `` element, it must be closed inside the `` element.

XML Documents Must Have a Root Element

XML documents must contain one element that is the **parent** of all other elements. This element is called the **root** element.

```
<root>  
  <child>  
    <subchild>.....</subchild>  
  </child>  
</root>
```

1. XML Concepts

XML Concepts – Synthax:

XML Attribute Values Must be Quoted

XML elements can have attributes in name/value pairs just like in HTML.

In XML, the attribute values must always be quoted.

Study the two XML documents below. The first one is incorrect, the second is correct:

```
<note date=12/11/2007>  
  <to>Tove</to>  
  <from>Jani</from>  
</note>
```

```
<note date="12/11/2007">  
  <to>Tove</to>  
  <from>Jani</from>  
</note>
```

The error in the first document is that the date attribute in the note element is not quoted.

1. XML Concepts

XML Concepts – Synthax:

Entity References

Some characters have a special meaning in XML.

If you place a character like "<" inside an XML element, it will generate an error because the parser interprets it as the start of a new element.

This will generate an XML error:

```
<message>if salary < 1000 then</message>
```

To avoid this error, replace the "<" character with an **entity reference**:

```
<message>if salary &lt; 1000 then</message>
```

There are 5 predefined entity references in XML:

Comments in XML

The syntax for writing comments in XML is similar to that of HTML.

```
<!-- This is a comment -->
```

XML Stores New Line as LF

* Windows applications store a new line as: carriage return and line feed (CR+LF).

* Linux/Unix and Mac OSX uses LF.

<	<	less than
>	>	greater than
&	&	ampersand
'	'	apostrophe
"	"	quotation mark

1. XML Concepts

What is an XML Element?

An XML element is everything from (including) the element's start tag to (including) the element's end tag. An element can contain: * other elements, * text, * attributes, * or a mix of all of the previous...

```
<bookstore>
  <book category="CHILDREN">
    <title>Harry Potter</title>
    <author>J K. Rowling</author>
    <year>2005</year>
    <price>29.99</price>
  </book>
  <book category="WEB">
    <title>Learning XML</title>
    <author>Erik T. Ray</author>
    <year>2003</year>
    <price>39.95</price>
  </book>
</bookstore>
```

In the example above, <bookstore> and <book> have **element contents**, because they contain other elements. <book> also has an **attribute** (category="CHILDREN"). <title>, <author>, <year>, and <price> have **text content** because they contain text.

1. XML Concepts

XML Concepts - Namespace:

Name Conflicts

In XML, element names are defined by the developer. This often results in a conflict when trying to mix XML documents from different XML applications.

This XML carries HTML table information:

```
<table>
  <tr>
    <td>Apples</td>
    <td>Bananas</td>
  </tr>
</table>
```

This XML carries information about a table (a piece of furniture):

```
<table>
  <name>African Coffee Table</name>
  <width>80</width>
  <length>120</length>
</table>
```

If these XML fragments were added together, there would be a name conflict. Both contain a `<table>` element, but the elements have different content and meaning.

A user or an XML application will not know how to handle these differences.

1. XML Concepts

XML Concepts - Namespaces:

XML Namespaces - The xmlns Attribute

When using prefixes in XML, a so-called **namespace** for the prefix must be defined. The namespace is defined by the **xmlns attribute** in the start tag of an element. The namespace declaration has the following syntax. `xmlns:prefix="URI"`. In the example above, the xmlns attribute in the <table> tag give the h: and f: prefixes a qualified namespace.

When a namespace is defined for an element, all child elements with the same prefix are associated with the same namespace. Namespaces can be declared in the elements where they are used or in the XML root element.

Note: The namespace URI is not used by the parser to look up information.

The purpose is to give the namespace a unique name. However, often companies use the namespace as a pointer to a web page containing namespace information.

Try to go to <http://www.w3.org/TR/html4/>

```
<root
xmlns:h="http://www.w3.org/TR/html4/"
xmlns:f="http://www.w3schools.com/fur
niture">
```

```
<h:table>
  <h:tr>
    <h:td>Apples</h:td>
    <h:td>Bananas</h:td>
  </h:tr>
</h:table>
```

```
<f:table>
  <f:name>African Coffee Table</f:name>
  <f:width>80</f:width>
  <f:length>120</f:length>
</f:table>
```

```
</root>
```

1. XML Concepts

Validating XML – XSD – XML Schema:

An XML Schema describes the structure of an XML document, just like a DTD.

An XML document with correct syntax is called "Well Formed".

An XML document validated against an XML Schema is both "Well Formed" and "Valid".

XML Schema

```
<xs:element name="note">
```

```
<xs:complexType>
```

```
<xs:sequence>
```

```
<xs:element name="to" type="xs:string"/>
```

```
<xs:element name="from" type="xs:string"/>
```

```
<xs:element name="heading" type="xs:string"/>
```

```
<xs:element name="body" type="xs:string"/>
```

```
</xs:sequence>
```

```
</xs:complexType>
```

```
</xs:element>
```

The XML Schema is interpreted like this:

- `<xs:element name="note">` defines the element called "note"
- `<xs:complexType>` the "note" element is a complex type
- `<xs:sequence>` the complex type is a sequence of elements
- `<xs:element name="to" type="xs:string">` the element "to" is of type string (text)
- `<xs:element name="from" type="xs:string">` the element "from" is of type string
- `<xs:element name="heading" type="xs:string">` the element "heading" is of type string
- `<xs:element name="body" type="xs:string">` the element "body" is of type string

Everything is wrapped in "Well Formed" XML.

1. XML Concepts

XML Schema:

Why Use an XML Schema?

With XML Schema, your XML files can carry a description of its own format.

With XML Schema, independent groups of people can agree on a standard for interchanging data.

With XML Schema, you can verify data

XML Schemas are More Powerful than DTD

XML Schemas are written in XML

XML Schemas are extensible to additions

XML Schemas support data types

XML Schemas support namespaces

XML Schemas Support Data Types

One of the greatest strength of XML Schemas is the support for data types:

It is easier to describe document content

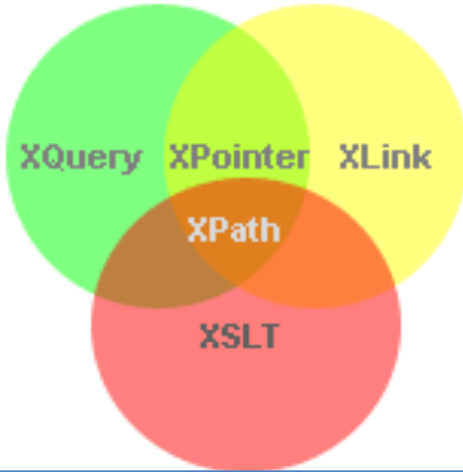
It is easier to define restrictions on data

It is easier to validate the correctness of data

It is easier to convert data between different data types

1. XML Concepts

XML Path: is a language for finding information in an XML document.



- XPath is a syntax for defining parts of an XML document
- XPath uses path expressions to navigate in XML documents
- XPath contains a library of standard functions
- XPath is a major element in XSLT
- XPath is also used in XQuery, XPointer and XLink
- XPath is a W3C recommendation

XPath Path Expressions

XPath uses path expressions to select nodes or node-sets in an XML document. These path expressions look very much like the expressions you see when you work with a traditional computer file system.

Today **XPath** expressions can also be used in **JavaScript, Java, XML Schema, PHP, Python, C and C++**, and lots of other languages

XPath is Used in XSLT

XPath is a major element in the XSLT standard. Without XPath knowledge you will not be able to create XSLT documents.

Xpath + XSLT Transformations + JSON should be detailed

Section Conclusion

Fact: **Java is working with various data structures encoding**

In few **samples** it is simple to understand: XML and JSON.





Java XML – SAX, DOM, XSLT, XPath, JAXB 2, org.json

Java XML & JSON Programming

2. Java XML Programming – see XML Samples

```
package eu.ase.jaxb;

import java.util.ArrayList;

import javax.xml.bind.annotation.XmlElement;
import javax.xml.bind.annotation.XmlElementWrapper;
import javax.xml.bind.annotation.XmlRootElement;

//This statement means that class "BookStore.java" is the root-element of our example
@XmlRootElement(namespace = "eu.ase.jaxb")
public class BookStore {

    // XmlElementWrapper generates a wrapper element around XML representation
    @XmlElementWrapper(name = "bookList")
    // XmlElement sets the name of the entities
    @XmlElement(name = "book")
    private ArrayList<Book> bookList;
    private String name;
    private String location;

    public void setBookList(ArrayList<Book> bookList) {
        this.bookList = bookList;
    }

    public ArrayList<Book> getBooksList() {
        return bookList;
    }

    public String getName() {
        return name;
    }

    public void setName(String name) {
        this.name = name;
    }

    public String getLocation() {
        return location;
    }
}
```

2. Java JSON Programming – see JSON samples

```
import java.io.FileWriter;
import java.io.IOException;

public class BuildJson1 {
    public static void main(String[] args) {
        try {
            JSONObject dataset = new JSONObject();
            dataset.put("genre_id", 1);
            dataset.put("genre_parent_id", JSONObject.NULL);
            dataset.put("genre_title", "International");
            // use the accumulate function to add to an existing value. The value
            // will now be converted to a list
            dataset.accumulate("genre_title", "Pop");
            // append to the key
            dataset.append("genre_title", "slow");
            dataset.put("genre_handle", "International");
            dataset.put("genre_color", "#CC3300");
            // get the json array for a string
            System.out.println(dataset.getJSONArray("genre_title"));
            // prints ["International","Pop","slow"]
            // increment a number by 1
            dataset.increment("genre_id");
            // quote a string allowing the json to be delivered within html
            System.out.println(JSONObject.quote(dataset.toString()));
            System.out.println("\n\nWrite to the file:\n\n");
            System.out.println(dataset.toString());

            FileWriter fw = new FileWriter(new File("myJsonObj.json"));
            fw.write(dataset.toString());
            fw.close();

            // prints
            // "{ \"genre_color\": \"#CC3300\", \"genre_title\": [\"International\", \"Pop\", \"slow\"],
            // \"genre_handle\": \"International\", \"genre_parent_id\": null, \"genre_id\": 2}"
        } catch (JSONException jsone) {
            jsone.printStackTrace();
        } catch (IOException ioe) {
            ioe.printStackTrace();
        }
    } //end main
} //end class
```


Section Conclusions

Please review Java XML and JSON samples.

Java XML-JSON Programming
for easy sharing



Java Programming & XML | JSON

Communicate & Exchange Ideas



Questions & Answers!

But wait...

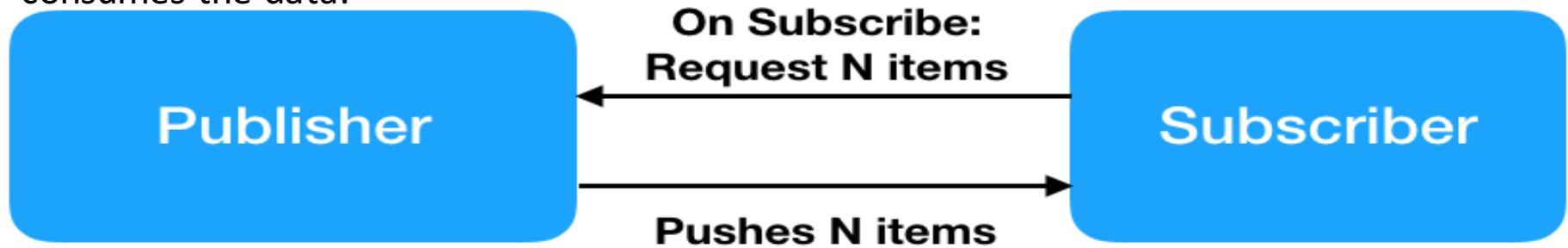
There's More!



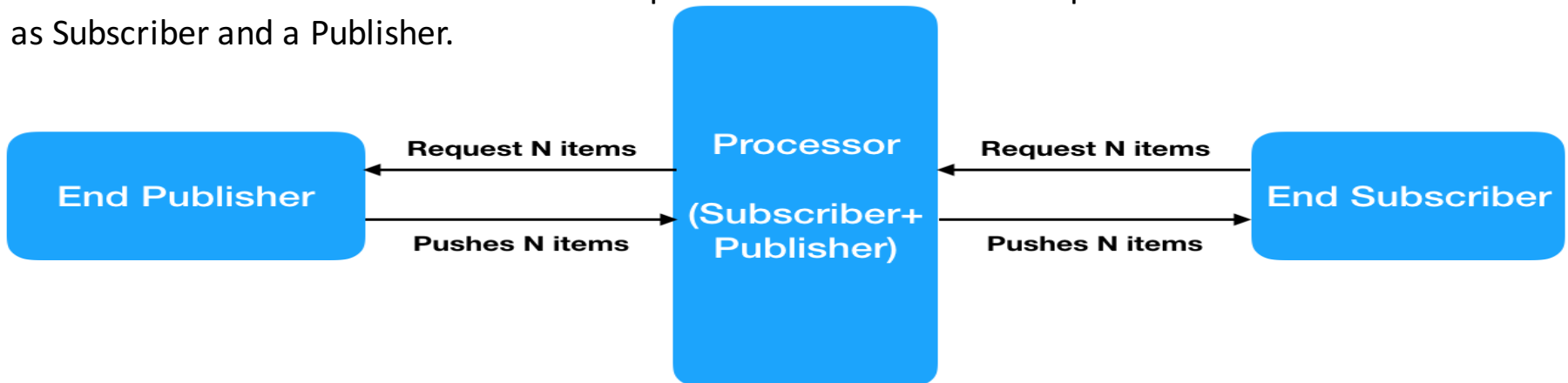
3. Java 9+ and 11 Reactive Streams

Java 9 Reactive Streams

Reactive Streams is about asynchronous processing of stream, so there should be a Publisher and a Subscriber. The Publisher publishes the stream of data and the Subscriber consumes the data.



Sometimes it is necessary to transform the data between Publisher and Subscriber. **Processor** is the entity sitting between the end publisher and subscriber to transform the data received from publisher so that subscriber can understand it. It is possible to have a chain of processors. Processor works both as Subscriber and a Publisher.

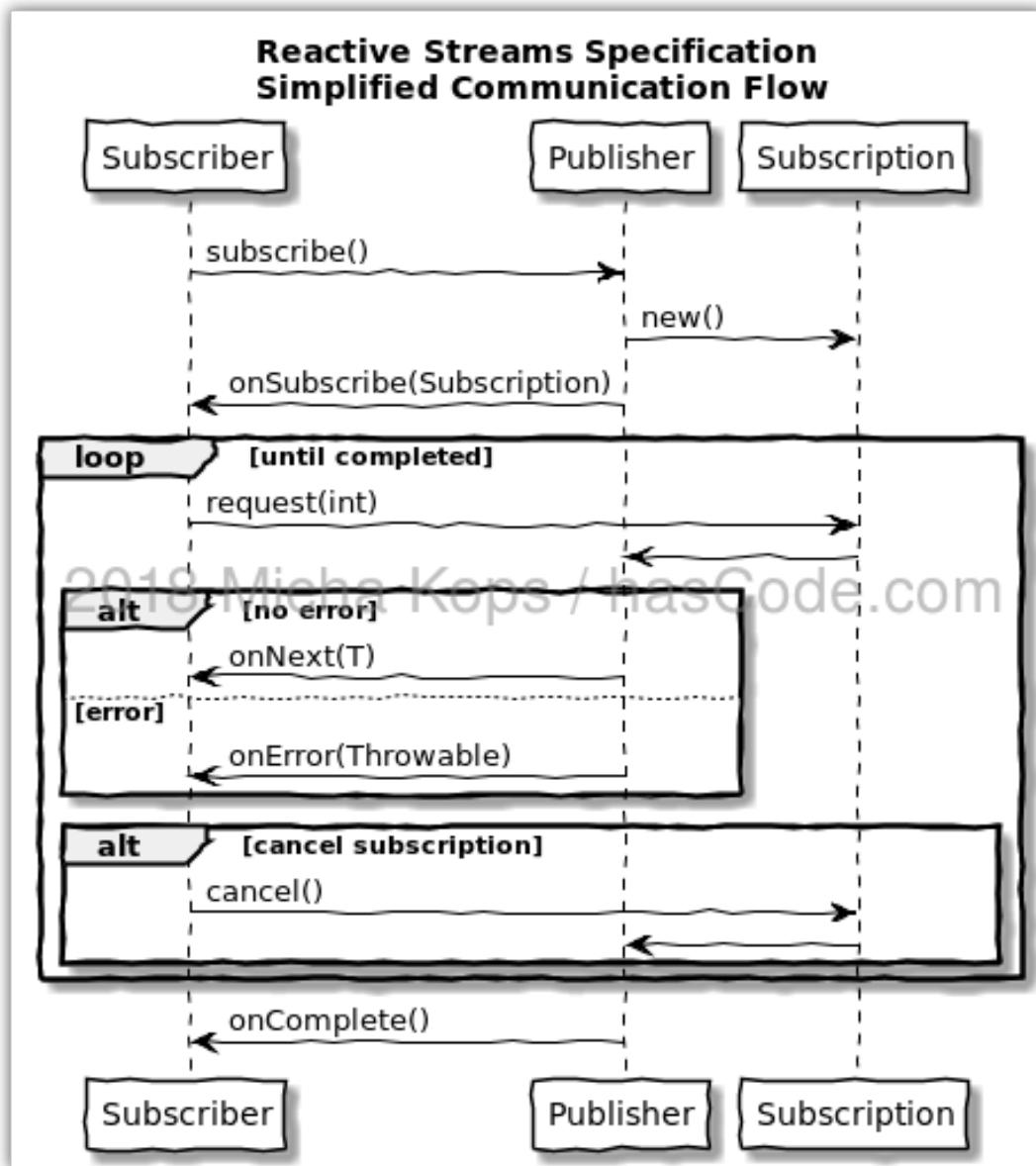


3. Java 9+ and 11 Reactive Streams

The new Flow API in Java 9 follows the [Reactive Streams Specification](#) and is aligned with the paradigms of the [Reactive Manifesto](#): Responsive, Resilient, Elastic, Message Driven.

The reactive streams can be used with:

- Java 9 and the Flow API,
- RxJava2,
- Akka,
- Reactor



Copyright:

<https://www.hascode.com/2018/01/reactive-streams-java-9-flow-api-rxjava-and-reactor-examples/>

3. Java 9+ and 11 Reactive Streams

Java 9 Flow API Classes and Interfaces

```
public final class Flow {  
    private Flow() {} // uninstantiable  
    @FunctionalInterface  
    public static interface Publisher<T> {  
        public void subscribe(Subscriber<? super T> subscriber);  
    }  
    public static interface Subscriber<T> {  
        public void onSubscribe(Subscription subscription);  
        public void onNext(T item);  
        public void onError(Throwable throwable);  
        public void onComplete();  
    }  
    public static interface Subscription {  
        public void request(long n);  
        public void cancel();  
    }  
    public static interface Processor<T,R> extends Subscriber<T>,  
        Publisher<R> {}  
}
```

3. Java 9+ and 11 Reactive Streams

Java 9 Flow API Classes and Interfaces

Java 9 Flow API implements the **Reactive Streams Specification**. Flow API is a combination of [Iterator](#) and [Observer](#) pattern. Iterator works on pull model where application pulls items from the source, whereas Observer works on push model and reacts when item is pushed from source to application. Flow API classes and interfaces:

java.util.concurrent.Flow: This is the main class of Flow API. This class encapsulates all the important interfaces of the Flow API. This is a final class and it can't be extend.

java.util.concurrent.Flow.Publisher: This is a functional interface and every publisher has to implement its subscribe method to add the given subscriber to receive messages.

java.util.concurrent.Flow.Subscriber: Every subscriber has to implement this interface. The methods in the subscriber are invoked in strict sequential order. There are four methods in this interface:

onSubscribe: This is the first method to get invoked when subscriber is subscribed to receive messages by publisher. Usually we invoke subscription.request to start receiving items from processor.

onNext: This method gets invoked when an item is received from publisher, this is where we implement our business logic to process the stream and then request for more data from publisher.

onError: This method is invoked when an irrecoverable error occurs, we can do cleanup tasks in this method, such as closing database connection.

onComplete: This is like finally method and gets invoked when no other items are being produced by publisher and publisher is closed. We can use it to send notification of successful processing of stream.

3. Java 9+ and 11 Reactive Streams

Java 9 Flow API Classes and Interfaces

Flow API classes and interfaces (cont.).

java.util.concurrent.Flow.Subscription: This is used to create asynchronous non-blocking link between publisher and subscriber. Subscriber invokes its request method to demand items from publisher. It also has cancel method to cancel the subscription i.e. closing the link between publisher and subscriber.

java.util.concurrent.Flow.Processor: This interface extends both Publisher and Subscriber, this is used to transform the message between publisher and subscriber.

java.util.concurrent.SubmissionPublisher: A Publisher implementation that asynchronously issues submitted items to current subscribers until it is closed. It uses Executor framework. We will use this class in reactive stream examples to add subscriber and then submit items to them.

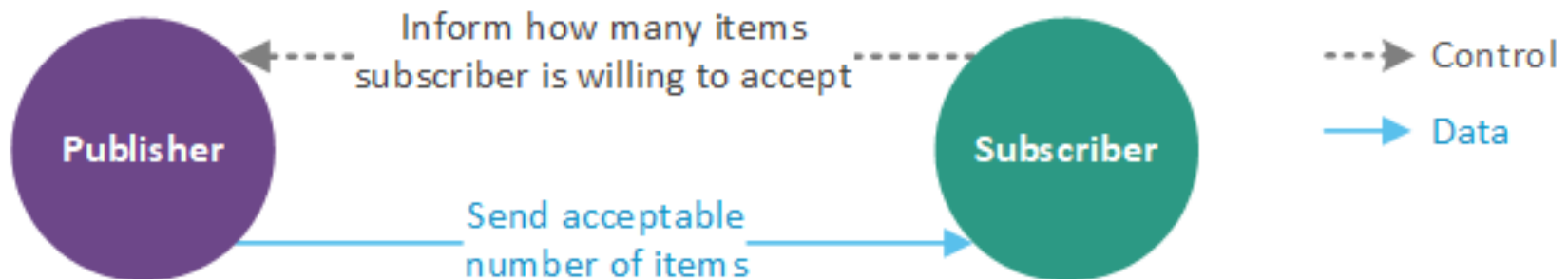
3. Java 9+ and 11 Reactive Streams

Reactive Streams - Publishers, Subscribers, and Subscriptions

Instead of having a client and server style of data handling, where a client requests data from a server and the server responds, possibly asynchronously, to the client with the requested data, we instead use a publish-subscribe mechanism: A **subscriber** informs a **publisher** that it is willing to accept a given number of **items** (**requests** a given number of items), and if items are available, the publisher pushes the maximum receivable number of items to the subscriber. It is important to note that this is a two-way communication, where the subscriber informs the publisher how many items it is willing to handle and the publisher pushes that number of items to the subscriber.

The process of restricting the number of items that a subscriber is willing to accept (as judged by the subscriber itself) is called **backpressure** and is essential in prohibiting the overloading of the subscriber (pushing more items that the subscriber can handle). This scheme is illustrated in the figure below.

When publisher is producing messages in much faster rate than it's being consumed by subscriber, back pressure gets built. Java 9 Flow API doesn't provide for the moment any mechanism to signal about back pressure or to deal with it. But we can devise our own strategy to deal with it, such as fine tuning the subscriber or reducing the message producing rate.



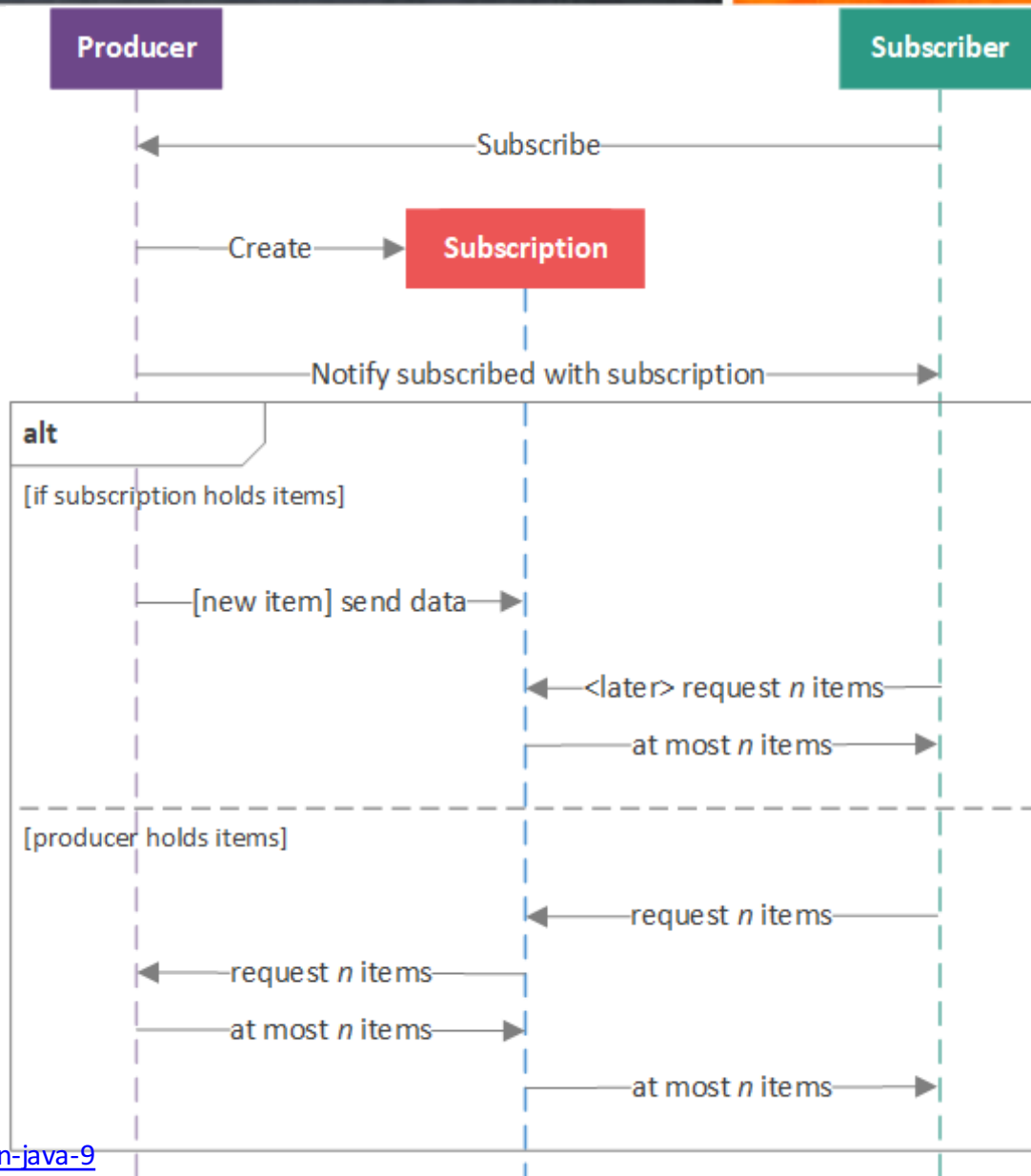
3. Java 9+ and 11 Reactive Streams

Reactive Streams - Publishers, Subscribers, and Subscriptions

This two-way connection between a publisher and a subscriber is called a **subscription**. This subscription binds a single publisher to a single subscriber (one-to-one relationship) and may be unicast or multicast. Likewise, a single publisher may have multiple subscribers subscribed to it, but a single subscriber may only be subscribed to a single producer (a publisher may have many subscribers, but a subscriber may subscribe to at most one publisher).

When a subscriber subscribes to a publisher, the publisher notifies the subscriber of the subscription that was created, allowing the subscriber to store a reference to the subscription (if desired). Once this notification process is completed, the subscriber can inform the publisher that it is ready to receive some n number of items.

When the publisher has items available, it then sends at most n number of items to the subscriber. If an error occurs in the publisher, it signals the subscriber of the **error**. If the publisher is permanently finished sending data, it signals the subscriber that it is **complete**. If the subscriber is notified that either an error occurred or the publisher is complete, the subscription is considered **canceled** and no more interactions between the publisher and subscriber (or the subscription) will take place. This subscription workflow is illustrated in the figure below.



3. Java 9+ and 11 Reactive Streams

Reactive Streams - Publishers, Subscribers, and Subscriptions

It is important to note that there are two theoretical approaches to streaming data to a subscriber:

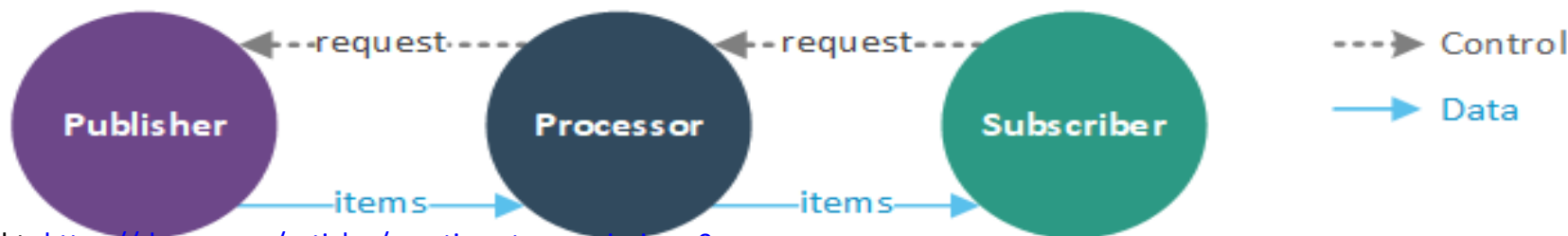
- (1) the subscription holds the items or
- (2) the publisher holds the items.

In the first case, the publisher pushes items to the subscription when they become available; when, at a later time, the subscriber requests n items, the subscription provides n or fewer items it has previously been given by the publisher. This may be used when the publisher manages queued items, such as incoming HTTP requests.

In the second case, the subscriber forwards requests to the publisher, which pushes n or fewer items to the subscription, which in turn pushes those same items to the subscriber. This scenario may be more suitable for instances where items are generated as needed, such as with a prime number generator.

For example, suppose a subscriber requests 5 items and 7 are currently available in the publisher. The outstanding demand for the subscriber is 5 so 5 of the 7 items are pushed to the subscriber. The remaining 2 items are maintained by the publisher, awaiting the subscriber to request more items. If the subscriber then requests 10 more items, the 2 remaining items are pushed to the subscriber, resulting in an outstanding demand of 8. If 5 more items become available in the publisher, these 5 items are pushed to the subscriber, leaving an **outstanding demand** of 3. The outstanding demand will remain at 3 unless the subscriber requests n more items, in which case the outstanding demand will increase to $3 + n$, or more i items are pushed to the subscriber, in which case the outstanding demand will decrease to $3 - i$ (to a minimum of 0).

If an entity is both a publisher and a subscriber, it is called a **processor**. A processor commonly acts as an intermediary between another publisher and subscriber (either of which may be another processor), performing some transformation on the stream of data. For example, a processor can be created that filters out items that match some criteria before passing them onto its subscriber. A visual representation of a processor is illustrated in the figure below.





Thanks!



Java SE
End of Lecture 12 – XML | JSON Programming

