Interoperating with External Services

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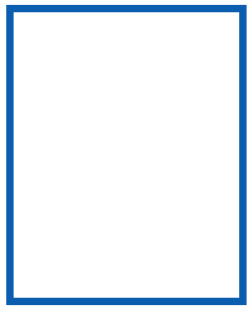
Previous Module



Web tier

Servlets

JavaServer Faces

WebSockets

Module Outline

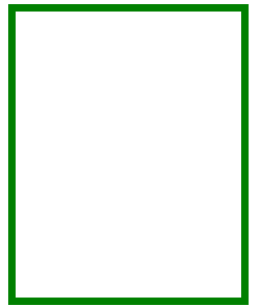
Module Outline

XML & JSON

JAX-B 2.0 & JAX-P 1.2 & JSON-P 1.0

What Is XML?

- eXtensible Markup Language
- World Wide Web Consortium (W3C)
- Data independence and interoperability
- Interchange data
- Meta-language

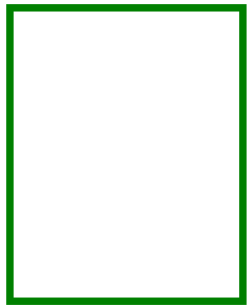


XML Document

```
<?xml version="1.0" encoding="UTF-8" ?>
<book isbn="1234" title="H2G2" unit-cost="63.98">
  <description>Best Scifi book</description>
  <nb-of-pages>123</nb-of-pages>
  <language>ENGLISH</language>
  <category name="IT"/>
  <publisher name="Megadodo"/>
  <authors>
    <author>
      <first-name>Douglas</first-name>
      <last-name>Adams</last-name>
    </author>
    <author>
      <first-name>John</first-name>
      <last-name>Cleese</last-name>
    </author>
  </authors>
</book>
```

What Is JSON?

- JavaScript Object Notation
- Originated with JavaScript
- Less verbose than XML
- Browsers have native JSON support
- Data interchange format

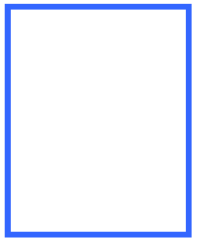


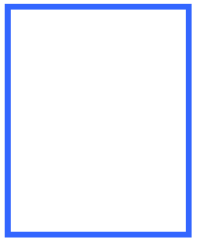
JSON Document

```
{
  "book": {
    "isbn": "1234", "title": "H2G2", "unit-cost": "63.98", "nb-of-pages": "123",
    "description": "Best Scifi book", "language": "ENGLISH",
    "category": { "name": "IT" },
    "publisher": { "name": "Megadodo" },
    "authors": [
      { "first-name": "Douglas", "last-name": "Adams" },
      { "first-name": "John", "last-name": "Cleese" }
    ]
  }
}
```

When to Use XML Over JSON

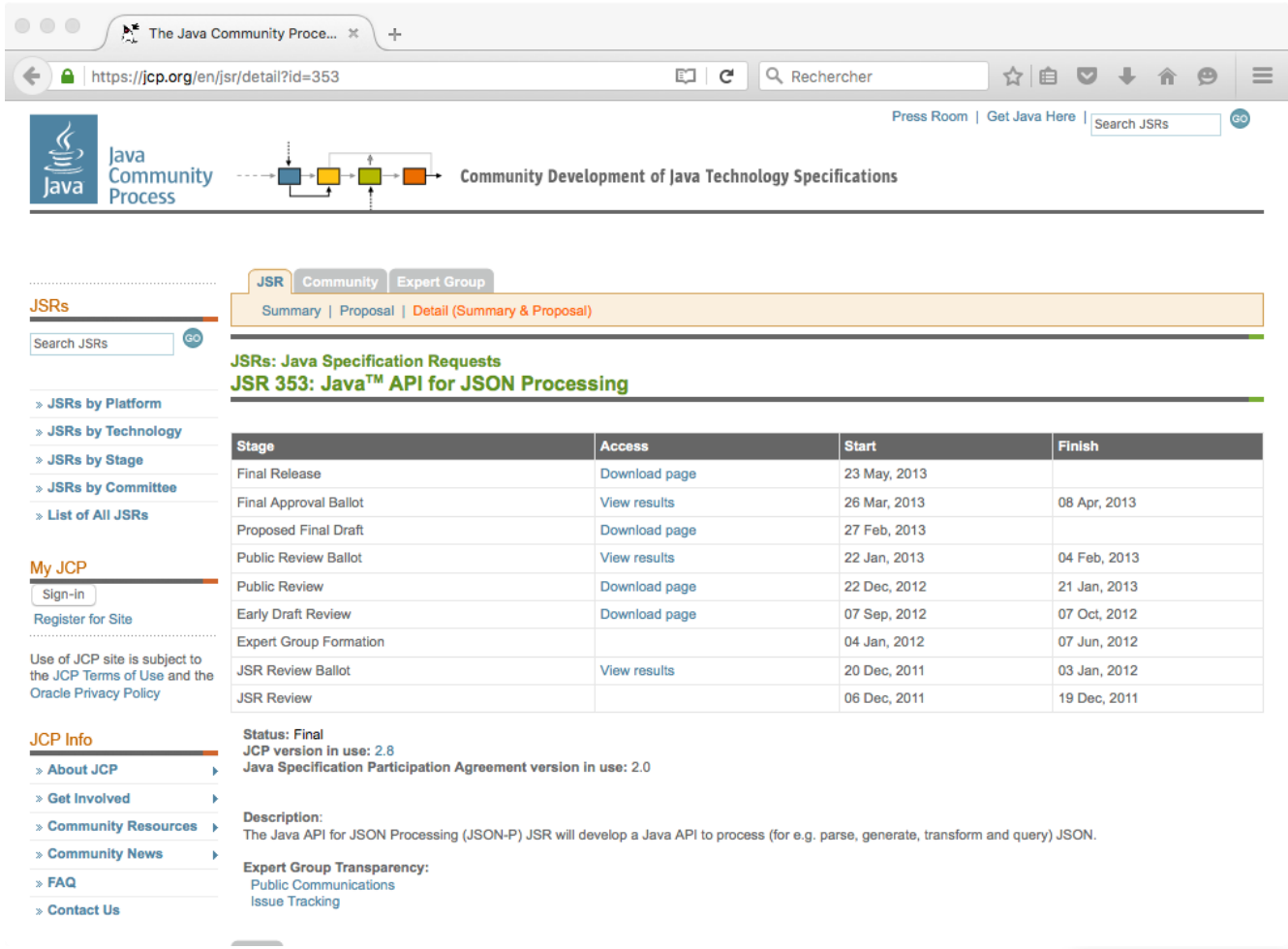
- XML
  - Validation
  - Contract between systems
  - Transform
  - Desktop applications
- JSON
  - Directly consumable by JavaScript
  - Documents are shorter





JAX-B, JAX-P and JSON-P Specifications

- JAX-P 1.3 (JSR 206)
- JAX-B 2.2 (JSR 222)
- JSON-P 1.0 (JSR 353)



XML and JSON

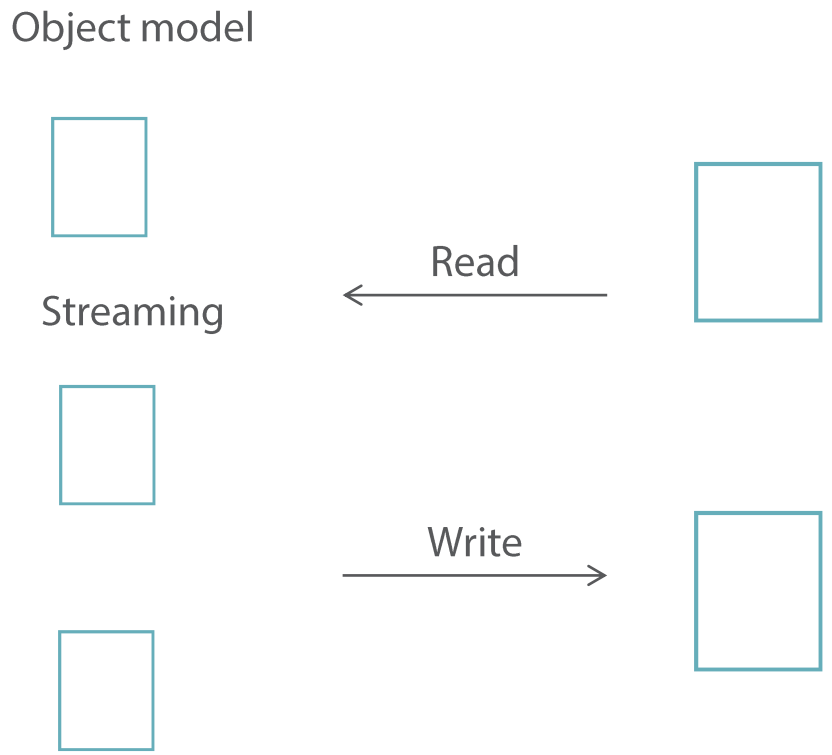
XML

JSON

REST consumers

Understanding Processing

- JAX-P and JSON-P
- Read
  - Object model
  - Streaming
- Write
  - Build
  - Stream



Reading JSON

```
Path file = Paths.get("books.json");
InputStream stream = Files.newInputStream(file);

try (JsonReader reader = Json.createReader(stream)) {

  JsonArray array = reader.readArray();
  for (int i = 0; i < array.size(); i++) {
    array.getJsonObject(i).getInt("id");
    array.getJsonObject(i).getString("title");
  }
}
```

```
[
  { "id": 1001, "title": "AAAAAAAAA" },
  { "id": 1002, "title": "BBBBBBBBB" },
  { "id": 1003, "title": "CCCCCCCCC" },
  { "id": 1004, "title": "DDDDDDDDD" },
  { "id": 1005, "title": "EEEEEEEEE" },
  { "id": 1006, "title": "FFFFFFFFF" },
  { "id": 1007, "title": "GGGGGGGGG" },
  { "id": 1008, "title": "HHHHHHHHH" },
  { "id": 1009, "title": "IIIIIIIII" },
  { "id": 1010, "title": "JJJJJJJJJ" },
  { "id": 1011, "title": "KKKKKKKKK" },
  { "id": 1012, "title": "LLLLLLLLL" },
  { "id": 1013, "title": "MMMMMMMMM" },
  { "id": 1014, "title": "NNNNNNNNN" },
  { "id": 1015, "title": "OOOOOOOOO" },
  { "id": 1016, "title": "PPPPPPPPP" },
  { "id": 1017, "title": "QQQQQQQQQ" },
  { "id": 1018, "title": "RRRRRRRRR" },
  { "id": 1019, "title": "SSSSSSSSS" },
  { "id": 1020, "title": "TTTTTTTTT" },
  { "id": 1021, "title": "UUUUUUUUU" }
]
```

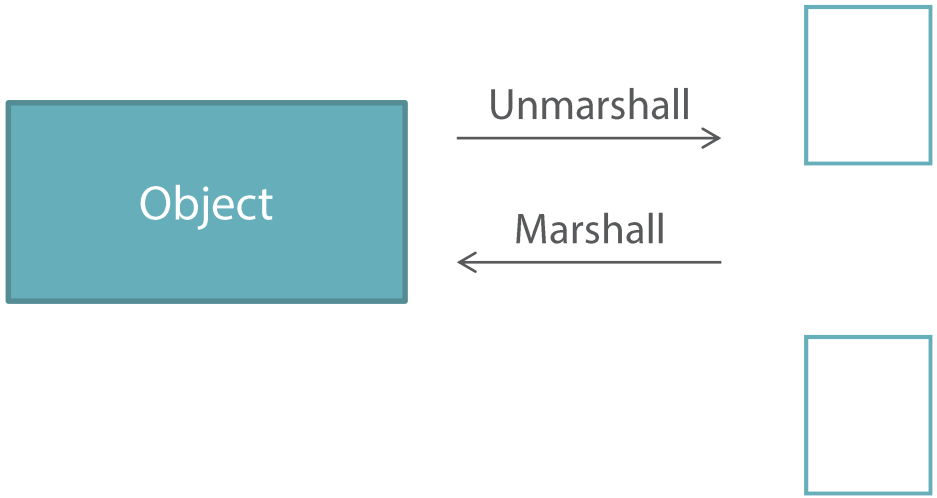
Writing JSON

```
JsonObject jsonBook = Json.createObjectBuilder()
  .add("book", Json.createObjectBuilder()
  .add("isbn", "1234")
  .add("title", "H2G2")
  .add("unit-cost", "63.98")
  .add("nb-of-pages", "123")
  .add("description", "Best Scifi book")
  .add("language", "ENGLISH")
  .add("category", Json.createObjectBuilder()
    .add("name", "IT")
  )
  .add("publisher", Json.createObjectBuilder()
    .add("name", "Megadodo")
  )
  .add("authors", Json.createArrayBuilder()
    .add(Json.createObjectBuilder()
      .add("first-name", "Douglas")
      .add("last-name", "Adams"))
    .add(Json.createObjectBuilder()
      .add("first-name", "John")
      .add("last-name", "Cleese"))
  )
).build();
```

```
{
  "book": {
    "isbn": "1234",
    "title": "H2G2",
    "unit-cost": "63.98",
    "nb-of-pages": "123",
    "description": "Best Scifi book",
    "language": "ENGLISH",
    "category": {
      "name": "IT"
    },
    "publisher": {
      "name": "Megadodo"
    },
    "authors": [
      { "first-name": "Douglas", "last-name": "Adams"},
      { "first-name": "John", "last-name": "Cleese" }
    ]
  }
}
```

Understanding Binding

- JAX-B (and JSON-B)
- Higher level of abstraction
- Based on annotations
- Unmarshall
- Marshall



Binding XML

```
Book book = new Book("1234", "H2G2", "Best Scifi book", 63.98F, 123, ENGLISH);
book.setCategory(new Category("IT"));
book.setPublisher(new Publisher("Megadodo"));
book.addAuthor(new Author("Douglas", "Adams"));
book.addAuthor(new Author("John", "Cleese"));

JAXBContext context = JAXBContext.newInstance(Book.class);

Marshaller m = context.createMarshaller();
StringWriter writer = new StringWriter();
m.marshal(book, writer);

System.out.println(writer.toString());
```

Binding XML

```java
public class Book {


  private Long id;

  private String isbn;

  private String title;

  private Float unitCost;
  private String description;

  private Integer nbOfPage;
  private Language language;
  private Category category;
  private Publisher publisher;


  private Set<Author> authors = new HashSet<>();
}
```

```xml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<book>

  <isbn>1234</isbn>
  <title>H2G2</title>
  <unitCost>63.98</unitCost>
  <description>Best Scifi book</description>
  <nbOfPage>123</nbOfPage>
  <language>ENGLISH</language>
  <category name="IT"/>
  <publisher name="Megadodo"/>
  <authors>
    <first-name>Douglas</first-name>
    <last-name>Adams</last-name>
  </authors>
  <authors>
    <first-name>John</first-name>
    <last-name>Cleese</last-name>
  </authors>


</book>
```

Binding XML

```java
@XmlRootElement
public class Book {

  @XmlTransient
  private Long id;

  private String isbn;

  private String title;

  private Float unitCost;
  private String description;

  private Integer nbOfPage;
  private Language language;
  private Category category;
  private Publisher publisher;


  private Set<Author> authors = new HashSet<>();
}
```

```xml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<book isbn="1234" title="H2G2" unit-cost="63.98">

  <description>Best Scifi book</description>
  <nbOfPage>123</nbOfPage>
  <language>ENGLISH</language>
  <category name="IT"/>
  <publisher name="Megadodo"/>
  <authors>
    <first-name>Douglas</first-name>
    <last-name>Adams</last-name>
  </authors>
  <authors>
    <first-name>John</first-name>
    <last-name>Cleese</last-name>
  </authors>


</book>
```

Binding XML

```java
@XmlRootElement
public class Book {

  @XmlTransient
  private Long id;
  @XmlAttribute
  private String isbn;
  @XmlAttribute
  private String title;
  @XmlAttribute(name = "unit-cost")
  private Float unitCost;
  private String description;

  private Integer nbOfPage;
  private Language language;
  private Category category;
  private Publisher publisher;


  private Set<Author> authors = new HashSet<>();
}
```

```xml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<book isbn="1234" title="H2G2" unit-cost="63.98">

  <description>Best Scifi book</description>
  <nb-of-pages>123</nb-of-pages>
  <language>ENGLISH</language>
  <category name="IT"/>
  <publisher name="Megadodo"/>
  <authors>
    <first-name>Douglas</first-name>
    <last-name>Adams</last-name>
  </authors>
  <authors>
    <first-name>John</first-name>
    <last-name>Cleese</last-name>
  </authors>

</book>
```

Binding XML

```java
@XmlRootElement
public class Book {

  @XmlTransient
  private Long id;
  @XmlAttribute
  private String isbn;
  @XmlAttribute
  private String title;
  @XmlAttribute(name = "unit-cost")
  private Float unitCost;
  private String description;
  @XmlElement(name = "nb-of-pages")
  private Integer nbOfPage;
  private Language language;
  private Category category;
  private Publisher publisher;


  private Set<Author> authors = new HashSet<>();
}
```

```xml
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<book isbn="1234" title="H2G2" unit-cost="63.98">


  <description>Best Scifi book</description>
  <nb-of-pages>123</nb-of-pages>
  <language>ENGLISH</language>
  <category name="IT"/>
  <publisher name="Megadodo"/>
  <authors>
    <author>
      <first-name>Douglas</first-name>
      <last-name>Adams</last-name>
    </author>
    <author>
      <first-name>John</first-name>
      <last-name>Cleese</last-name>
    </author>
  </authors>
</book>
```

JAX-P, JAX-P and JSON-P Packages

Package	Description
`javax.xml.bind`	Marshalling, unmarshalling APIs
`javax.xml.bind.annotation`	Binding annotations
`javax.xml.transform`	Transformation APIs
`javax.xml.parsers`	Object model and streaming APIs
`javax.json`	Core JSON APIs
`javax.json.stream`	Streaming APIs

XML and JSON

Binding

Customizing binding

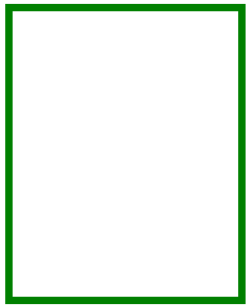
Processing JSON

REST Web Services

Java API for RESTful Web Services (JAX-RS) 2.0

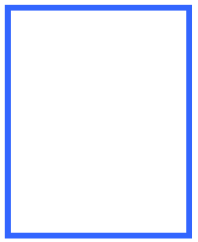
What Is REST?

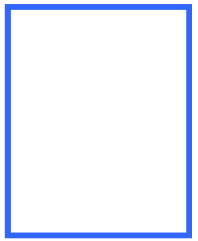
- REpresentational State Transfer
- Architectural style
- Based on how the Web works
- HTTP
- Very robust transport protocol
- Stateless
- Handle high load and scale better



When to Use REST

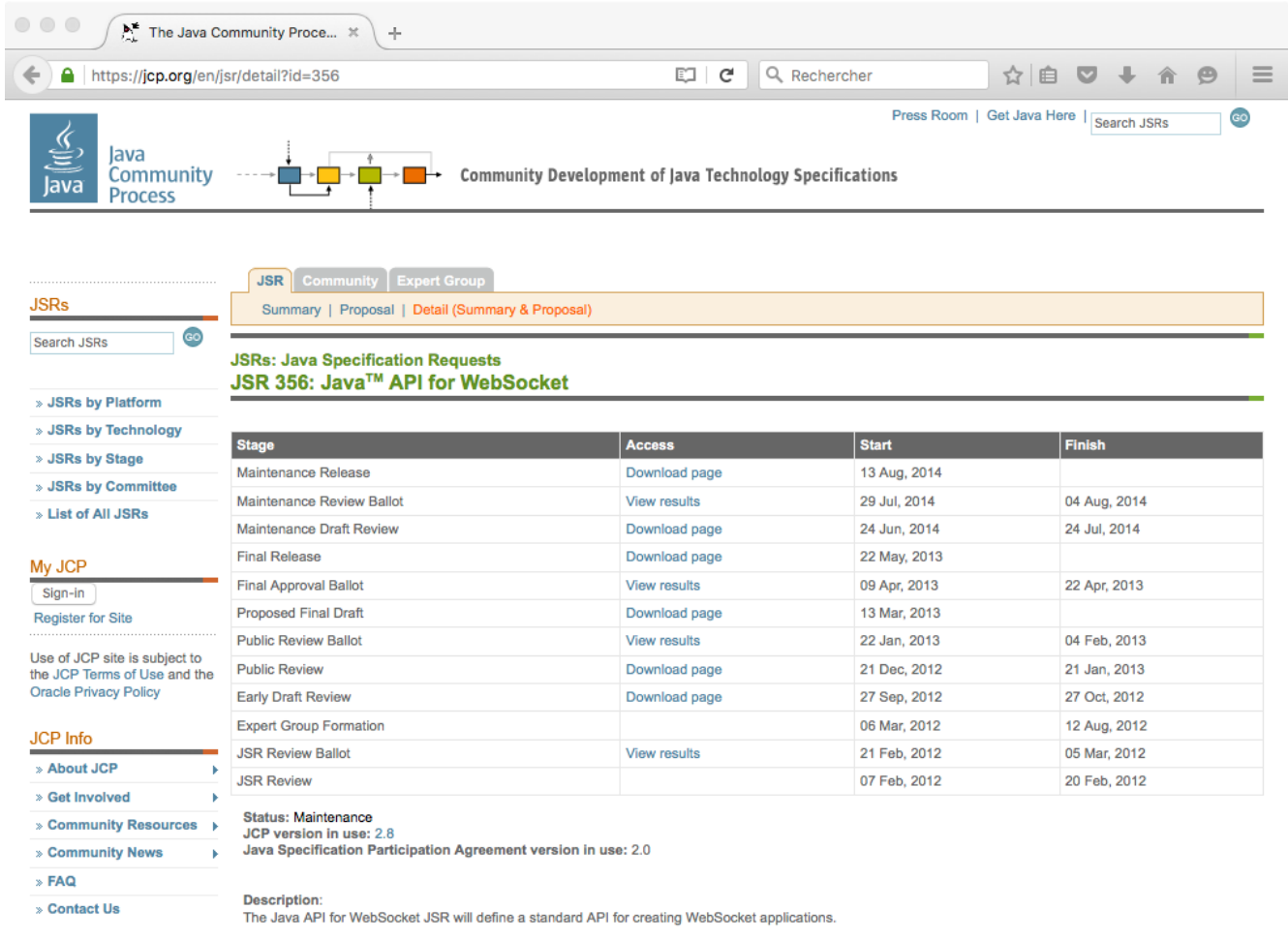
- SOAP vs REST Web services
- HTTP is used everywhere
- Many different clients
- Reduce the client/server coupling
- Updating the server regularly
- Easy to build





JAX-RS Specification

- JAX-RS 2.0
- JSR 339
- http://jcp.org/en/jsr/detail?id=339



JAX-RS Implementations

- Jersey
- Apache CXF
- RESTEasy
- Restlet

REST Services

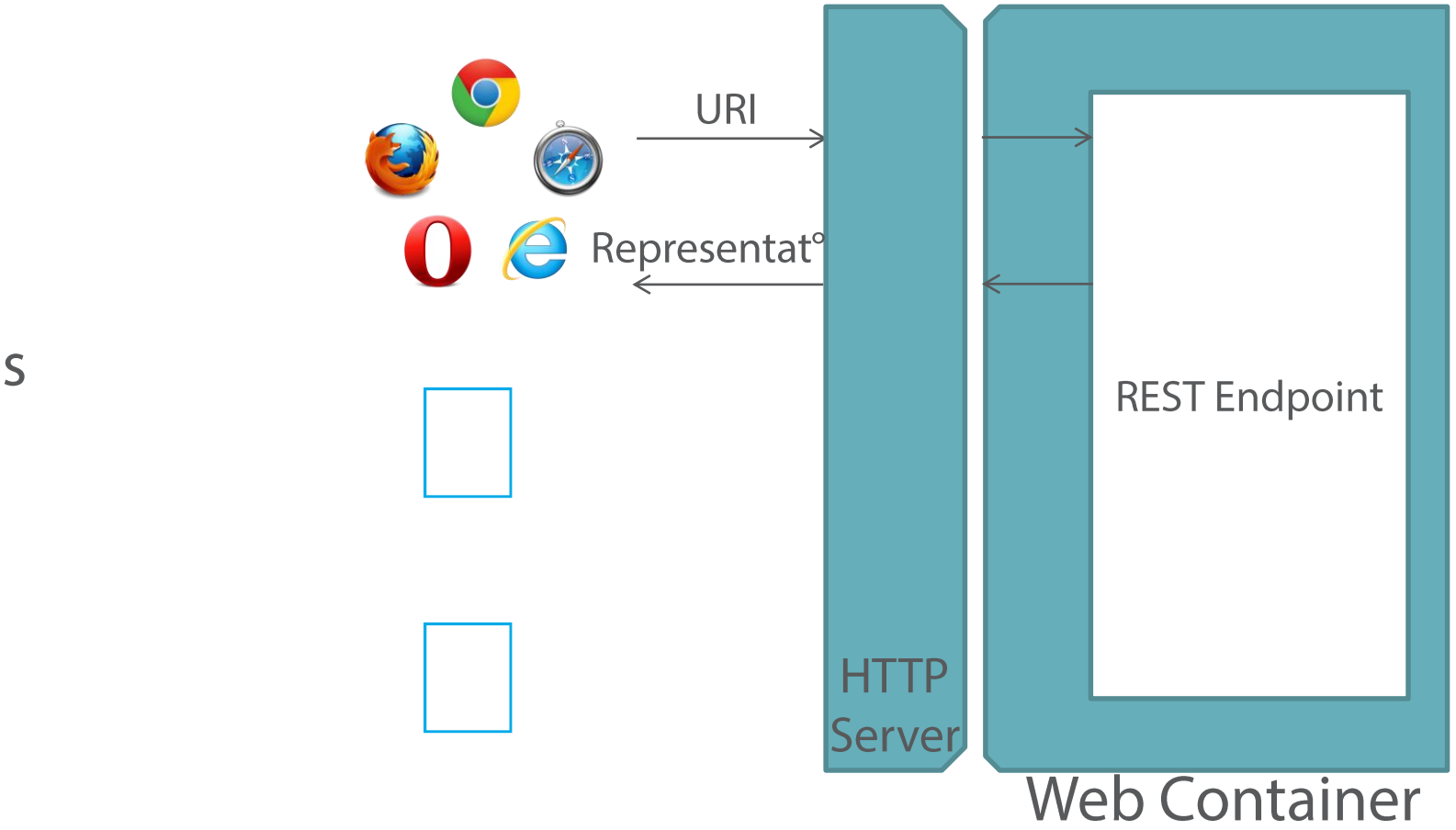
Expose catalog of items

Consume TopRated items

External service

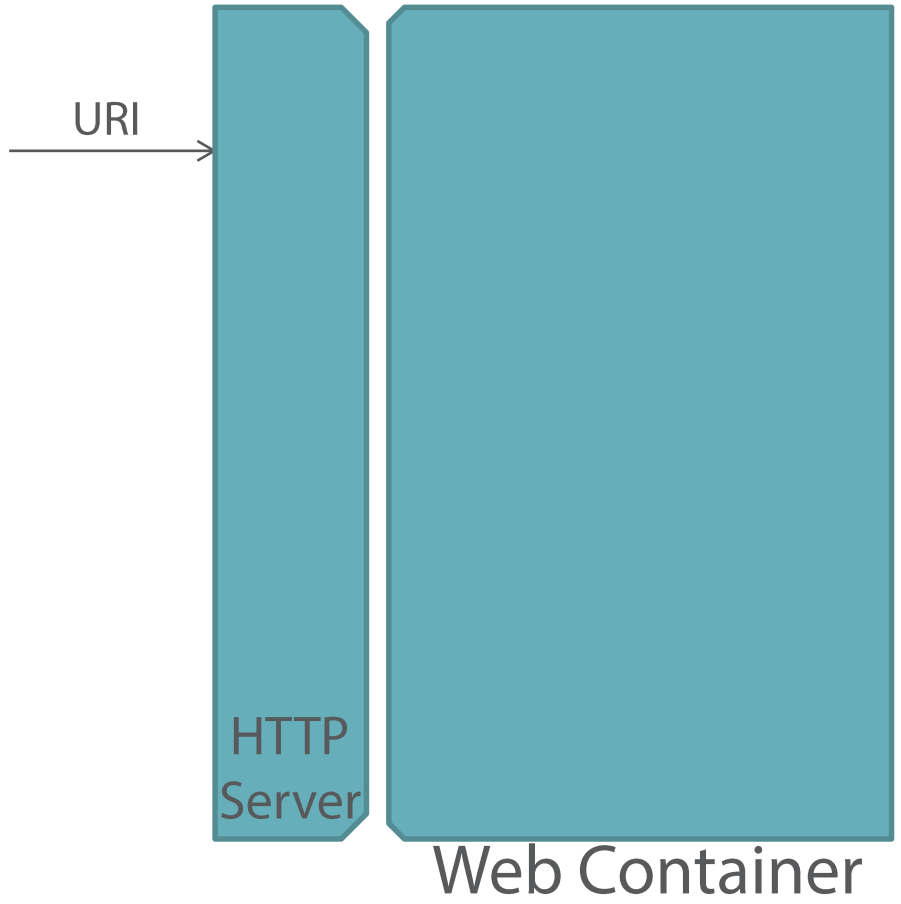
Understanding JAX-RS

- HTTP
- Web clients
- URI
- Several representations
- Status code



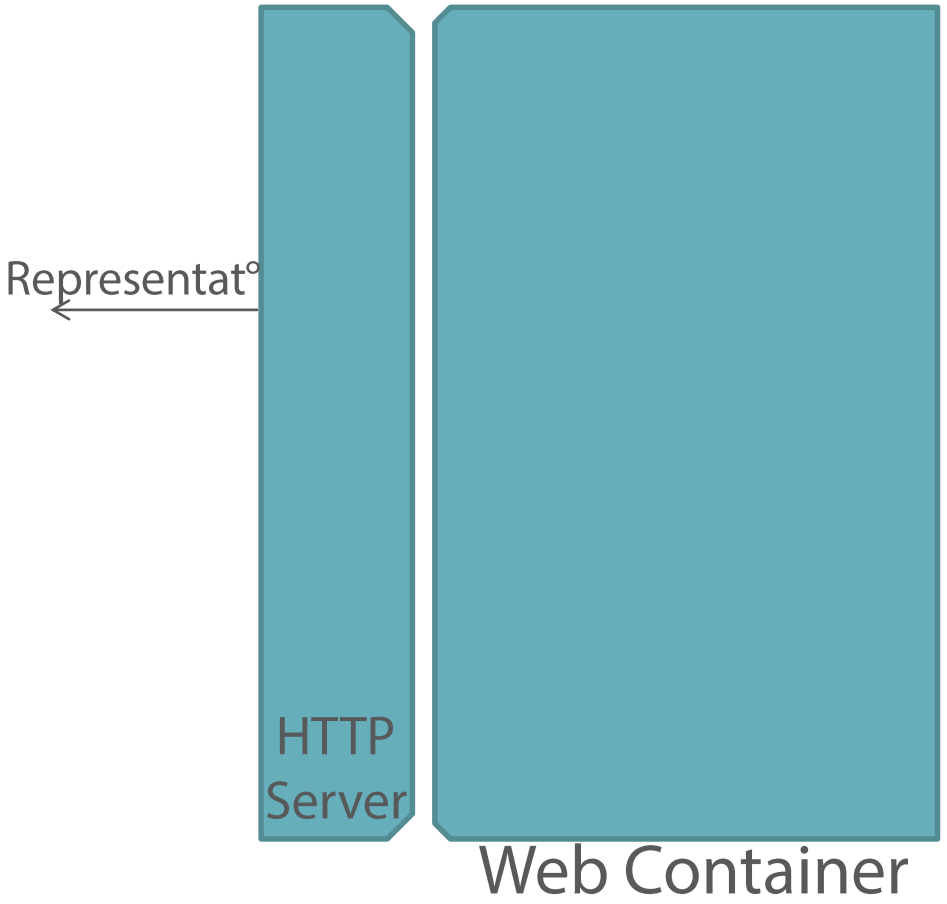
Resources and URIs

- Resource addressed with a URI
- Any piece of information
- Unique identifier
- www.cdbookstore.com/**books**
- www.cdbookstore.com/books/**1234**
- www.cdbookstore.com/**info/jobs**
- Descriptive as possible



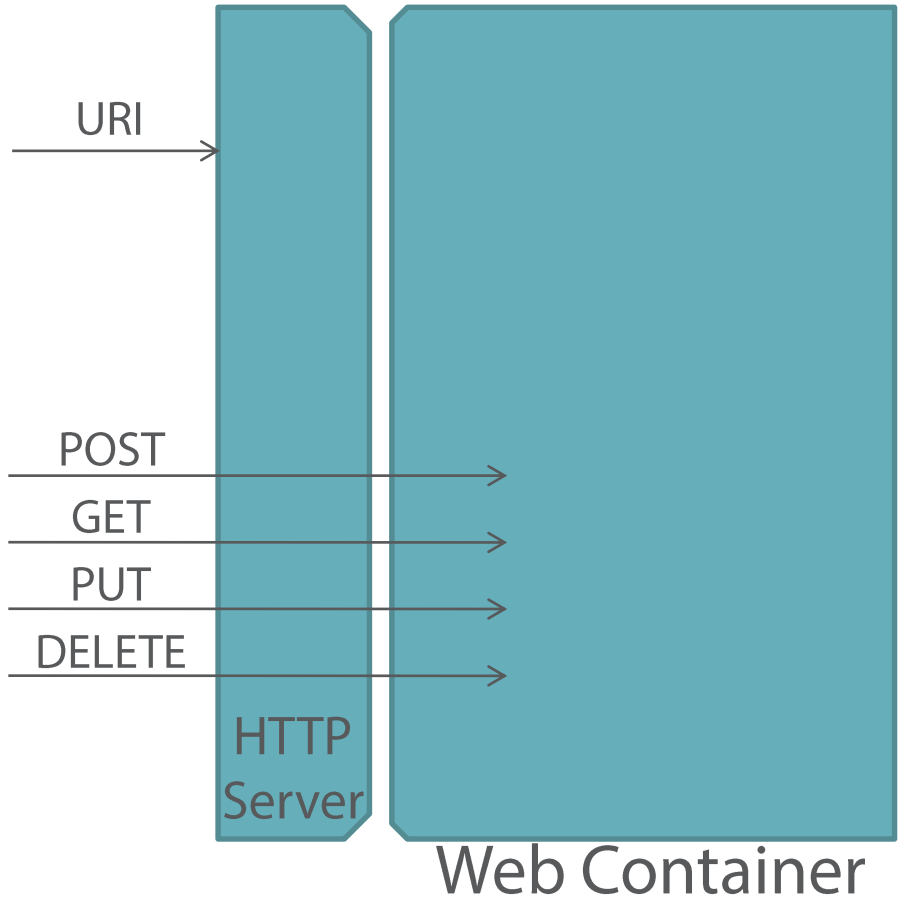
Representations

- Many representations for one resource
- Text, JSON, XML, PDF, image…
- Several URIs
  - www.cdbookstore.com/books/**xml**
  - www.cdbookstore.com/books/**csv**
- One single URI
  - www.cdbookstore.com/books
  - content negotiation
  - HTTP headers



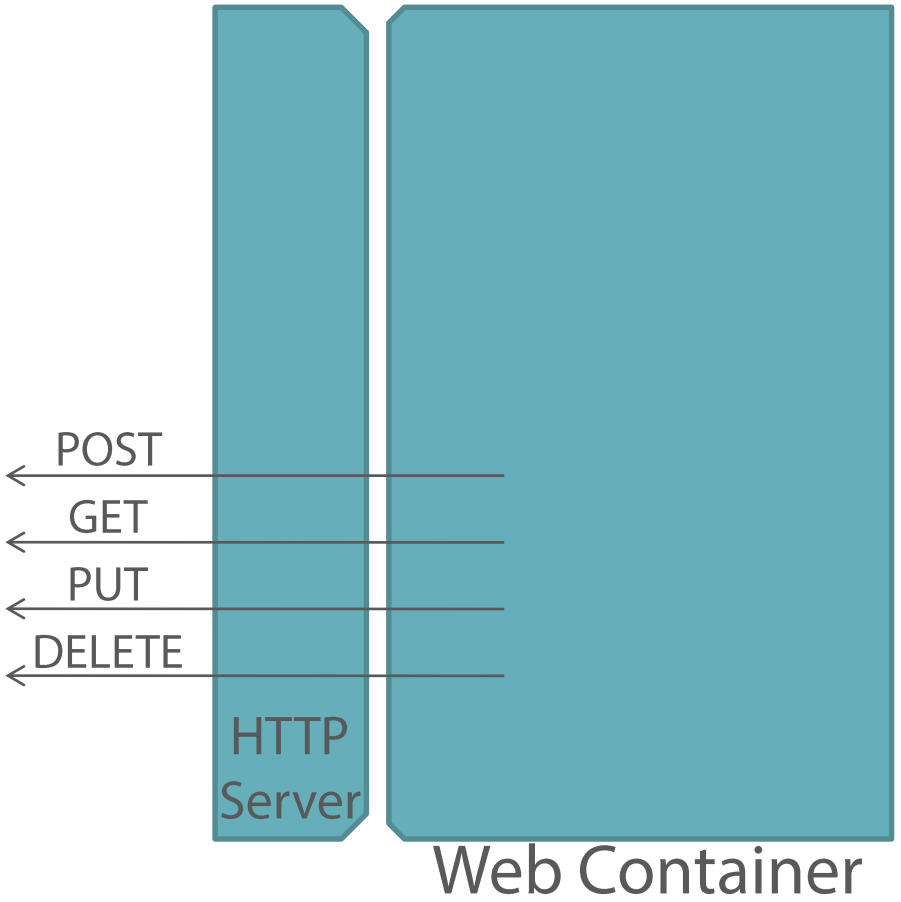
Uniform Interface

- Architecture is simplified
- Interaction is improved
- HTTP semantic
- POST (**C**)reates
- GET (**R**)eads
- PUT (**U**)pdates
- DELETE (**D**)eletes



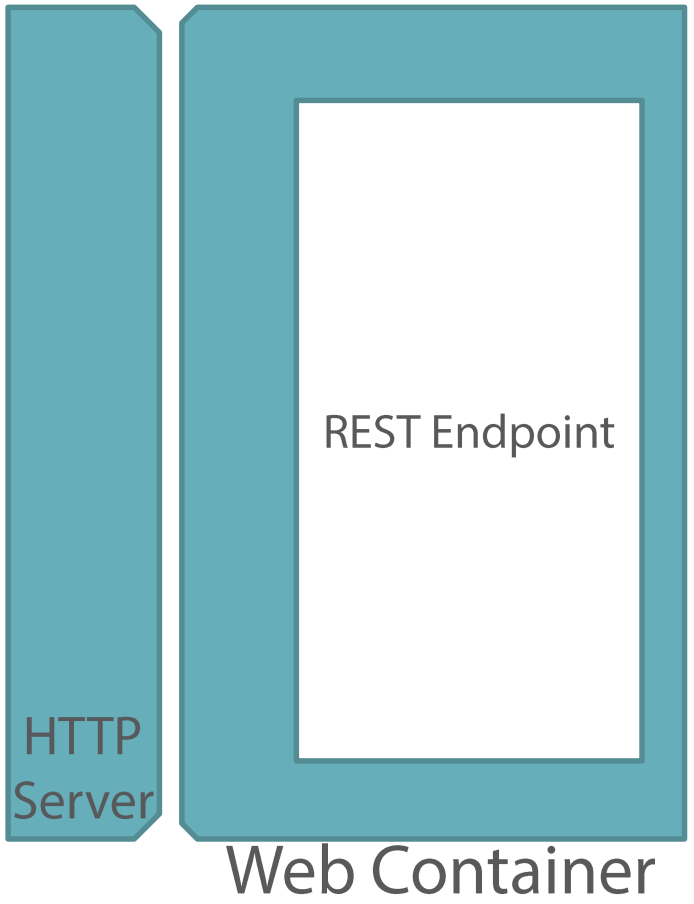
HTTP Status Code

- 1xx Informational
- 2xx Success
- 3xx Redirection
- 4xx Client Error
- 5xx Server Error
- 200 OK
- 401 Unauthorized
- 404 Not Found



REST Endpoint

- HTTP is low-level
- Higher-level of abstraction
- Don't write plumbing code
- Describe REST Web service
- With few annotations



REST Endpoint

```
@Path("/books")
public class BookEndpoint {

  @Inject
  private EntityManager em;

  @GET
  @Produces({"application/xml"})
  public List<Book> listAll() {
    TypedQuery<Book> query = em.createQuery("SELECT b FROM Book b", Book.class);
    return query.getResultList();
  }
}
```

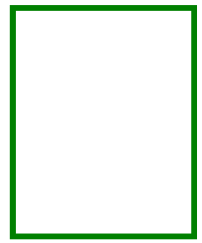
http://www.cdbookstore.com/**books**

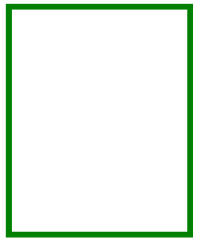
JAX-RS Packages

Package	Description
`javax.ws.rs`	Core JAX-RS
`javax.ws.rs.client`	Client API
`javax.ws.rs.container`	Container-specific JAX-RS API
`javax.ws.rs.core`	Low-level interfaces and annotations
`javax.ws.rs.ext`	Extensions

Exposing REST Services

- Programmable Web
- Applying REST to services
- Focus on resources
- URIs
- Representations
- Uniform interface





URIs

```
@Path("/books")
public class BookEndpoint {


  @GET
  public List<Book> listAll() { // ... }









}
```

```
http://www.cdbookstore.com
```

URIs

```
@Path("/books")
public class BookEndpoint {


  @GET
  public List<Book> listAll() { // ... }

  @GET
  @Path("/paper")
  public List<Book> listPaperBooks() { // ... }




}
```

http://www.cdbookstore.com/**books**

URIs

```
@Path("/books")
public class BookEndpoint {


  @GET
  public List<Book> listAll() { // ... }

  @GET
  @Path("/paper")
  public List<Book> listPaperBooks() { // ... }

  @GET
  @Path("/paper/old")
  public List<Book> listOldPaperBooks() { // ... }


}
```

http://www.cdbookstore.com/**books/paper**

Extracting Parameters

```
@Path("/books")
public class BookEndpoint {


  @GET
  public List<Book> listAll() { // ... }

  @GET
  @Path("/{id}")
  public Book findById(@PathParam("id") long id) { // ... }

}
```

```
http://www.cdbookstore.com/books
```

Extracting Parameters

```
@Path("/books")
public class BookEndpoint {


  @GET
  public List<Book> listAll() { // ... }

  @GET
  @Path("/{id}")
  public Book findById(@PathParam("id") Long id) { // ... }

  @GET
  @Path("/search/{text}")
  public List<Book> search(@PathParam("text") Long searchText) { // ... }


}
```

http://www.cdbookstore.com/**books**

Representations

```
@Path("/books")
public class BookEndpoint {

  @Produces({"application/xml"})
  @GET
  public List<Book> listAll() { // ... }

  @Produces({"application/json"})
  @GET
  public List<Book> listAllinJson() { // ... }

}
```

http://www.cdbookstore.com/**books**

Representations

```
@Path("/books")
public class BookEndpoint {

  @Produces({"application/xml"})
  @GET
  public List<Book> listAll() { // ... }

  @Produces({"application/json"})
  @GET
  public List<Book> listAllinJson() { // ... }

  @Produces({"application/xml", "application/json"})
  @GET
  @Path("/{id}")
  public Book findById(@PathParam("id") Long id) { // ... }


}
```

http://www.cdbookstore.com/**books/1234**

CRUD Operations

```
@Path("/books")
public class BookEndpoint {

  @GET
  @Produces({"application/xml"})
  @Path("/{id}")
  public Book findById(@PathParam("id") Long id) { // ... }

}
```

http://www.cdbookstore.com/**books/1234**

CRUD Operations

```
@Path("/books")
public class BookEndpoint {

  @GET
  @Produces({"application/xml"})
  @Path("/{id}")
  public Book findById(@PathParam("id") Long id) { // ... }

  @DELETE
  @Path("/{id}")
  public void deleteById(@PathParam("id") Long id) { // ... }

}
```

http://www.cdbookstore.com/**books/1234**

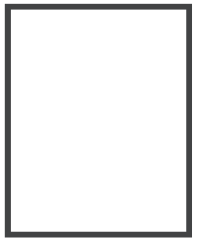
CRUD Operations

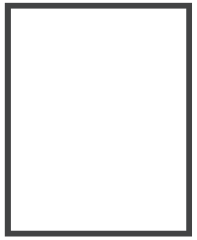
```
@Path("/books")
public class BookEndpoint {

  @GET
  @Produces({"application/xml"})
  @Path("/{id}")
  public Book findById(@PathParam("id") Long id) { // ... }

  @DELETE
  @Path("/{id}")
  public void deleteById(@PathParam("id") Long id) { // ... }

  @POST
  @Consumes({"application/xml"})
  public Response create(Book book) { // ... }


}
```

http://www.cdbookstore.com/**books**

Consuming REST Services

- Make an HTTP request on a URI
- Web browser
- Extensions to add more flexibility
- JavaScript
- cUrl
- Client API
  - Java SE
  - Android
  - Java EE





Client API

```
Client client = ClientBuilder.newClient();
WebTarget target = client.target("http://www.cdbookstore.com/books/1234");
Invocation invocation = target.request(MediaType.TEXT_PLAIN).buildGet();
Response response = invocation.invoke();
```

```
GET        http://www.cdbookstore.com/books/1234
```

Client API

```
Response response = ClientBuilder.newClient()
                        .target("http://www.cdbookstore.com/books/1234")
                        .request(MediaType.TEXT_PLAIN)
                        .get();
```

GET http://www.cdbookstore.com/**books/1234**

Client API

```
Response response = ClientBuilder.newClient()
                        .target("http://www.cdbookstore.com/books/1234")
                        .request(MediaType.TEXT_PLAIN)
                        .get();
```

DELETE http://www.cdbookstore.com/**books/1234**

Client API

```
Response response = ClientBuilder.newClient()
                        .target("http://www.cdbookstore.com/books/1234")
                        .request(MediaType.TEXT_PLAIN)
                        .delete();
```

DELETE http://www.cdbookstore.com/**books/1234**

Response

```
Response response = ClientBuilder.newClient()
                        .target("http://www.cdbookstore.com/books/1234")
                        .request(MediaType.TEXT_PLAIN)
                        .delete();

assertTrue(response.getStatusInfo() == Response.Status.OK);
assertTrue(response.getLength() == 4);
assertTrue(response.getDate() != null);
assertTrue(response.getHeaderString("Content-type").equals("text/plain"));
```

DELETE http://www.cdbookstore.com/**books/1234**

Response

```
Response response = ClientBuilder.newClient()
                        .target("http://www.cdbookstore.com/books/1234")
                        .request(MediaType.TEXT_PLAIN)
                        .get();

assertTrue(response.getStatusInfo() == Response.Status.OK);
assertTrue(response.getLength() == 4);
assertTrue(response.getDate() != null);
assertTrue(response.getHeaderString("Content-type").equals("text/plain"));

String body = response.readEntity(String.class);
Book book = response.readEntity(Book.class);
```

```
GET        http://www.cdbookstore.com/books/1234
```

REST Services

Exposing REST services

CRUD operations

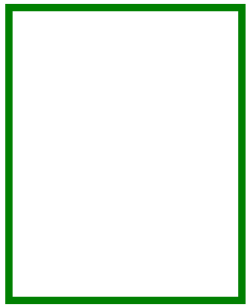
Client API

Messaging

Java Messaging Service (JMS) 2.0

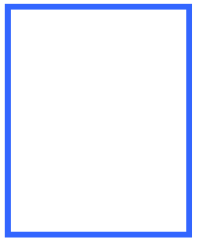
What Is Messaging?

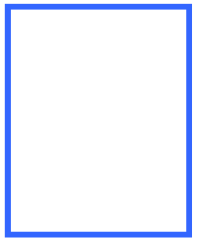
- Message-oriented middleware (MOM)
- Broker
- Exchange messages asynchronously
- Between heterogeneous systems
- At their own pace
- Loosely coupled
- Not available at the same time



When to Use Messaging

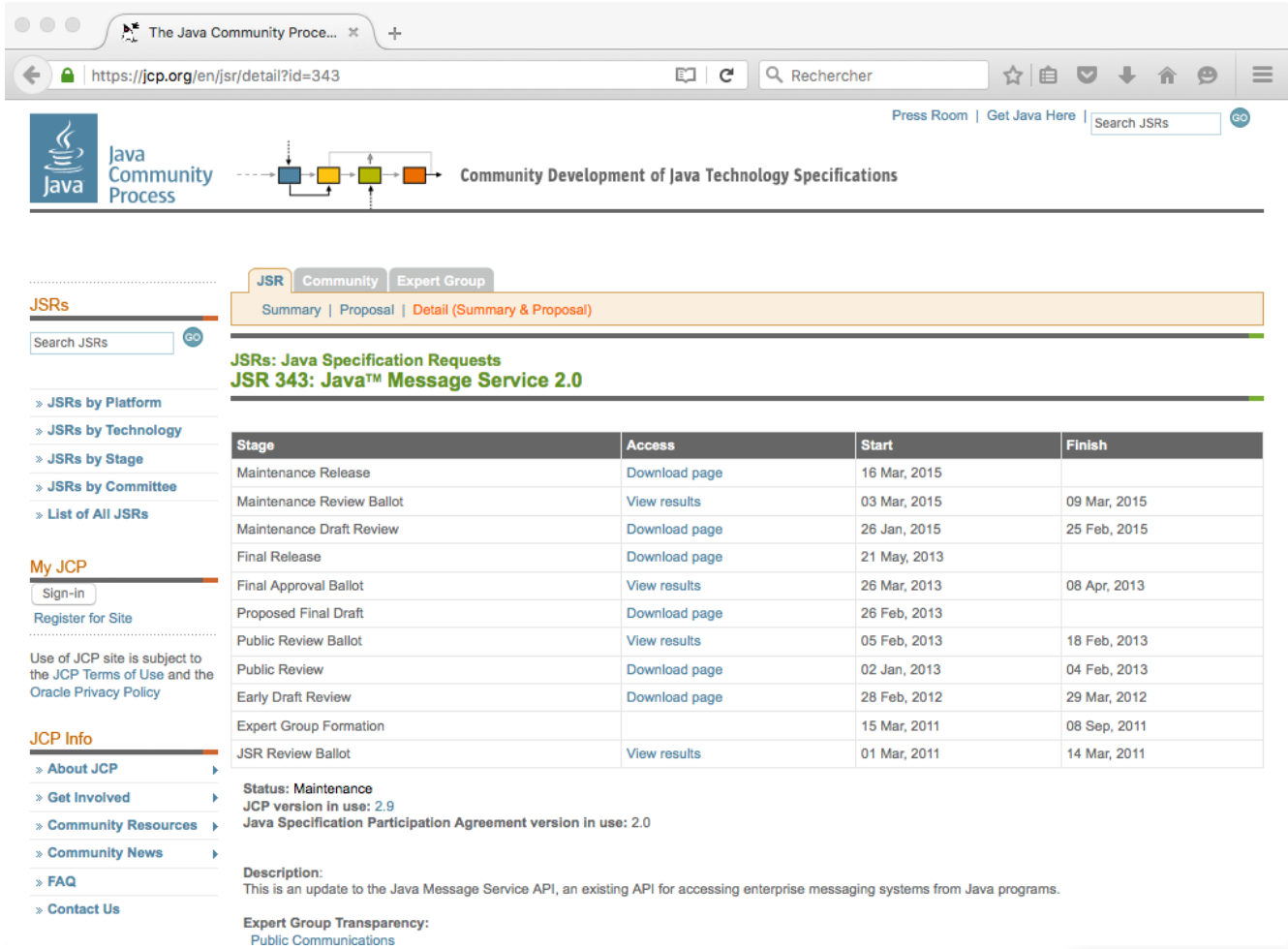
- Many applications
- Written in different languages
- Different operating systems
- Asynchronous interaction
- Work independently
- Loosely coupled
- Producer and consumer agree on the message
- Local or distributed





JMS Specification

- Java Message Service 2.0
- JSR 343
- http://jcp.org/en/jsr/detail?id=343



JMS Implementations

- OpenMQ
- ActiveMQ
- HornetQ
- RabbitMQ
- WebsphereMQ

ActiveMQ

HornetQ

WebSphere®

MQ

RabbitMQ

Messaging

CD-BookStore 24/7

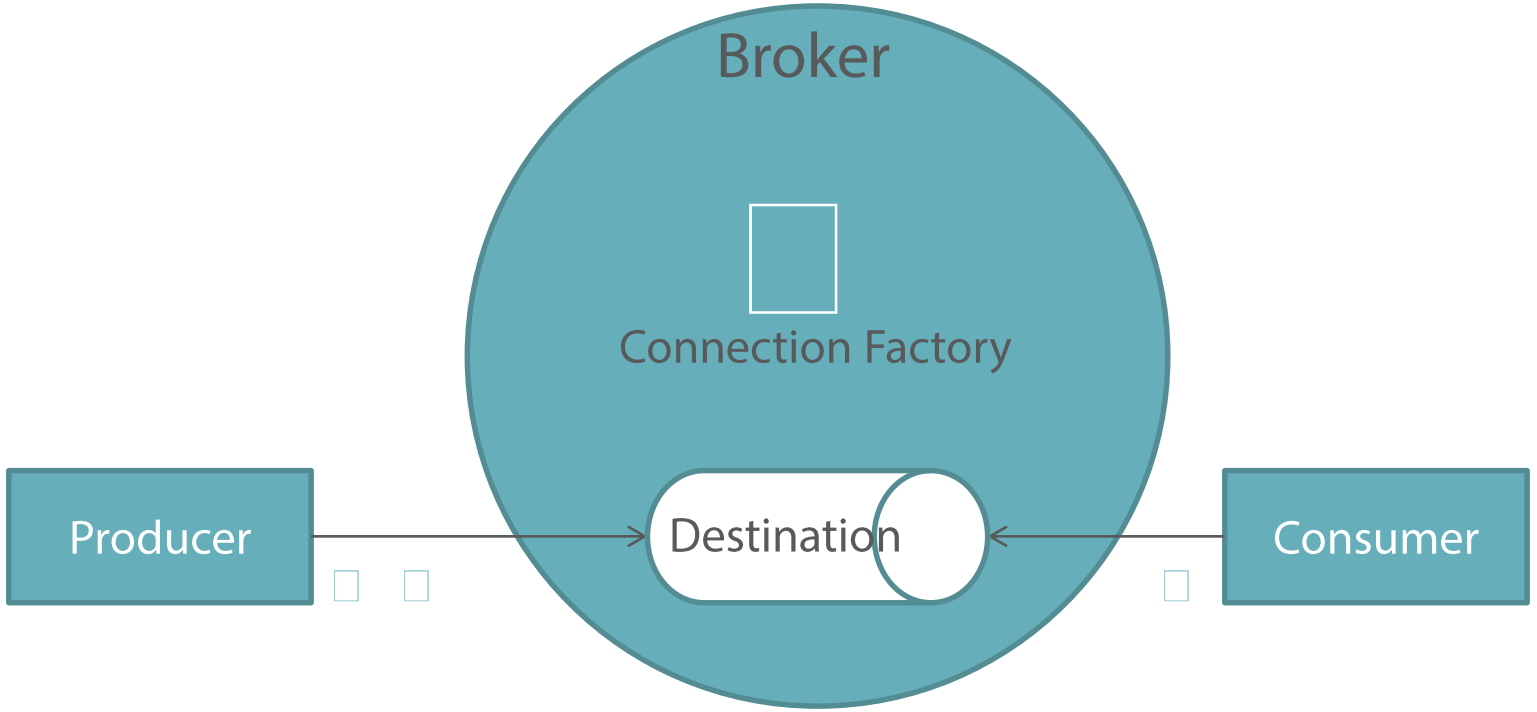
Sends messages

Invoice application

Even if down

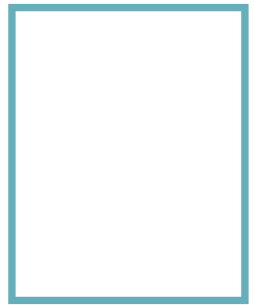
Understanding JMS

- Message broker
- Producer
- Destination
- Consumer
- Connection factory
- Messages



Messages

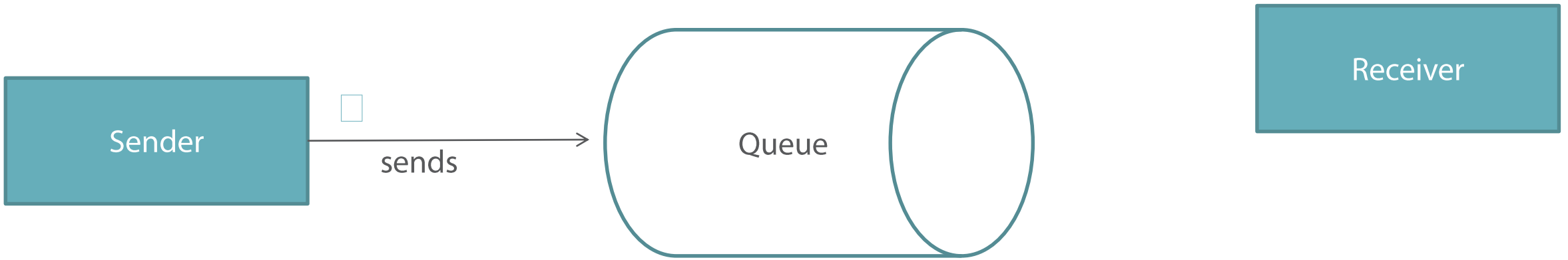
- Encapsulate information
- Header
  - Identifying and routing
- Properties
  - Name-value pairs
- Body
  - Text, bytes, object, map or a stream



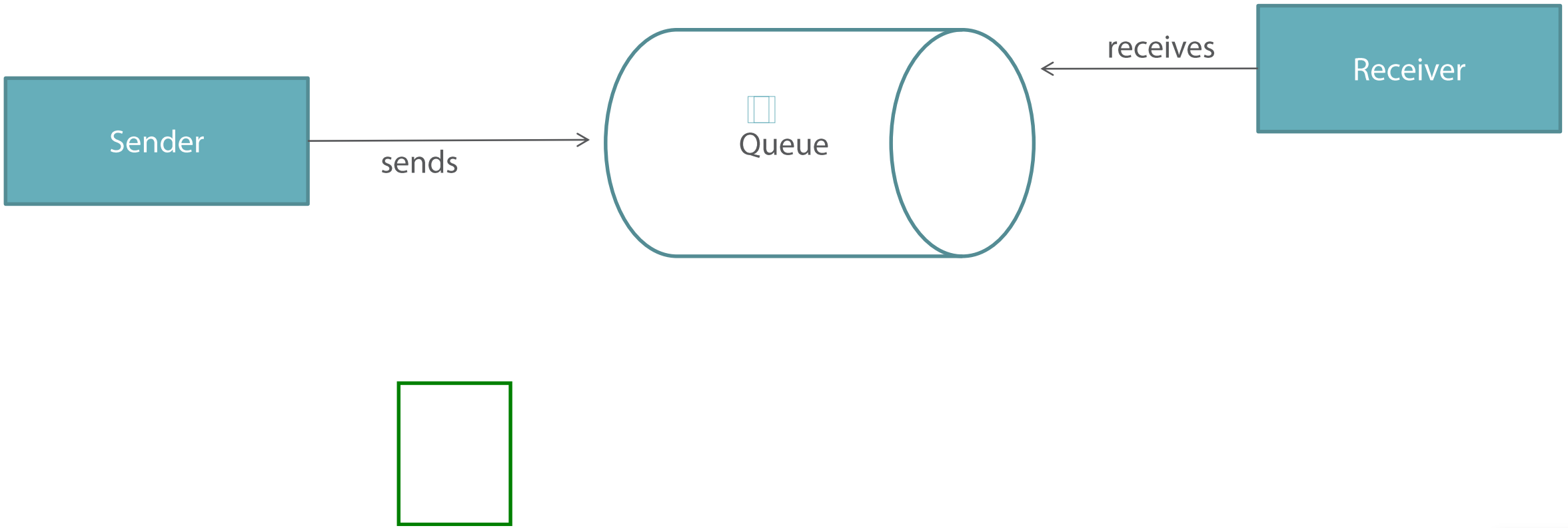
Destinations

- Administered object
- JNDI name
  - JNDI lookup
  - Injection
- Queue
  - Point-to-point
- Topic
  - Publish-subscribe

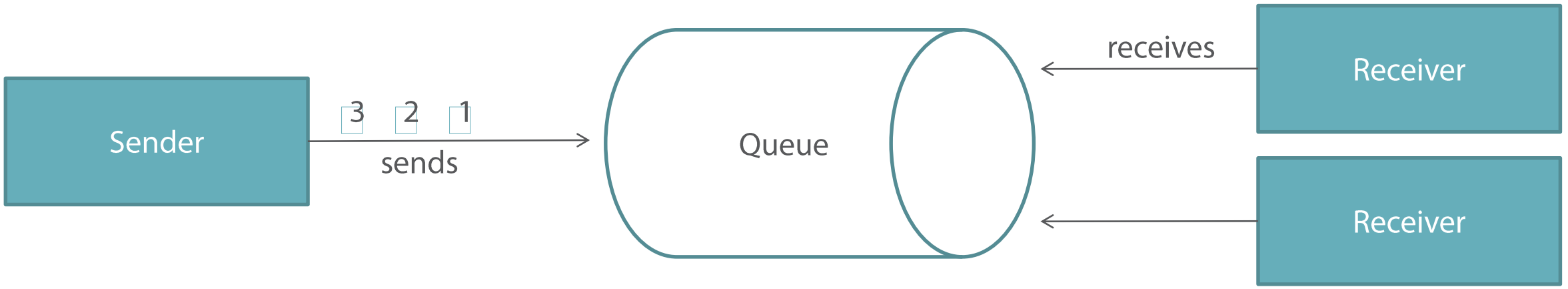
Queue and Point-to-Point



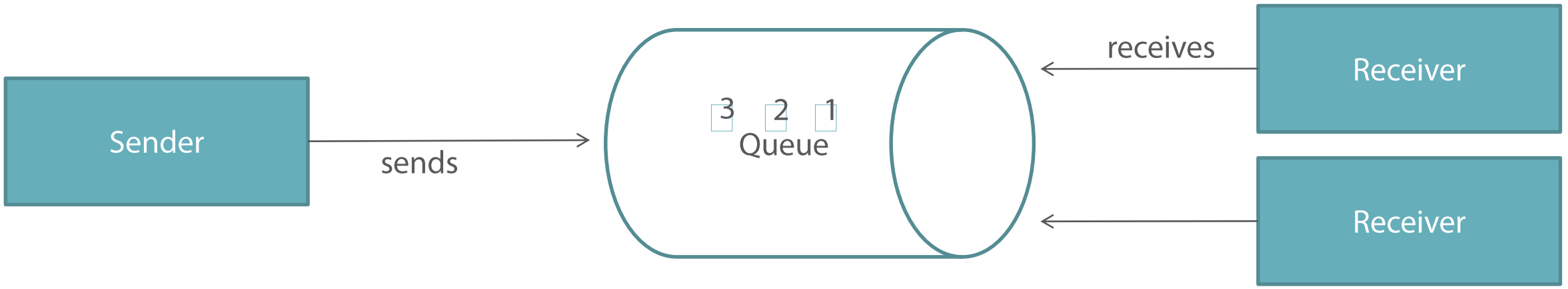
Queue and Point-to-Point



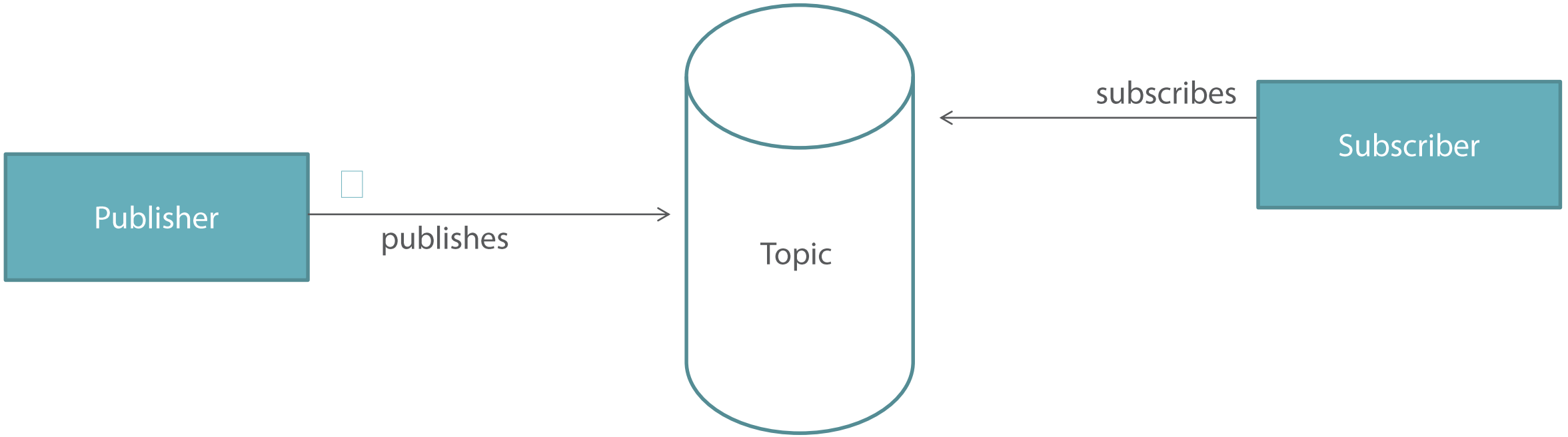
Queue and Point-to-Point



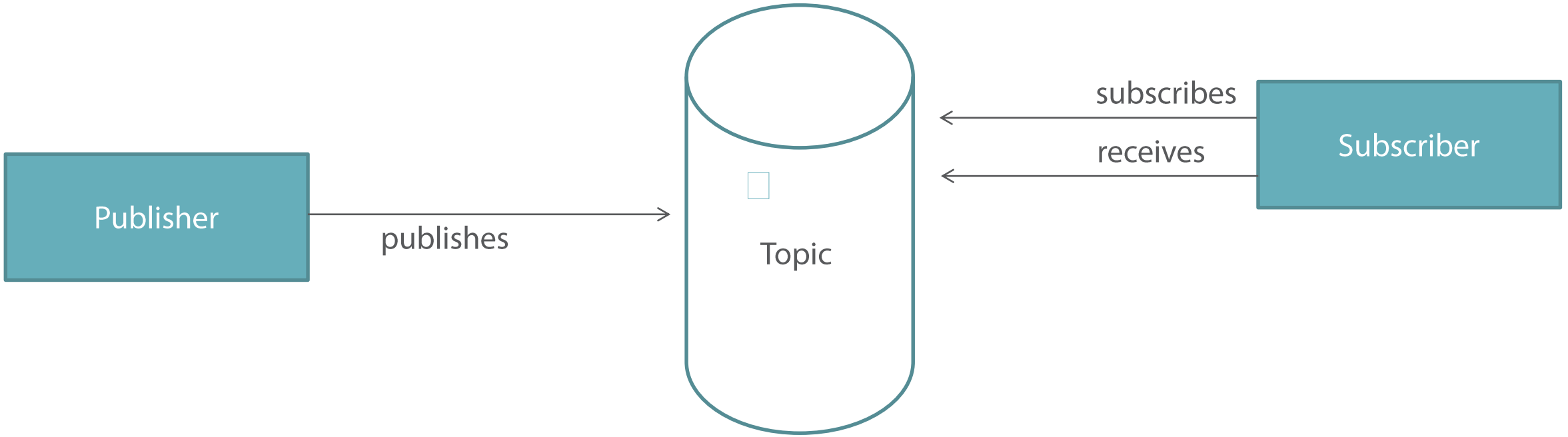
Queue and Point-to-Point



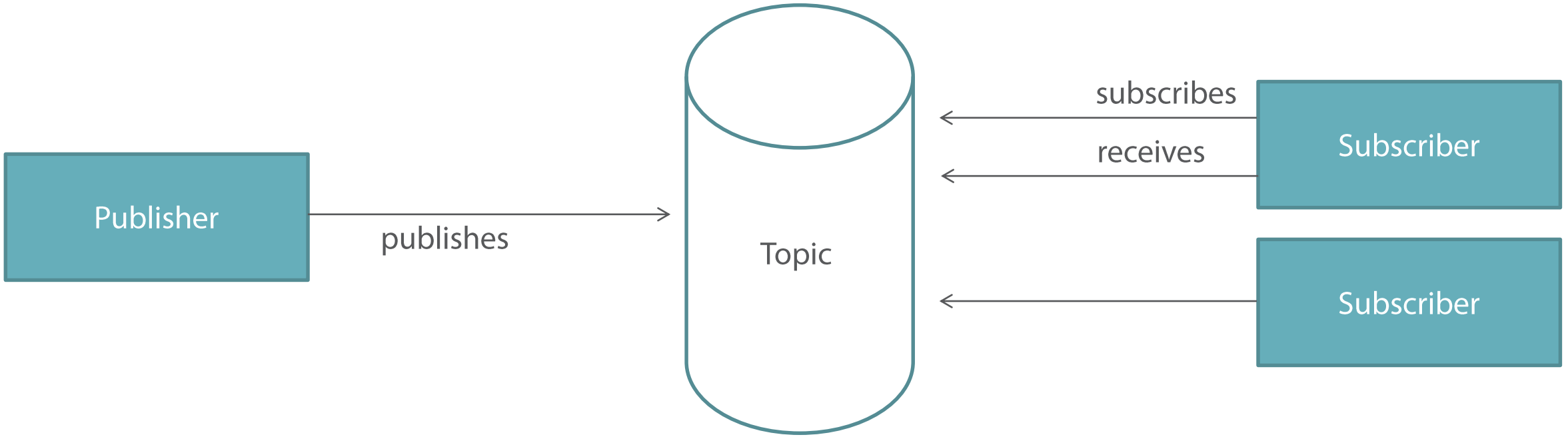
Topic and Publish-Subscribe



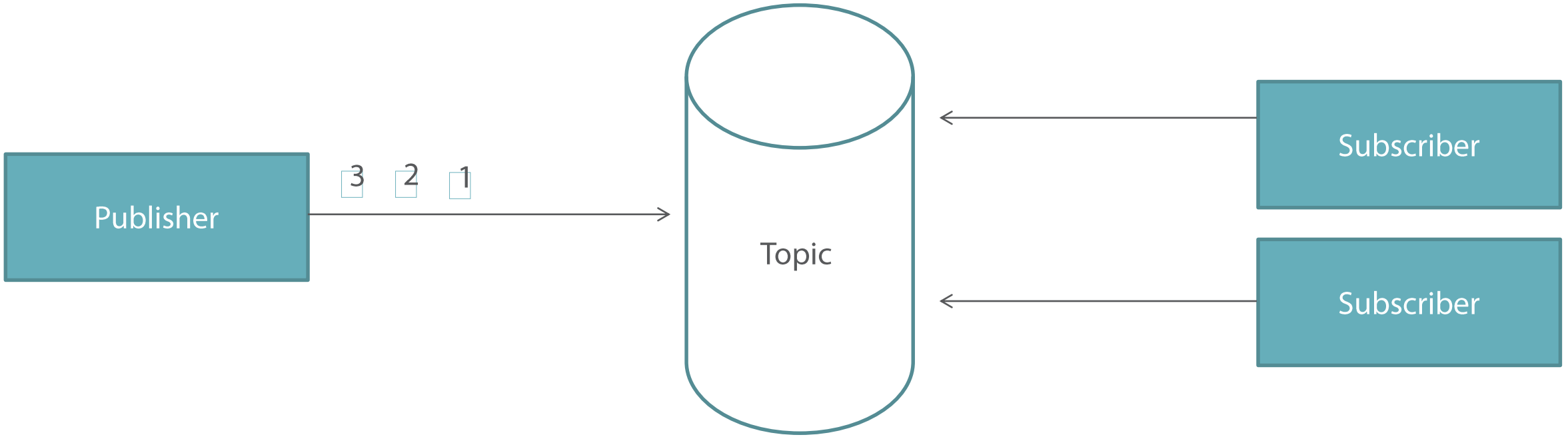
Topic and Publish-Subscribe



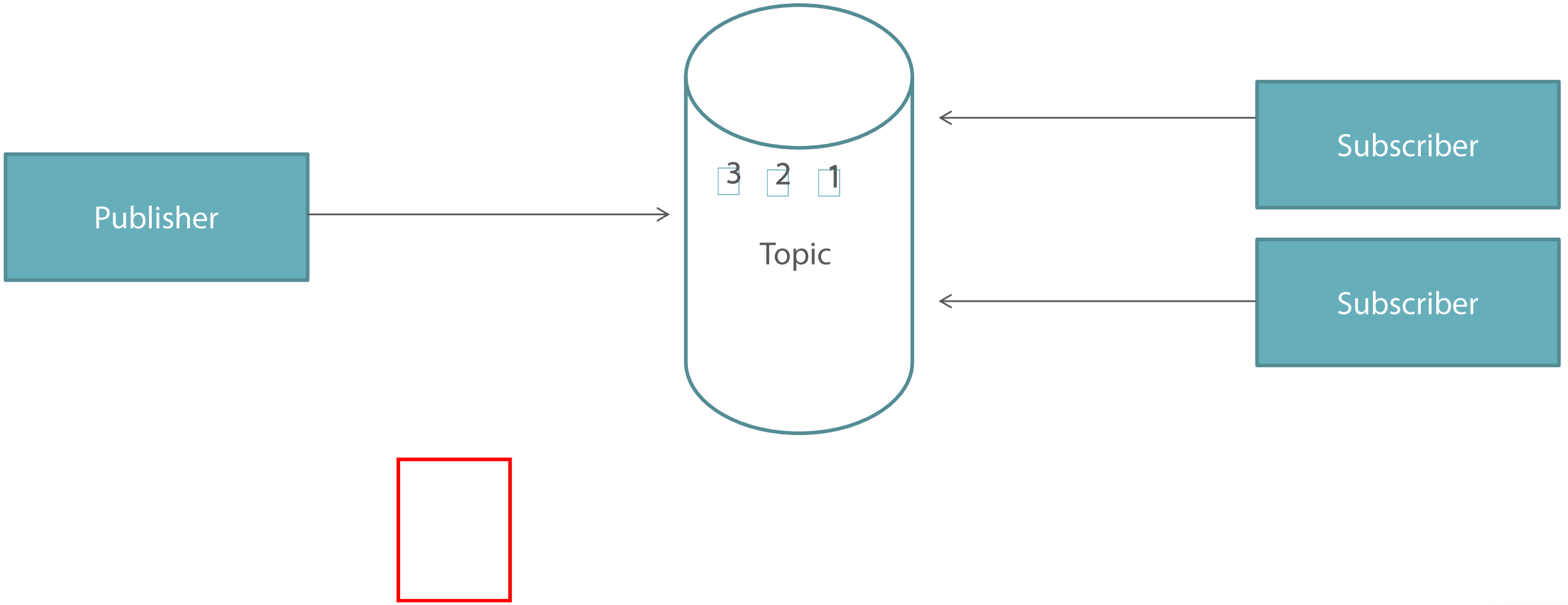
Topic and Publish-Subscribe



Topic and Publish-Subscribe

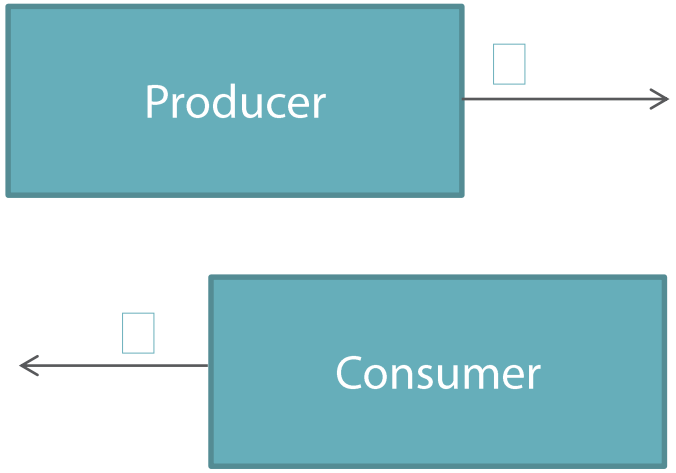


Topic and Publish-Subscribe



Producers and Consumers

- Producer
  - Sender
  - Publisher
- Consumer
  - Receiver
  - Subscriber
- Any Java EE component



Producing a Message

```
public class Sender {

  @Resource(lookup = "jms/queue/invoiceQueue")
  private Queue destination;

  @Inject
  private JMSContext jmsContext;

  public void sendMessage() {
    jmsContext.createProducer().send(destination, "Message sent at " + new Date());
  }
}
```

Producing a Message

```
public class Sender {

  @Resource(lookup = "jms/queue/invoiceQueue")
  private Topic destination;

  @Inject
  private JMSContext jmsContext;

  public void sendMessage() {
    jmsContext.createProducer().send(destination, "Message sent at " + new Date());
  }
}
```

Producing a Message

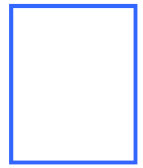
```
public class Sender {

  @Resource(lookup = "jms/queue/invoiceTopic")
  private Topic destination;

  @Inject
  private JMSContext jmsContext;

  public void sendMessage() {
    jmsContext.createProducer().send(destination, "Message sent at " + new Date());
  }
}
```

Consuming a Message

```
@MessageDriven(activationConfig = {
  @ActivationConfigProperty(propertyName  = "destinationType",
                            propertyValue = "javax.jms.Queue"),
  @ActivationConfigProperty(propertyName  = "destination",
                            propertyValue = "jms/queue/invoiceQueue")
})
public class Receiver                                  {

  @Override
  public void onMessage(Message message) {
    // Process message
  }
}
```

Reliability Mechanisms

- Ensure messages are delivered
- Broker crashes or is under load
- Filtering messages
- Setting Time-to-live
- Providing message persistence
- Controlling acknowledgment
- Setting priorities
- Creating durable subscribers



Reliability Mechanisms

```
public class Sender {

  @Resource(lookup = "jms/queue/invoiceQueue")
  private Queue destination;

  @Inject
  private JMSContext jmsContext;

  public void sendMessage() {

    jmsContext.createProducer()
        .setPriority(2)
        .setTimeToLive(1000)
        .setDeliveryMode(DeliveryMode.NON_PERSISTENT)
        .send(queue, "Text message sent at " + new Date());
  }
}
```

JMS Packages

Package	Description
`javax.jms`	Core JMS API

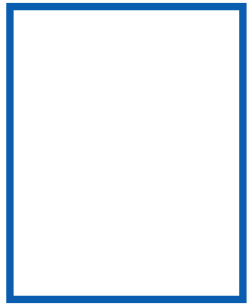
Messaging

Send invoice message

Receive message

Queue

Summary



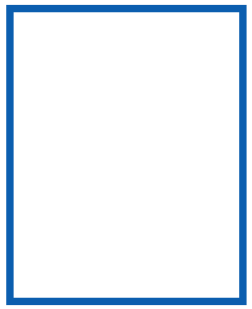
Interoperability tier

XML and JSON

RESTful Web Services

Java Message Service

What's Next



All together

Flexibility

Modular