MuleSoft

Module 5: Transforming Data

Transforming data using transformers

- Anypoint Studio provides a set of transformers to handle the most common data transformation scenarios
- Up to Mule 3.6, this was the main way to transform messages

MuleSoft

We've already used some transformers

- DOM to XML (Delta)
- Object to String (American DB)
- File to String (CSV)
- Object to JSON (Salesforce)

- Variable
- Property
- Session

About the DataMapper transformer

- Introduced in Mule 3.3 (2012)
- Provided a way for users to graphically manipulate data and work with many different data formats
- Customers loved the direction, but wanted much more in terms of capabilities, performance, and ease of use
- DataWeave is the new solution for the future
- DataMapper will not be supported from Mule 4.0 on
  - There will be a migration tool later this year

MuleSoft

Transforming data using DataWeave (new in 3.7!)

- DataWeave is a full-featured and fully native framework for querying and transforming data on Anypoint Platform
- Powered by the DataWeave data transformation language
  - A JSON-like language that's built just for data transformation use cases
- Powered by the core Mule runtime
  - Provides 5x performance vs previous approaches
- Fully integrated with Anypoint Studio and DataSense
  - Graphical interface with payload-aware development

MuleSoft

Goal

Objectives

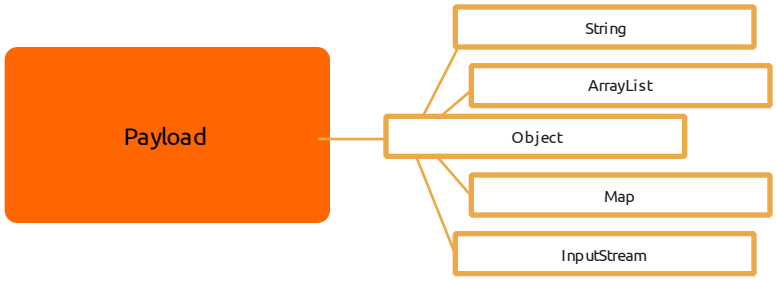
- In this module, you will learn:
  - About the different types of transformers
  - To use the DataWeave Transform Message component
  - To write DataWeave expressions for basic and complex XML, JSON, and Java transformations
  - To use DataWeave with data sources that have associated metadata
  - To add custom metadata to data sources

MuleSoft

Introducing transformers

Transformers

- Transformers prepare a message to be processed through a flow by enhancing or altering the message header or message payload
- Remember payloads are Java objects and can be any Java type



MuleSoft

Transformer categories

- Java object transformers
  - Transform a Java object into another Java object or some other data type (like HTTP request) or vice versa
- Message and variable transformers
  - Do not modify the message directly, but make special info available as a message makes its way through a Mule app
- Content transformers
  - Modify messages by adding to, deleting from, or converting a message payload (or a message header)
- Script transformers
  - Use Groovy, JavaScript, Python, or Ruby to perform the transformation

MuleSoft

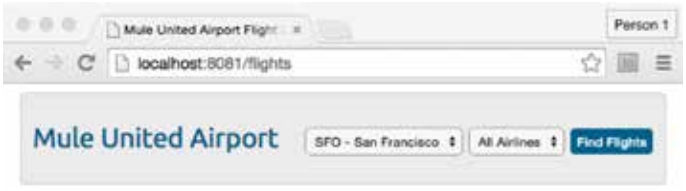
Parse Template transformer

- A content transformer
- Loads the content of an external file into a Mule flow
- Commonly used to return customized HTML responses
  - The file can have MEL expressions in it that are evaluated

MuleSoft

Walkthrough 5-1: Load external content into a message

- Create a flow that receives GET requests at http://localhost:8081/flights
- Use the Parse Template transformer to load the content of an HTML file into a flow
- Examine the HTML code and determine what data it sends where



MuleSoft

Java object transformers

- Transform a Java object into another Java object or some other data type or vice versa
- Some can simply be dropped in (like the ones we used so far)
- Others require configuration using 3rd party libraries
  - JAXB
  - Jackson
  - org.w3c.dom

Complex transformations

- Up to Mule 3.6, if a transformer did not exist for your specific needs you would
  - Chain transformers
  - Create a custom Java transformer
  - Use a Script transformer to write the transformation in Groovy, JavaScript, Python, or Ruby

MuleSoft

Using DataWeave for all transformations

- For Mule 3.7, you can use the new DataWeave framework for all your transformations
  - From simple to complex
  - No longer need to use most other transformers unless you want to use specific Java frameworks
    - Like JAXB, Jackson, org.w3c.dom
    - To integrate with existing code bases or leverage existing skill sets

MuleSoft

Introducing DataWeave

Introducing DataWeave (again)

- DataWeave is a full-featured and fully native framework for querying and transforming data on Anypoint Platform
- Powered by the DataWeave data transformation language
  - A JSON-like language that's built just for data transformation use cases
- Powered by the core Mule runtime
  - Provides 5x performance vs previous approaches
- Fully integrated with Anypoint Studio and DataSense
  - Graphical interface with payload-aware development

DataWeave data transformation language

- A universal, simple, JSON-like language for transforming and querying data
- Easy to write, easy to maintain, and capable of supporting simple to complex mappings for any data type
  - Supports XML, JSON, Java, CSV, EDI out of the box
  - Extensible for new formats via an API
  - Excel support coming later this year
- More elegant and re-usable than custom code
  - Data transformations can be stored in external DWL files and used across applications

DataWeave data transformation use cases

- DataWeave was purposefully built to make it easy to write simple to complex transformations
  - Simple 1-to-1 mappings
  - Transforming hierarchical data models
  - De-duplication of data
  - Filtering data
  - Grouping and partitioning data
  - Joining data across multiple data sources
  - Streaming inbound and outbound data

MuleSoft

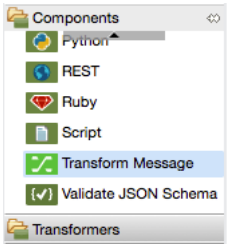
DataWeave under the hood

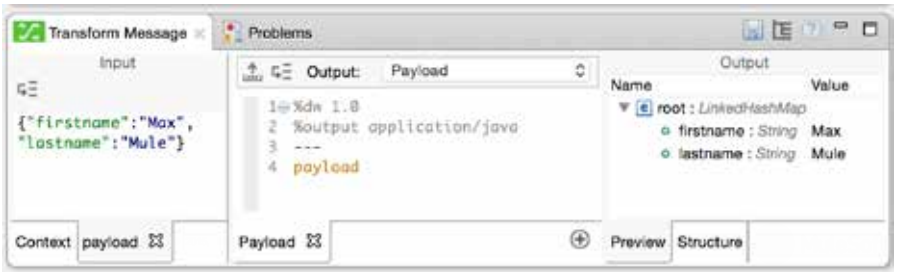
- Underneath, DataWeave includes a connectivity layer and engine that is fundamentally different from other transformation technologies
- It contains a data access layer that indexes content and accesses the binary directly, without costly conversions
  - Enables larger than memory payloads
  - Random access to input documents
  - Very high performance

MuleSoft

DataWeave integration with Anypoint Studio

- The DataWeave Transform Message component provides an Anypoint Studio interface
- The Properties view has Input, Transform, and Output sections





DataWeave integration with DataSense

- DataWeave is fully integrated with DataSense allowing payload-aware development
- Metadata from connectors, schemas and sample documents can be used to more easily build transformations
  - In the Input section of the Properties view
    - Any metadata of incoming message displayed
  - In the Transform section
    - Auto-completion of code
    - Auto-scaffolding of transforms
  - In the Output section
    - Any metadata for outbound message displayed
    - Live transformation previews

MuleSoft

Writing DataWeave expressions

Example DataWeave expression

The **header** contains directives – high level info about the transformation

Input	Transform	Output
{ "firstname": "Max", "lastname": "Mule" }	%dw 1.0 %output application/xml --- { user: { fname: payload.firstname, lName: payload.lastname } }	<?xml version="1.0" encoding="UTF-8"?> <user> <fname>Max</fname> <lname>Mule</lname> </user>

The **body** contains a DataWeave expression that generates the output structure

MuleSoft

DataWeave expressions

- The DataWeave expression is a data model for the output
  - It is not dependent upon the types of the input and output, just their structures
  - It's against this model that the transform executes
- The data model of the produced output can consist of three different types of data
  - **Objects**: Represented as collection of key value pairs
  - **Arrays**: Represented as a sequence of comma separated values
  - **Simple literals**

The output directive

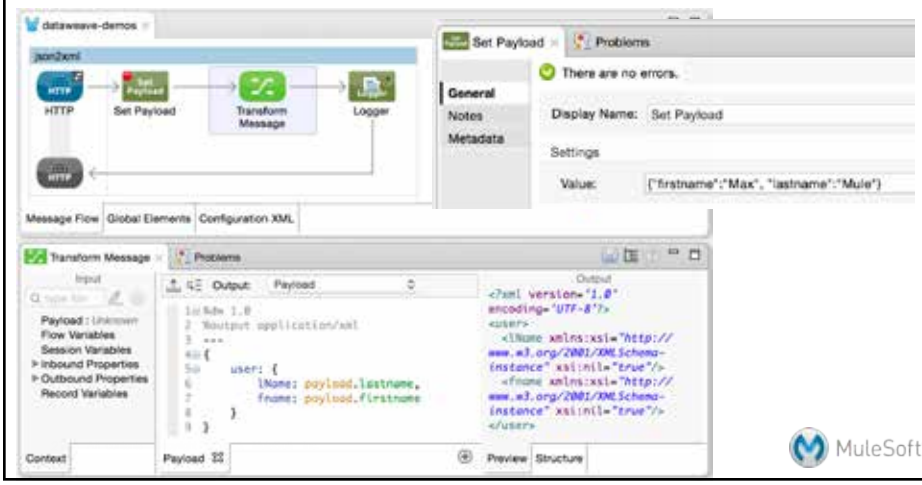
- Sets the output type of the transformation
- Specified using content/type
  - application/json, text/json
  - application/xml, text/xml
  - application/java, text/java
  - application/csv, text/csv
  - application/dw

```
%dw 1.0
%output application/xml
---
{
  a: payload
}
```

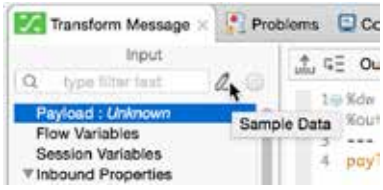
- The structure of the output is defined in the DataWeave body

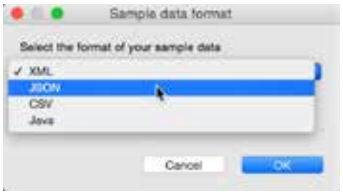
Previewing transformations in Anypoint Studio

- As you write a DataWeave expression, a live preview of output will be shown
  - You will not see actual values unless you add sample data



Adding sample data to get live transformation previews





Setting input data MIME types

- When you run your application, you may get an error unless the MIME type for the input data has been set
  - It may be set automatically if the data is posted to the flow
    - See inbound properties content-type
  - Otherwise, you can set it
    - The transformers have a mimeType property

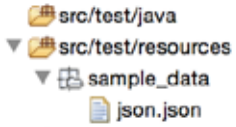
MuleSoft

Where is the code?

- By default, it is placed inline

```
<flow name="json2xml">
    <http:listener config-ref="HTTP_Listener_Configurati
    <set-payload value="{&amp;quot;firstname&amp;quot;:&amp;quot;Max
    <dw:transform-message doc:name="Transform Message">
        <dw:input-payload doc:sample="json.json"/>
        <dw:set-payload><![CDATA[%dw 1.0
%output application/xml
---
{
    user: {
        lName: payload.lastname,
        fname: payload.firstname
    }
}]]></dw:set-payload>
    </dw:transform-message>
    <logger level="INFO" doc:name="Logger"/>
</flow>
```

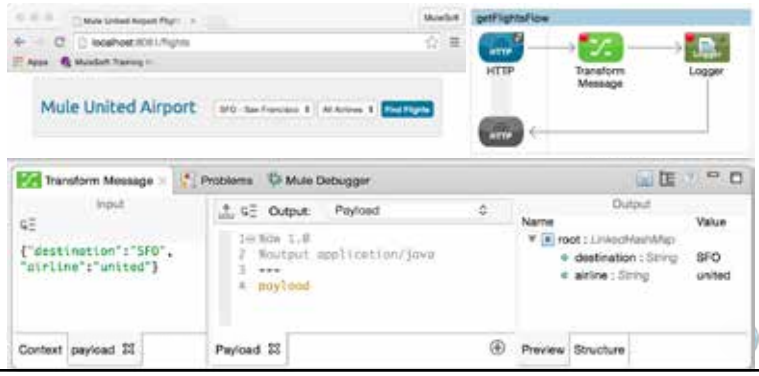
- Any added sample data is stored in src/test/resources



MuleSoft

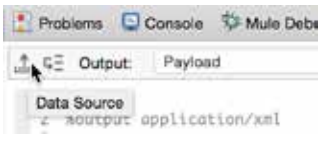
Walkthrough 5-2: Write your first DataWeave transformation

- Create a flow that receives POST requests at http://localhost:8081/flights
- Use the DataWeave Transform Message component
- Add sample data and use live preview
- Transform the form data from JSON to a Java object



Reusing transformations

- To place it an external file, click the Data Source button
  - Transform is saved in a DWL file
  - DWL files are stored in src/main/resources



- To reference an existing DWL, specify it in code

```
<flow name="json2xml">
    <http:listener config-ref="HTTP_Listener_Configuration" path="/json" allowedMe
    <set-payload value="{&amp;quot;firstname&amp;quot;:&amp;quot;Max&amp;quot;, &amp;quot;lastname&amp;quo
    <dw:transform-message doc:name="Transform Message">
        <dw:input-payload doc:sample="json.json"/>
        <dw:set-payload resource="classpath:user_transform.dwl"></dw:set-payload>
    </dw:transform-message>
    <logger level="INFO" doc:name="Logger"/>
</flow>
```

Writing expressions for XML output

- XML can only have one top-level value and that value must be an object with one property
  - This will throw an exception

  - This will work

 MuleSoft

Specifying attributes for XML output

- Use @(attName: attValue) to create an attribute

  MuleSoft

Writing expressions for XML input

- By default, only XML elements and not attributes are created as JSON fields or Java object properties
- Use @ to reference attributes

Input	Transform	JSON Output
`<user firstname="Max">   <lastname>Mule</lastname> </user>`	`payload`	`{ "user": {   "lastname": "Mule"   } }`
	`payload.user`	`{"lastname": "Mule" }`
	`{  fname: payload.user.@firstname,  lname: payload.user.lastname }`	{"fname": "Max", "lname": "Mule"}

- Note: Be sure to update to Anypoint Studio 5.2.1 or later
  - Live preview for XML sample input does not work in 5.2.0

Referencing message variables

- So far, we referenced payload
- You can also reference
  - flowVars
  - inboundProperties
  - outboundProperties
- This is not MEL!
  - Do not preface these values by “message.” or use #[]

```
%dw 1.0
%output application/xml
---
{
  a: flowVars.userName
}
```


Creating multiple transformations

- You can also create multiple transformations with one Transform Message component

MuleSoft

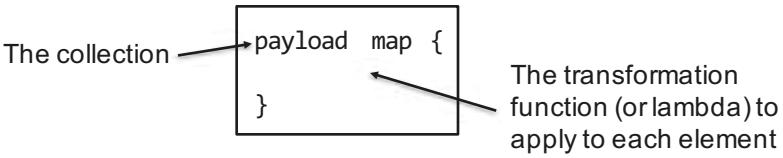
Walkthrough 5-3: Transform basic Java, JSON, and XML data structures

- Write transformations to store data in multiple outputs as different types of data
- Create a 2nd transformation to store destination in a flow variable
- Create a 3rd transformation to output data as JSON
- Create a 4th transformation to output data as XML

Transforming complex data structures with DataWeave

Working with collections

- Use the **map** operator to apply a transformation to each element in a collection
  - A collection can be JSON or Java arrays or XML repeated elements



- The map operator
  - Returns an array of elements
  - Can be applied to each element in an array or each value in an object

MuleSoft

The transformation function

- Inside the transformation function
  - $$ refers to the index (or key)
  - $ refers to the value

Input	Transform	Output

`[{"firstname":"Max", "lastname":"Mule"}, {"firstname":"Molly", "lastname":"Mule"}]`	`%dw 1.0`
	`%output application/json`
	`---`
	`payload map {`
	`  num: $$,`
	`  fname: $.firstname,`
	`  lname: $.lastname`
	`}`
		`[`
		`  {"num": 0,`
		`  "fname": "Max",`
		`  "lname": "Mule"},`
		`  {"num": 1,`
		`  "fname": "Molly",`
		`  "lname": "Mule"}`
		`]`

	`%dw 1.0`
	`%output application/json`
	`---`
	`users: payload map {`
	`  user: {`
	`  fname: $.firstname,`
	`  lname: $.lastname`
	`  }`
	`}`
		`{`
		`  "users": [`
		`  {"user": {`
		`  "fname": "Max",`
		`  "lname": "Mule"`
		`  }},`
		`  {"user": {`
		`  "fname": "Molly",`
		`  "lname": "Mule"`
		`  }}`
		`  ]`
		`}`

Using the index as a key in a transformation function

- To set the index as a new key, surround it with () or "

Input	Transform	Output

`[{"firstname":"Max", "lastname":"Mule"}, {"firstname":"Molly", "lastname":"Mule"}]`	`%dw 1.0`
	`%output application/json`
	`---`
	`payload map {`
	`  num: $$,`
	`  ($$): $`
	`}`
		`[`
		`  {`
		`  "num": 0,`
		`  "0": {`
		`  "firstname": "Max",`
		`  "lastname": "Mule"`
		`  }`
		`  },`
		`  {`
		`  "num": 1,`
		`  "1": {`
		`  "firstname": "Molly",`
		`  "lastname": "Mule"`
		`  }`
		`  }`
		`]`

	`payload map {`
	`  num: $$,`
	`  '$$': $`
	`}`	

	`payload map {`
	`  'num$$': $`
	`}`
		`[`
		`  {`
		`  "num0": {`
		`  "firstname": "Max",`
		`  "lastname": "Mule"`
		`  }`
		`  },`
		`  {`
		`  "num1": {`
		`  "firstname": "Molly",`
		`  "lastname": "Mule"`
		`  }`
		`  }`
		`]`

Writing expressions for XML output

- When mapping array elements (JSON or JAVA) to XML, wrap the map operation in {(…)}
  - {} are defining the object
  - () are transforming each element in the array as a key/value pair

Input	Transform	Output

[{"firstname":"Max", "lastname":"Mule"}, {"firstname":"Molly", "lastname":"Mule"}]	%dw 1.0
	%output application/xml
	--- 	
	users: payload map {
	fname: $.firstname,
	lname: $.lastname
	}
		Cannot coerce an array to an object (starting with 3.7.1)

	users: {(payload map { fname: $.firstname, lname: $.lastname })}	<users> <fname>Max</fname> <lname>Mule</lname> <fname>Molly</fname> <lname>Mule</lname> </users>

MuleSoft

Writing expressions for XML output (cont)

Input	Transform	Output
[{"firstname":"Max", "last Name":"Mule"}, {"firstname":"Molly", "lastName":"Mule"}]	users: {(payload map { fname: $.firstname, lname: $.lastname })}	<users> <fname>Max</fname> <lname>Mule</lname> <fname>Molly</fname> <lname>Mule</lname> </users>

	users: {(payload map {
	user: {
	fname: $.firstname,
	lname: $.lastname
	}
	}
	)}
		<?xml version='1.0' encoding='UTF-8'?>
		<users>
		<user>
		<fname>Max</fname>
		<lname>Mule</lname>
		</user>
		<user>
		<fname>Molly</fname>
		<lname>Mule</lname>
		</user>
		</users>

MuleSoft

Writing expressions for XML input

- Use * to reference repeated elements

Input	Transform	JSON Output
<users> <user firstname="Max"> <lastname>Mule</lastname> </user> <user firstname="Molly"> <lastname>Mule</lastname> </user> </users>	payload	{ "users": { "user": { "lastname": "Mule" } } }
	payload.users	{ "user": { "lastname": "Mule" } }
	payload.users.user	{ "lastName": "Mule" }
	payload.users.*user	[{ "lastName": "Mule" }, { "lastName": "Mule" }]

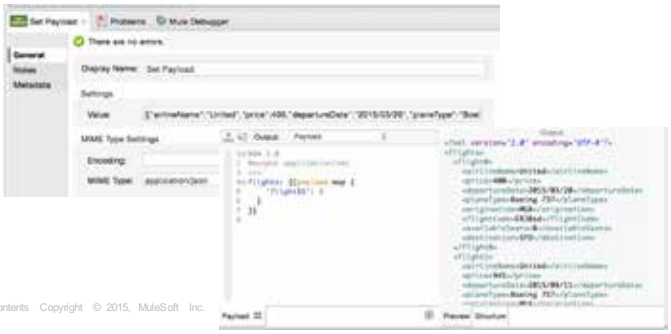
	payload.users.*user map {
	fname: $.@firstname,
	lname: $.lastName
	}
		[{ "fname": "Max", "lname": "Mule" }, { "fname": "Molly", "lname": "Mule" }]

MuleSoft

Walkthrough 5-4: Transform complex data structures

- Create a new flow that receives GET requests at http://localhost:8081/static
- Transform a JSON array of objects to Java, JSON, and XML
- Explicitly set the MIME type of the data to be transformed
- Transform XML with repeated elements to XML and JSON

Note: You will work with CSV data in the Processing Records module



MuleSoft

Using DataWeave operators

DataWeave reference documentation

- https://developer.mulesoft.com/docs/dataweave

Formatting operators

Input	Transform	Output

	`%dw 1.0`
	`%output application/xml`
	`---`	

`{"name": "max_mule"}`	`n: upper payload.firstname`	`<n>MAX_MULE</n>`
	`n: lower payload.firstname`	`<n>Max_mule</n>`
	`n: camelize payload.name`	`<n>maxMule</n>`
	`n: capitalize payload.name`	`<n>Max Mule</n>`
	`n: dasherize payload.name`	`<n>max-mule</n>`
	`n: pluralize payload.name`	`<n>max-mules</n>`
	`n: upper (dasherize payload.name)`	`<n>MAX-MULE</n>`
`{"name": "max mules"}`	`n: singularize payload.name`	`<n>max mule</n>`
	`n: underscore payload.name`	`<n>max_mules</n>`
`{"place": 2}`	`n: ordinalize payload.place`	`<n>2nd</n>`

MuleSoft

Using the as operator for type coercion

```
price: payload.price as :number
```

- Defined types include
  - :string
  - :number
  - :boolean
  - :object
  - :array
  - :date, :time, :timezone, :datetime, :localdatatime, :period
  - :regex

MuleSoft

Specifying custom data types

- Specify inline

```
customer:payload.user as :object {class: "my.company.User"}
```

- Assign a custom name with the type directive
  - Name has to be all lowercase letters
    - No special characters, uppercase letters, or numbers

```
%type user = :object {class: "my.company.User"}
customer:payload.user as :user
```


Using format patterns

- Use metadata **format** key to format numbers and dates
- Inline

```
tax: (tax * 100) as :number {format: "##.#" } ++ "%"
someDate as :datetime {format: "yyyyMMddHHmm"}
```

For pattern letters, see Java DateTimeFormatter class API
https://docs.oracle.com/javase/8/docs/api/java/time/format/DateTimeFormatter.html

- With custom type

```
%type currency = :number {format: "##"}
price: $.price as :currency
```

Conditional logic operators

- In expressions, you can use ==, !=, or ~= (equal regardless of type)

Input	Transform	Output

	`%dw 1.0`
	`%output application/xml`
	`---`	

`{"firstname":"Max", "lastname":"Mule"}`	`n: payload.nickname default payload.firstname`	`<n>Max</n>`

`{"firstname":"Max", "lastname":"Mule", "nickname":""}`	`n: payload.nickname`
	`when payload.nickname != ""`
	`otherwise payload.firstname`
		`<n>Max</n>`

	`n: payload.firstname`
	`unless payload.nickname != ""`
	`otherwise payload.nickname`
		`<n>Max</n>`

	`n: payload.firstname`
	`unless payload.nickname !="" or payload.firstname != ""`
	`otherwise payload.nickname`
		`<n></n>`

	`n: payload.lastname`
	`unless payload.nickname !="" and payload.firstname !=""`
	`otherwise payload.nickname`
		`<n>Max</n>`

Math operators

- +
- -
- *
- /

- max: returns the highest number in an array or object
- min: returns the lowest number in an array or object
- sizeOf: returns number of elements in an array

Additional operators

- concat

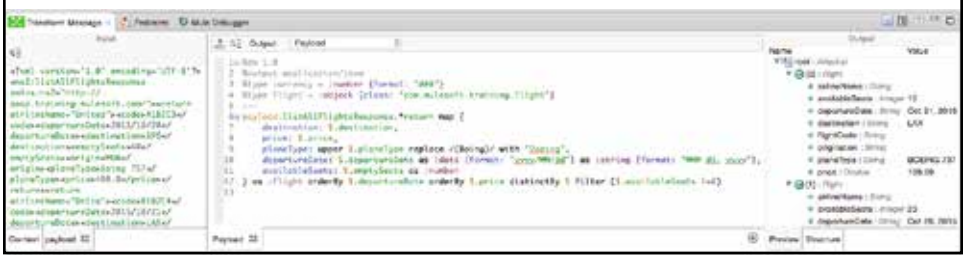
```
n: payload.firstname ++ " " ++ payload.lastname
```

- orderBy
- distinctBy
- groupBy
- replace
- matches
- regex
- More…

MuleSoft

Walkthrough 5-5: Use DataWeave operators

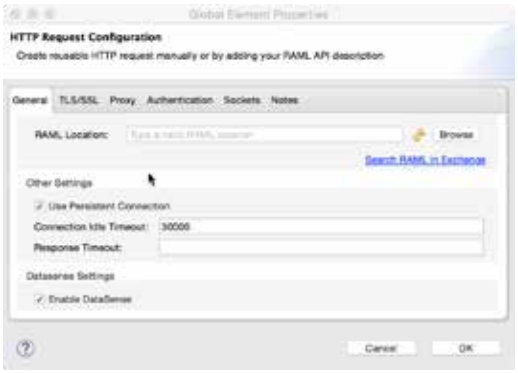
- Format strings, dates, and numbers
- Convert data types
- Replace data values using pattern matching
- Order data, filter data, and remove duplicate data
- Define and use custom data types
- Transform objects to POJOs



Using DataWeave to transform data structures that have associated metadata

DataSense and metadata

- Many connectors can be DataSense enabled



MuleSoft

Transformations and metadata

- If message input and/or output has metadata, Anypoint Studio will build an initial scaffolding for the transformation based on it
  - Based on the processors on either side of the transformer
  - The scaffolding is just the starting transformation code automatically written based on metadata
  - You may need to modify this a little or a lot depending upon what the metadata is and what you want to accomplish
- For this reason, it is best to add processors first and then the Transform Message component

MuleSoft

Updating the scaffolding

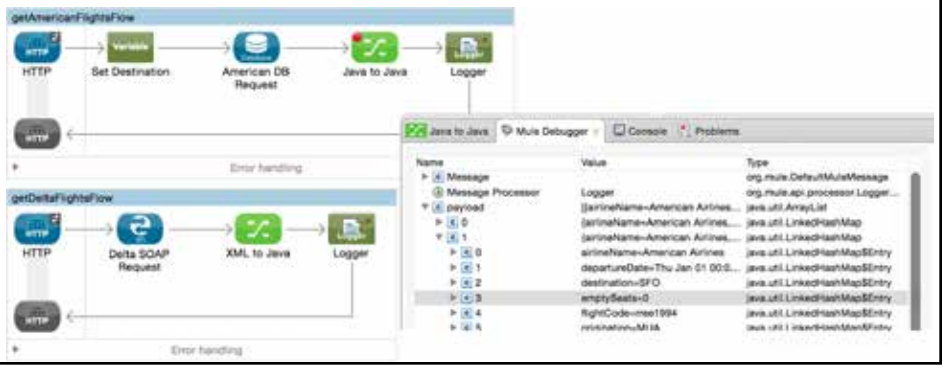
- If you add new processors upstream or downstream or add metadata to existing ones, you can update the scaffolding
  - Refresh metadata and/or recreate scaffolding

- To recreate scaffolding from metadata, click Scaffold output structure button
  - Deletes existing DataWeave code and re-scaffolds output

MuleSoft

Walkthrough 5-6: Transform data structures that have associated metadata

- Use DataWeave to transform American flight data from a collection of Java objects to one with a different data structure
- Use DataWeave to transform the Delta flight data from XML to a collection of Java objects



Using DataWeave to pass arguments to SOAP web services

Using DataWeave to specify SOAP web service input arguments

- When you drag-and-drop a DataWeave message transformer before a Web Service Consumer that has input arguments, a scaffold for populating the arguments will be created automatically

Walkthrough 5-7: Pass arguments to a SOAP web service

- Return the flights for a specific destination instead of all the flights
- Change the web service operation invoked to one that requires a destination as an input argument
- Use DataWeave to pass an argument to a web service operation
- Create a variable to set the destination to a dynamic query parameter value

Using DataWeave to transform data structures that need custom metadata

A more metadata aware Anypoint Studio and Mule runtime

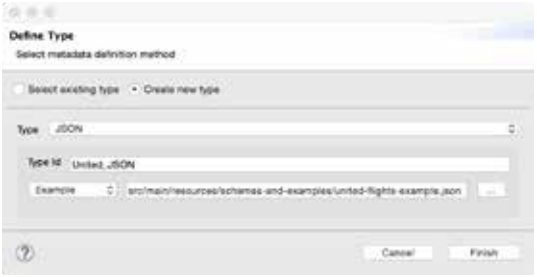
- New in 3.7, Mule now tracks the payload type internally so that metadata can be used during transformations
- In Anypoint Studio, you can now provide design time metadata to message processors and declare the type of the payload
  - Provides content-assist capabilities
  - Gives you visibility into your payload everywhere

MuleSoft

Adding metadata

- Specify what the metadata is for

- Specify the data type: JSON, XML, CSV, JAVA

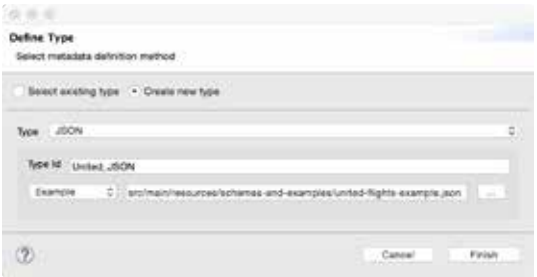


MuleSoft

Adding metadata

- For XML and JSON
  - Provide schema or example file
- For CSV

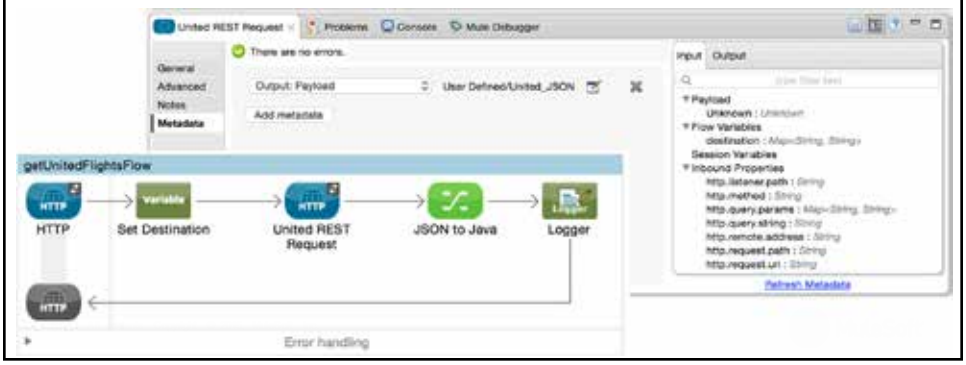
- Specify the data type: JSON, XML, CSV, JAVA



MuleSoft

Walkthrough 5-8: Transform a data source to which you add custom metadata

- Add custom metadata to an HTTP Request endpoint
- Use DataWeave to transform the United flight data from JSON to a collection of Java objects



Using DataWeave with CSV data

- You will apply this technique to transform CSV data in a later module, Processing Records
  - Add metadata to File endpoint using example CSV file

MuleSoft

Using dw() to query data

- The DataWeave universal language for data access can not only be used for transformation, but also for querying data throughout your flow
- Using the dw() function, you can quickly query data and use it to log information from payloads, route data, or extract it for message enrichment

Summary

Summary

- In this module, you learned about the different types of transformers and the DataWeave framework
- There are Java object, message and variable, content, and script transformers
- The Parse Template transformer loads the content of an external file (that can have MEL expressions)
- The DataWeave Transform Message component can be used in place of most other transformers
- DataWeave a full-featured and fully native framework for querying and transforming data on Anypoint Platform
- DataWeave is new in Mule 3.7

MuleSoft

Summary

- For the DataWeave component, you set the output type and a transformation expression using the DataWeave data transformation language
  - A JSON-like language built just for data transformation use cases
- DataWeave transformations are fast and reusable
- DataWeave is fully integrated with Anypoint Studio and DataSense
  - There is a graphical interface that is aware of associated metadata for input and output structures
  - Easy to use with data sources that have associated metadata

MuleSoft