

The Order Fulfillment Process Model

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1 Introduction

This document describes the Order Fulfillment process followed by a fictitious company named Genko Oil. The process is freely inspired by the VICS (Voluntary Inter-industry Commerce Solutions) reference model¹ and provides a demonstration of YAWL's capabilities in modeling complex control-flow, data and resourcing requirements.

2 Overall Process

The Genko Oil company features four departments: the *Order Management Department* (OD), the *Supply Department* (SD) including the *Warehouse*, the *Carrier Department* (CD) and the *Finance Department* (FD). The Order Fulfillment process model is divided into the following phases:

- Ordering,
- Logistics, which includes:
 - Carrier Appointment,
 - Freight in Transit,
 - Freight Delivered,
- Payment.

The Order Fulfillment process model is shown in Figure 1, where each of the above phases is captured by a composite task. The orders remitted by customers are processed by the Orders Management Department. In order to keep the example manageable, a number of simplifying assumptions were made. For example we assume that an order does not lead to more than one shipment. On the other hand orders from different clients may be combined into a single shipment. A single package only occupies a fraction of a truck and can correspond to one of a fixed number of sizes.

The process starts with the *Ordering* task, where purchase orders can be created, modified, approved or rejected. If an order is rejected or not confirmed in time, the process terminates, otherwise the logistical arrangements can start in the task *Carrier Appointment*. This task deals with the preparation of the shipment quote, with delivery and pick-up arrangements and culminates in the actual pickup of the freight from the *Carrier Department*. If the quote is not prepared in time, the whole process terminates and the order is cancelled. If the freight was picked up, tasks *Payment* and *Freight in Transit* are started in parallel. The former deals with the processing of the payment for the freight and for the shipment. The latter allows the Order department to issue inquiries after the status of the freight in transit, and handles notifications of the shipment's progress from the *Carrier Department*. This task terminates with the actual delivery of the freight to the customer. After completion of payment and delivery, task *Freight Delivered* handles loss or damage claims and requests for return of merchandise. If no claim or request is lodged within a certain time frame, the process terminates.

Table 1 lists all participants of the Order Fulfillment process with their user identifier, name, positions and roles. Each participant has default password 'apple', whereas the YAWL administrator has user identifier 'admin' and password 'YAWL'. Figure 2 depicts the organizational chart of Genko Oil, where each participant belongs to one or more positions within a department.

All participants except *Don Vito Corleone* have the privilege to choose which work item to start, to start work items concurrently and to reorder work items. *Don Carmine Cuneo* can also chain work item execution, while *Tom Hagen* and *Virgil 'The Turk' Sollozzo* can also view all work items of their organizational group. *Don Vito Corleone* can only manage cases in his role of Manager of the Order Fulfillment process.

3 Ordering

The *Ordering* sub-process starts with the creation of a Purchase Order by the Order Management Department (see Figure 3). A Purchase Order (PO) needs to be approved by the *Supply Department* and may then be subject to a number of modifications, though it requires confirmation within a certain time frame.

The creation of a PO is handled by an *OD clerk*, who may choose to reallocate the task to another *PO Manager* with or without the work performed on it thus far. A *PO Manager* may also choose to relinquish

¹www.vics.org

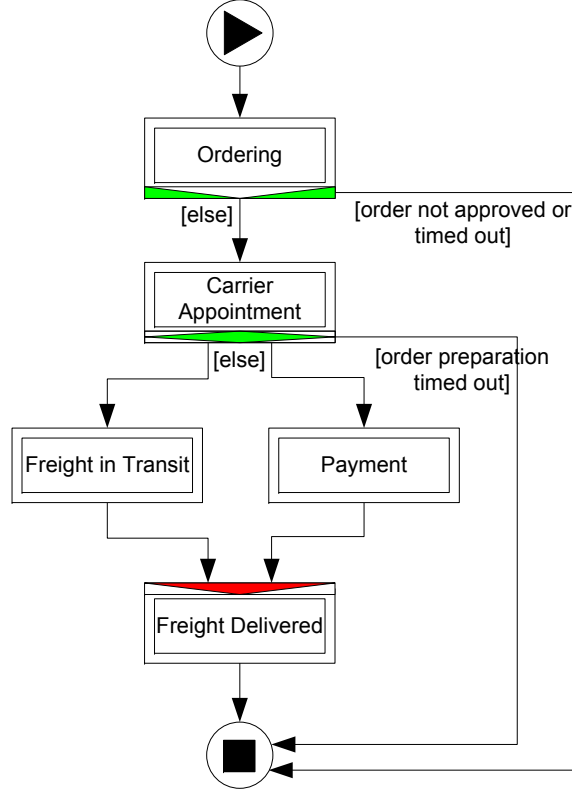


Figure 1: The Order Fulfillment process model in YAWL

working on the task and have the system offer it again to the available *PO Managers*. Moreover, a *PO Manager* may suspend working on the creation of a PO and choose to resume working on it at some later stage. Finally, a *PO Manager* may volunteer to be the main entry point for processing POs during a certain period of time. When a *PO Manager* is offered a task to create a PO, and they volunteer for it, the system will initiate the task automatically. Upon completing the PO, the *PO Manager* needs to decide which *PO Manager* will work on modification requests as they may eventuate at a later stage. The default *PO Manager* for PO modifications and confirmations is *Carmine Marino* (user id ‘cm’).

The completed PO is passed on to a *Supply Officer* who needs to approve it. If the *Supply Officer* who allocates this task to themselves is the *Head of SD*, they may choose to delegate this task to an *SD clerk* who reports to them. *Supply Officers* choose which approval tasks they will work on and once they have chosen such a task they may decide when to actually start work on it. This interaction pattern with the system is the default one for the various tasks that need to be performed in the Genko Oil company.

A PO contains information about the client’s company (e.g. name, address and business number), information about the order (e.g. order number and date, currency, order terms, line items), the freight cost and the delivery location. Moreover, it is possible to specify whether the order needs to be invoiced and whether it is part of a prepayment agreement between the client and Genko Oil.

Once a PO has been approved, repeated modifications may be requested. These are tracked by a revision number attached to the PO which is increased at each change. Each of these changes again need to be approved. If the original PO or any modification is rejected, the order process ends. Moreover, the PO needs to be confirmed within 3 days otherwise it is discarded and the process terminates.

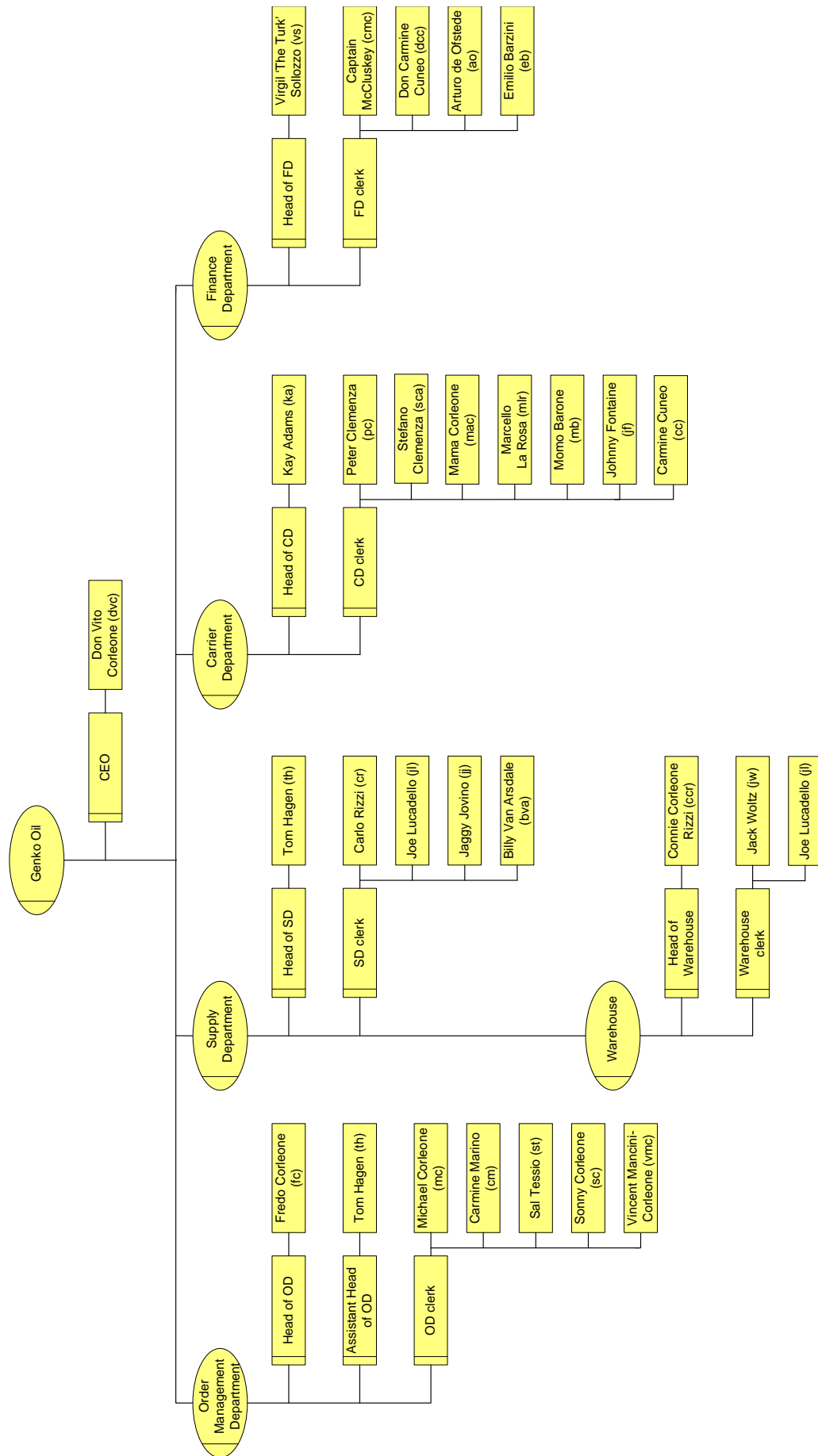


Figure 2: Organizational chart of the Genko Oil company

User id	First name	Last name	Position	Role
ao	Arturo	de Ofstede	FD clerk	Finance Officer
bva	Billy	Van Arsdale	SD clerk	Junior Supply Officer
cc	Carmine	Cuneo	CD clerk	Shipment Planner
ccr	Connie	Corleone Rizzi	Head of warehouse	Warehouse Admin Officer
cm	Carmine	Marino	OD clerk	PO Manager, Client Liaison
cmc	Captain	McCluskey	FD clerk	Finance Officer
cr	Carlo	Rizzi	SD clerk	Junior Supply Officer
dcc	Don Carmine	Cuneo	FD clerk	Account Manager
dvc	Don Vito	Corleone	CEO	Order Fulfillment Manager
eb	Emilio	Barzini	FD clerk	Finance Officer
fc	Fredo	Corleone	Head of OD	PO Manager
jf	Johnny	Fontaine	CD clerk	Shipment Planner
jj	Jaggy	Jovino	SD clerk	Senior Supply Officer
jl	Joe	Lucadello	SD clerk, Warehouse clerk	Senior Supply Officer
jw	Jack	Woltz	Warehouse clerk	Warehouse Officer
ka	Kay	Adams	Head of CD	Carrier Admin Officer
mac	Mama	Corleone	CD clerk	Shipment Planner
mb	Momo	Barone	CD clerk	Courier
mc	Michael	Corleone	OD clerk	PO Manager
mlr	Marcello	La Rosa	CD clerk	Courier
pc	Peter	Clemenza	CD clerk	Courier
sc	Sonny	Corleone	OD clerk	PO Manager
sca	Stefano	Clemenza	CD clerk	Shipment Planner, Courier
st	Sal	Tessio	OD clerk	Client Liaison
th	Tom	Hagen	Head of SD, Assistant head of OD	Senior Supply Officer, Supply Admin Officer
vmc	Vincent ‘Vinnie’	Mancini-Corleone	OD clerk	PO Manager
vs	Virgil ‘The Turk’	Sollozzo	Head of FD	Senior Finance Officer

Table 1: Participants of the Order Fulfillment process – name, position and role

4 Carrier Appointment

After confirmation of a PO, a route guide needs to be prepared and the trailer usage needs to be estimated. The route guide is prepared by determining the trackpoints that are going to be visited during the shipment. The trailer usage is determined by estimating the number of packages for the shipment, where each package has an identifier and a fixed volume of 25, 50, 100 or 200lbs. These operations are performed in parallel by the two tasks *Prepare Route Guide* and *Estimate Trailer Usage* (see Figure 4). The former task is allocated to the Shipment Planner with the shortest work queue, while the latter task is allocated to the Shipment Planner that was allocated an instance of this task the longest time ago. If either task takes too long, a time out is triggered, which leads to the cancelation of the PO and the termination of the overall process. This timer is set to five days for a PO with one line item and is increased by one day for each additional line item. This calculation is performed by the automated task *Calculate Carrier Timeout*, which is assigned to a codelet to perform the required additions.

If both tasks *Prepare Route Guide* and *Estimate Trailer Usage* are completed in time, a *Supply Officer* can perform task *Prepare Transportation Quote*, by establishing the shipment cost based on the number of packages and on the total volume of the freight, and by assigning a shipment number to the order number. Once a *Supply Officer* has chosen to perform this task they have the privilege to reallocate it to someone else without

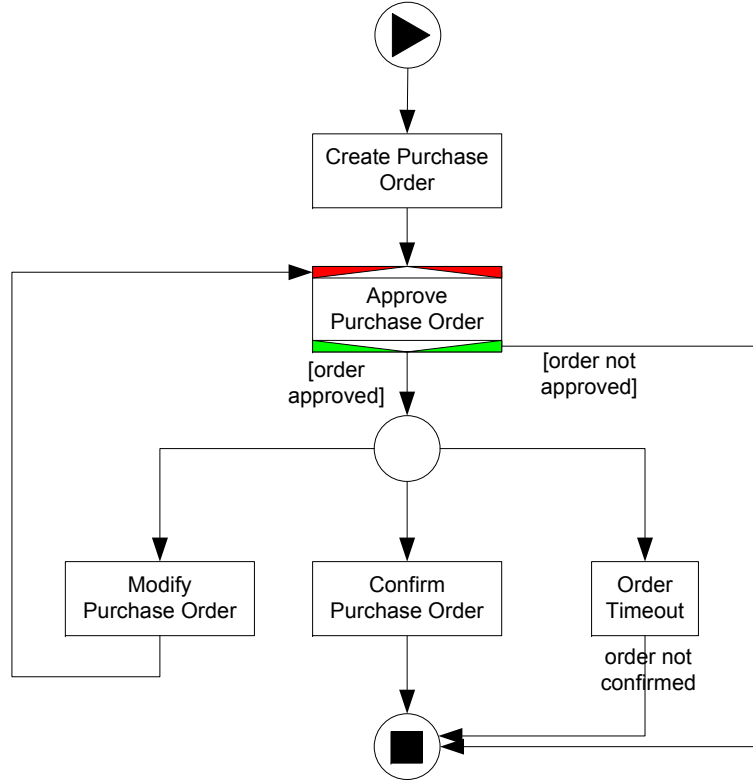


Figure 3: The *Ordering* sub-process

loss of the work performed thus far, and to suspend and resume working on the task. In addition, the system automatically starts the task for a *Supply Officer* once they have committed themselves to performing it.

After task *Prepare Transportation Quote*, based on the total volume of the freight and on the number of packages, a distinction is made among shipments that require a full truck load (total volume greater than or equal to 10.000lbs), those that require less than a truck load (total volume less than 10.000lbs and more than 1 package) and those that simply concern a single package (total volume less than 10.000lbs). For shipments that require a full truck load, *Client Liaisons* from the *OD* try to arrange a Pickup appointment and a Delivery appointment, by specifying the location for pickup/delivery and any specific instructions. The *Client Liaisons* associated with these two tasks should be different. It is possible that only one of these or even none of these appointments is made before a *Senior Supply Officer* holding a *Master's in Supply Chain and Logistics Management* decides to create a Shipment Information document.

The Shipment Information document is used by the *Senior Supply Officer* to specify an authorization code and a consignee number for the shipment number. After the creation of this document, any missing appointments are made, though this time a *Warehouse Officer* takes charge of arranging a Pickup appointment and a *Supply Officer* takes care of arranging a Delivery appointment, and there are subsequent opportunities to modify them until a *Warehouse Admin Officer* produces a Shipment Notice after which the freight can actually be picked up from the *Warehouse*. Modifications of Pickup appointments are handled by a *Warehouse Officer* while modifications of Delivery appointments are taken care of by a *Supply Officer*.

When the shipment consists of more than one package but a dedicated truck is not required, a *Warehouse Officer* arranges a Pickup appointment and a *Client Liaison* tries to arrange a Delivery appointment. Afterwards, a *Senior Supply Officer*, who holds a *Bachelor's in Supply Chain and Logistics Management*, creates a Bill of Lading, which, similar to the Shipment Information document, requires the specification of an authorization code and a consignee number. If no Delivery appointment was made prior, a *Supply Officer* takes care of this

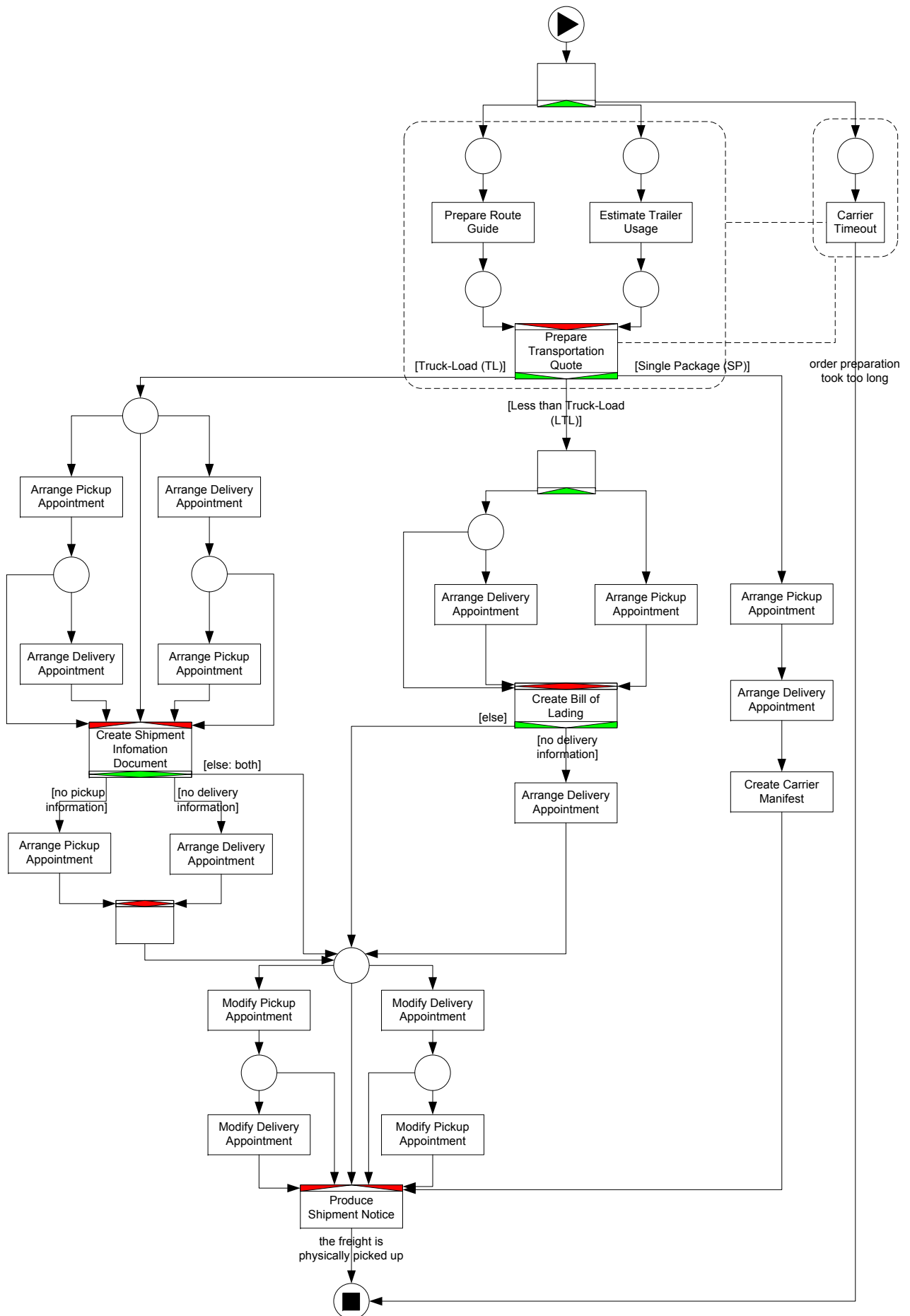


Figure 4: The *Carrier Appointment* sub-process

and the remainder of the process is the same as for a shipment that requires a dedicated truck.

For shipments consisting of a single package the process is straightforward. All that needs to be done is for a *Supply Officer* – one that has the most experience in performing this particular task (identified using the ‘Round Robin by Experience’ allocation strategy) – to create a Motor Carrier Pickup manifest. This is done by specifying only an authorization code. Afterwards a Shipment Notice is produced by a *Warehouse Admin Officer* and the freight is ready for pickup.

A Shipment Notice provides a summary of the shipment which includes the shipment number, the order number, the number of packages, the pickup and delivery appointments and a variable indicating whether the shipment is a full truck load. The *Warehouse Admin Officer* has to indicate when the freight loading on the carrier’s truck started and completed and provide the details of the driver (number and name), the delivery instructions and a deadline for the claims which will be used later on in sub-process *Freight Delivered*. Delivery instructions contain textual instructions, the delivery date and the delivery location (the latter being retrieved from the Route Guide).

5 Payment

After a freight has been picked up, the *Payment* sub-process can start (see Figure 5). This process has two components, one which is concerned with payment for the shipment and one which is concerned with payment for the freight.

The first task that needs to be performed in dealing with the payment for a shipment is the production of a Shipment Invoice containing the shipment costs related to the order number, the shipment number and the company to be invoiced. This task is handled by a *Supply Admin Officer*. During the creation of the PO in the *Ordering* sub-process, a *PO Manager* specified if shipments were paid in advance. In this case, all that is required is for a *Finance Officer* to issue a Shipment Remittance Advice, where he/she specifies the amount being debited to the client. Otherwise, a *Finance Officer* issues a Shipment Payment Order. This document includes a shipment payment order number that refers to both the order and the shipment numbers, the shipment costs and the details of the beneficiary, which includes the company, the name and code of the beneficiary bank, and the name and number of the bank account.

A *Senior Finance Officer* who is the superior of this *Finance Officer* has to approve this document. A number of updates may be made to this document by the *Finance Officer* that issued it, but each of these need to be approved by the *Senior Finance Officer*. After the document is finalized an *Account Manager* can process the payment for the shipment once the client has paid, by specifying the balance. It is possible that the client underpaid. This case requires a debit adjustment (the amount still due is specified), the Account Manager needs to notify the client and the payment needs to be reprocessed. A client can also overpay and then the *Account Manager* needs to perform a credit adjustment (the reimbursement amount and the beneficiary details are specified). In the latter case and in case of a correct payment, the shipment payment process is completed. An *Account Manager* can choose to have adjustment tasks to be immediately started for them upon completion of the processing of a Shipment Payment in order to expedite matters.

As regards payment for a freight, a *PO Manager* specifies during creation of a PO whether an invoice is required or not. Should an invoice be required, a Freight Invoice is created by a *Supply Admin Officer*, containing the freight costs related to the order number and the company to be invoiced. If a Product Invoice is not required then processing of the freight payment can start right away, if not, it can begin after creation of the Freight Invoice. The processing of a freight payment is an involved sub-process, which we will not consider further.

6 Freight in Transit

The *Freight in Transit* sub-process is performed in parallel with the *Payment* sub-process and is concerned with tracking progress of the delivery of an order and handling client inquiries (see Figure 6).

A delivery truck may visit multiple destinations and some of these may be designated trackpoints that may assist in finding out where a certain shipment is. When a trackpoint is visited a Trackpoint Notice is issued by the *Courier*, registering the truck’s arrival and departure time, plus additional notes. The *Courier* may choose to skip this task as it may lead to undesirable delay in some cases.

Once all trackpoints have been visited, *Carrier Admin Officers* need to log a Trackpoint Order Entry for each trackpoint, which contains a report for the specific trackpoint so that this information can be audited in the future. Trackpoint Order Entries can be logged in parallel so long as there are Carrier Admin Officers

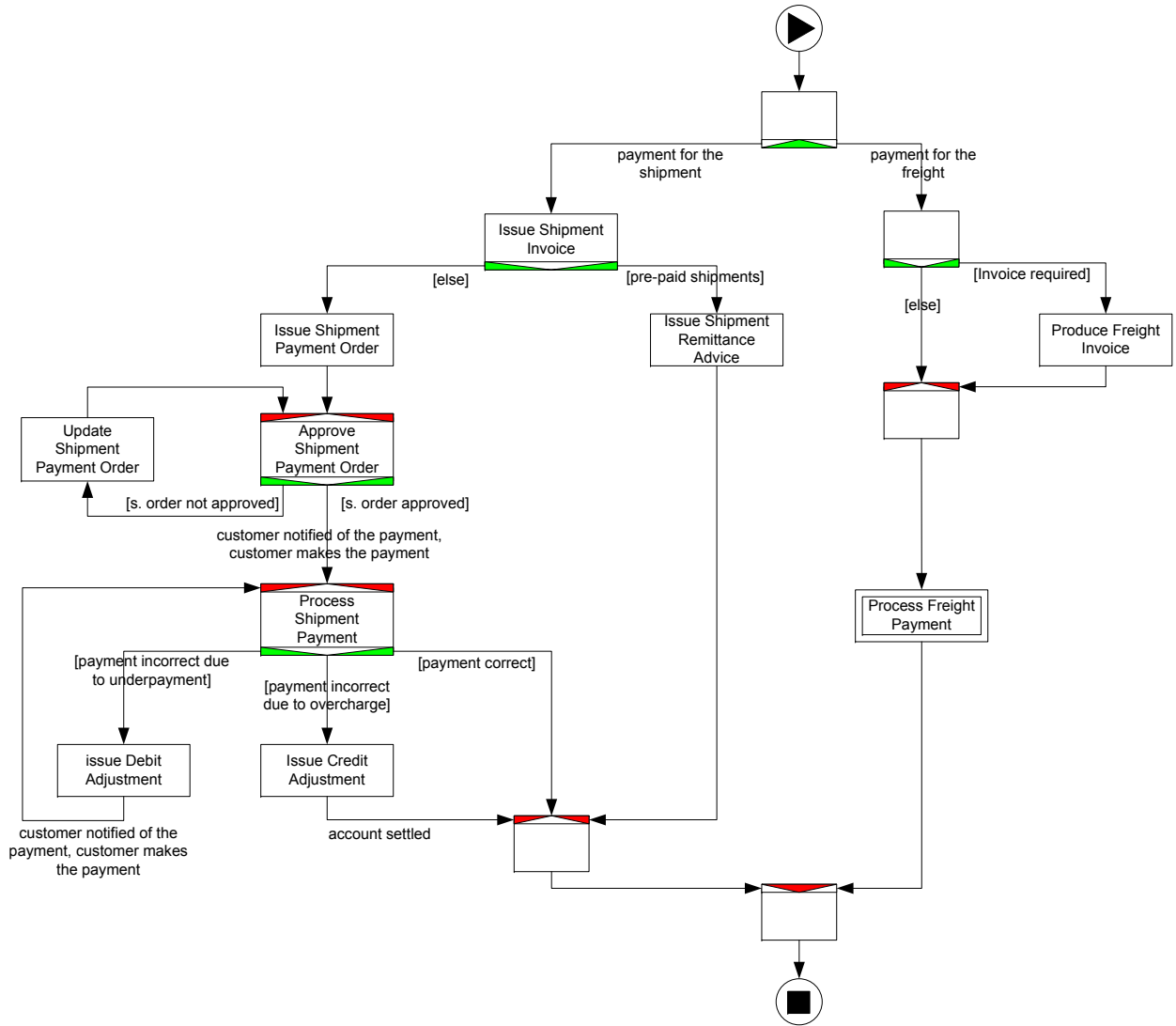


Figure 5: The *Payment* sub-process

available to work on the entries. While entries are being logged, customer enquiries need to be addressed by a *Client Liaison*. Once completed, new enquiries can be ignored and a *PO Manager* creates an Acceptance Certificate to register that the freight has been physically delivered. An Acceptance Certificate refers to an order number and a shipment number and contains the acceptance date and delivery notes.

7 Freight Delivered

After the delivery of the freight, clients may request a Return of Merchandise or may want to lodge a Loss or Damage Claim (see Figure 7). A Return of Merchandise document contains the reason for return and the line items to be returned, while a Loss or Damage Claim indicates the reason for claim. Both these documents are lodged into the system by a *Client Liaison* upon client's request. If no client communications are received within a certain period after the delivery – the length of which is specified in the Shipment Notice – the Order Fulfillment process is considered to be successfully completed.

A request for a Return of Merchandise needs to be approved by a *Senior Supply Officer*. If approved, an involved Return Management process starts which will not be considered further. Similarly, a Loss or Damage Claim also needs to be approved by a *Senior Supply Officer* and if approved, will involve the process of actually

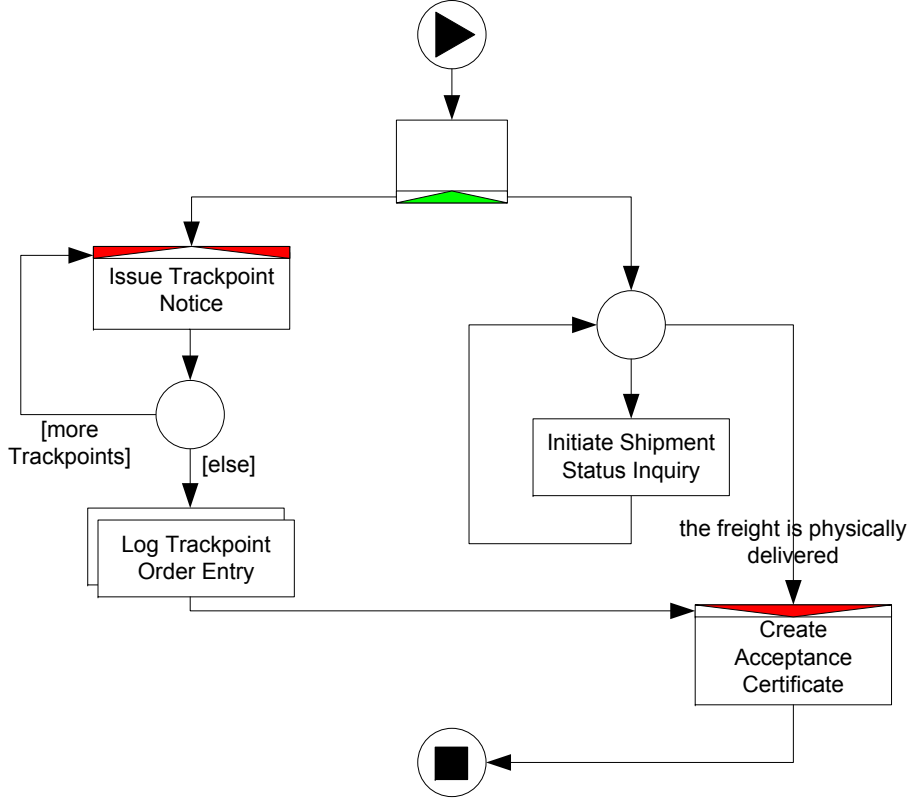


Figure 6: The *Freight in Transit* sub-process

managing this Loss or Damage Claim. Again, this is something we will not consider any further. In either case, if approval is not granted the process is considered to be completed.

8 Showcased YAWL features

The Order Fulfillment process demonstrates a wide range of language features. This section illustrates some advanced ones.

Cancellation Region The sub-process *Carrier Appointment* contains two cancellation sets. The first one is triggered by the timer task *CarrierTimeout*, which, once completed, leads to the termination of the Order Fulfillment process by consuming tokens in tasks *Prepare Route Guide*, *Estimate Trailer Usage*, *Prepare Transportation Quote* and in the conditions in-between. Similarly, the second cancellation set is triggered after completion of task *Prepare Transportation Quote*, leading to the consumption of tokens in task *CarrierTimeout* and in its preceding condition.

Multiple Instance Task In sub-process *Freight in Transit*, multiple instance task *Log Trackpoint Order Entry* reads all Trackpoint Notices created in task *Issue Trackpoint Notice* and assigns each notice to a *Carrier Admin Officer* who can attach a report to it. Multiple *Carrier Admin Officers* can work in parallel on this task.

OR-join Sub-process *Carrier Appointment* features 2 OR-join constructs. The first one is in the truck load branch after tasks *Arrange Pickup Appointment* and *Arrange Delivery Appointment*. The second OR-join is attached to task *Create Bill of Lading* in the less than truck load branch.

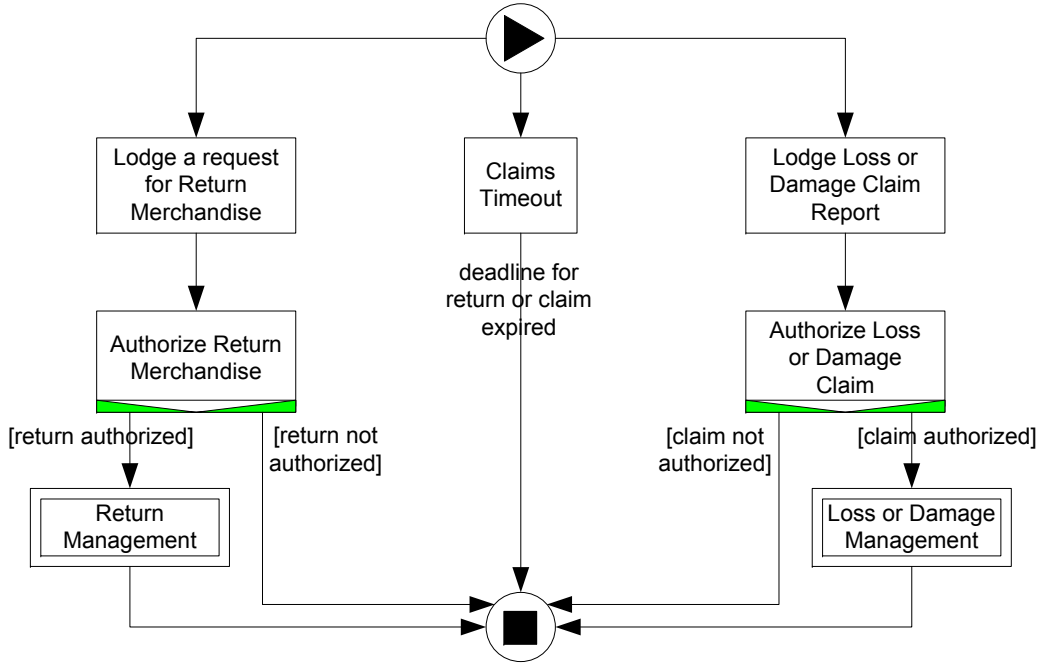


Figure 7: The *Freight Delivered* sub-process

Timer Task Sub-process *Carrier Appointment* features a timer task which fires upon work item starting (task *Carrier Timeout*), while sub-process *Freight Delivered* features a timer task which fires on work item enablement (task *Claims Timeout*). The deadline associated with both these timer tasks is dynamically determined via a net variable.

Codelet Automated task *Calculate Carrier Timeout* (sub-process *Carrier Appointment*) determines the timeout for the preparation of the Transportation Quote based on the number of Order Lines in the PO. This is done by using the *ExampleCodelet* in YAWL which allows one to make simple additions.

Extended attributes In task *Prepare Route Guide* of sub-process *Carrier Appointment*, task variables *OrderNumber* and *DeliveryLocation* are both Input & Output because their values need to be shown to the user and then used to compose the content of net variable *Prepare_Route_Guide*. However, in order to avoid that these values are modified by the user, the two variables have been assigned extended attribute *readOnly* with value *true*.

Dynamic Task Allocation In sub-process *Ordering*, task *Modify Purchase Order* is allocated to the participant whose user id is stored in net variable *PO_Manager*. This variable is set by task *Create Purchase Order* before executing *Modify Purchase Order*.

Retain Familiar When a single package is shipped, the participant who arranges the pickup appointment (task *Arrange Pickup Appointment* of sub-process *Carrier Appointment*) has also to arrange the Delivery Appointment (task *Arrange Delivery Appointment*).

Four Eyes Principle In full truck load shipments, tasks *Arrange Delivery Appointment* and *Arrange Pickup*

Appointment of sub-process *Carrier_Appointment* are never offered to the same participant during the same process instance.

Distribution Set Filter The initial distribution set assigned to task *Create Purchase Order* is filtered such that this task can be piled to a single participant (runtime filtering). Similarly, a filter on capabilities is applied to the distribution set assigned to tasks *Create Shipment Information Document* (which is only offered to a *Senior Supply Officer* holding a *Master's in Supply Chain and Logistics Management*) and *Create Bill of Lading* (which is only offered to a *Senior Supply Officer* holding a *Bachelor's in Supply Chain and Logistics Management*).

Allocation Strategy In sub-process *Carrier_Appointment*, task *Estimate Trailer Usage* is allocated to the *Shipment Planner* who was allocated this task the longest time ago (allocation by time). Similarly, in case of single package shipments, task *Arrange Pickup Appointment* is allocated to the *Supply Officer* who executed this task the most (allocation by experience).

Privileges Any participant with role of *Account Manager* has the privilege to chain the execution of work items assigned to them. In this way an *Account Manager* can have tasks *Issue Debit Adjustment* and *Issue Credit Adjustment* of sub-process *Payment* immediately started for them upon completion of task *Process Shipment Payment*.

Custom Forms The content of all manual tasks can be rendered to participants either via a dynamically generated Java Server Faces form, or via a custom JSP form which has been templated with the look&feel of Genko Oil.

9 Setup

The Order Fulfillment process has been tested to be executed by any YAWL 2.0 engine release (YAWL4Study, YAWL4Enterprise and YAWLive). This section provides instructions on how to successfully launch a case of the Order Fulfillment process.

The Order Fulfillment process is available in two specifications: file *orderfulfillment.yawl* (with dynamic forms) and file *orderfulfillment_customforms.yawl* (with custom forms). Both files can be found in the directory *[YAWL Installation folder]/misc/examples/orderfulfillment* while the custom forms are located in the directory *[YAWL Installation folder]/engine/apache-tomcat-6.0.18/webapps/orderfulfillment*.

To launch a case, first, import the organizational data associated with the Order Fulfillment example into the yawl database:

1. Start the YAWL Engine
2. Open the Control Centre and log in as administrator (id 'admin', password 'YAWL')
3. Click on *Org Data*
4. If the YAWL database has already been populated with resources, backup that data by clicking on the icon "Export Org Data to file" on the top-right corner
5. Click on the icon "Import Org Data from file" on the top-right corner and select the file *orderfulfillment.ybcp* from the directory *[YAWL Installation folder]/misc/examples/orderfulfillment/*

A message box at the bottom should appear and indicate that the operation has succeeded by listing the number of resources that have been imported in terms of participants, groups, capabilities and positions.

Now, a case of the Order Fulfillment process may be launched:

1. Click on *Cases* in the Control Centre
2. Upload one of the two files in the Control Centre.
3. Select the loaded specification *OrderFulfillment*
4. Click on *Launch Case*

Log out as administrator and log in as an employee of Genko Oil to view and edit the first work item. For example, log in as Fredo Corleone (user id 'fg', password 'apple') and start the creation of a PO.