Workflow Management Systems and Cross-Organisational Logistics

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Abstract
This position paper discusses the role of workflow management systems in supporting logistics processes. The paper is based on R&D projects[1] carried out for the TNT part of the TNT Post Group (TPG). After a short introduction we will present a typical logistics process, that of express parcel delivery. Based on this scenario we will present our position with respect to the use of workflow management systems to support cross-organisational logistics processes.

Introduction

At first glance logistics processes seem an excellent candidate for the deployment of workflow management systems (WfMSs). Within logistics processes one can distinguish two sub-processes: one sub-process handling the physical shipment of the goods and one sub-process handling the associated document and information streams. The second process is the target for the current generation of WfMSs. At first sight this is not strange, since current WfMSs are strong in handling relatively stable document oriented processes. Notwithstanding the limitations of current WfMSs such as lack of flexibility and lack of exception handling, we see a growing use of WfMSs in the logistics domain, especially in the area of Enterprise Resource Planning (ERP), where systems like SAP, BAAN, and Oracle Applications all incorporate WfMSs.

The situation described above applies to the internal logistics of organisations, where the document and information streams are under centralised control; a typical situation for ERP systems. However, in most areas logistics chains do not end at the company border. On the contrary, logistics chains often span a whole line of companies. This is where logistics companies like TNT show up. Since often these specialised logistics companies are already involved in the transportation links between the manufacturers, wholesalers and retailers that make up logistics supply chains, there is a tendency to outsource the overall logistics chains, including warehousing and inventory management, to these logistics service providers. The logistics companies are now faced with the problem of monitoring and controlling a logistics chain that is built out of a combination of autonomous sub-chains within the individual production companies and links that are under the control of the logistics company itself.

In the remainder of this paper we will address the issues with respect to the deployment of WfMSs for supporting overall logistics chains. In Section 2 we describe a typical logistics chain for express parcel delivery. In Section 3 we will use the express parcel delivery chain as an example to discuss the deployment of WfMSs to support logistics chains in general.

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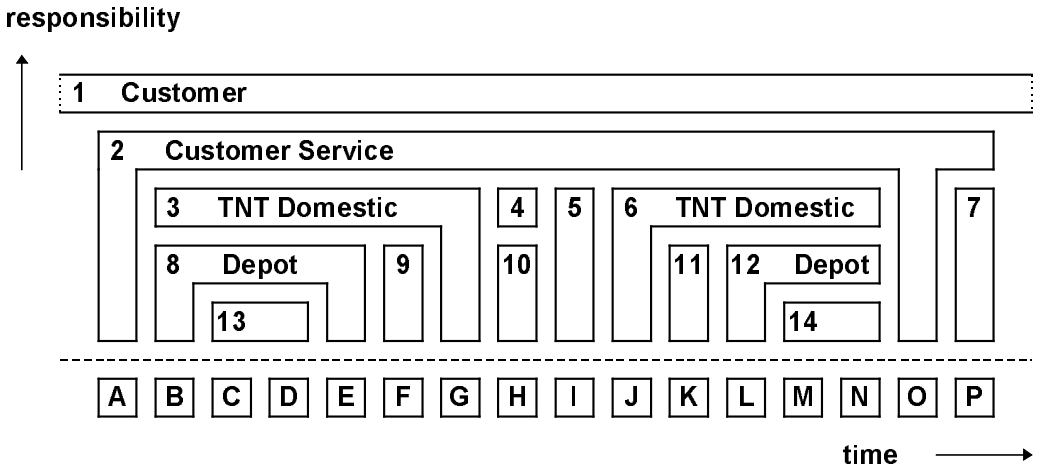
Logistics express delivery scenario
In order to simplify the discussion we take the express parcel delivery as an example of a logistics chain. The structure of the express parcel delivery is comparable to the structure of logistics chains over several production companies. As we will see, also in the case of express delivery we have to deal with several autonomous organisations that jointly form the overall chain.

We will describe a specific scenario for a TNT express parcel delivery from Gouda (The Netherlands) to Granada (Spain). The initiative is taken by a customer calling TNT Customer Service. Customer Service collects preliminary data about the parcel (dimensions, weight, pick-up address) to enable Customer Service to send the adequate vehicle for picking up the parcel. The next step is sending Pick-Up and Delivery (PUD) an order to pick up the parcel and to fill out the consignment note (a document containing all relevant information for the shipment). PUD delivers the parcel at the Hoofddorp Depot. There, a transport sticker is fixed onto the parcel, and the consignment note information is keyed in and sent to the world-wide information system at Atherstone, England, called Global Link. Meanwhile the route for the parcel is planned. After sorting at the Depot, the parcel is transported to the air-Hub at Liege. A further sorting is carried out in Liege in the evening and, at night, the parcel is transported by air to the air-Hub near Madrid. Again, the parcel is sorted out to the Depot serving Granada, and is delivered during the next day before 12.00 hrs. After the shipment is completed an invoice is sent to the customer.

The following chain summarises the delivery.

Another, more detailed, way to look at this chain is from an organisational point of view as depicted below.



Above the dotted line are depicted the parties, numbered from 1 through 14, below the line the activities, from A through P.
The time-axis goes from left to right; A through P correspond with the events that

evolve in time. From top to bottom, a kind of “client - server” relationship is shown. The party above requests a service from the party immediately below: the first defers or subcontracts the task(s) to the second (as long as it takes). The party below becomes responsible for the result. The lowest parties, immediately above the dotted line, finally carry out the real tasks that correspond with the events below the line. For our example case, the parties and activities include:

1. Customer	Customer at Gouda
2. Customer Service	TNT Customer Service (The Netherlands)
3. TNT Domestic	TNT Netherlands
4. TNT International	TNT European Road Network
5. Customs	Carried out at TNT Spain
6. TNT Domestic	TNT Spain
7. TNT Domestic Billing Department	TNT Netherlands Billing Department
8. TNT Depot	TNT Depot Hoofddorp
9. Depot - Hub Transport	Transporter A
10. International Linehaul	TNT Air-Transport
11. Hub - Depot Transport	Transporter C
12. TNT Depot	Depot servicing Granada
13. PUD Party	Pick Up Transporter D
14. PUD Party	Delivery Transporter E

A. Parcel announcement, first data entry
B. Pick up route planning
C. Collection route
D. Parcel pick up, consignment note fill in
E. Consignment note data entry and bar-code sticker application at Depot
F. Transport from Depot Hoofddorp to Hub Luik
G. Sortation at Hub Luik
H. Hub Luik to Hub Madrid air transport
I. Customs Madrid
J. Sortation at Hub Madrid
K. Transport from Hub Madrid to Depot Granada
L. Sortation at Depot Granada
M. Delivery route
N. Parcel delivery, POD signature
O. Proof of delivery
P. Billing and payment

TNT Customer Service is responsible for the service to the customer as a whole. It almost completely defers the activities to others. It only accepts the orders, deals withs status inquiries and receives the proof of delivery at the end. TNT Domestic (Netherlands, Spain) has the responsibility for operations within the country. TNT International links these activities by exploiting international networks. The actual transportation may be subcontracted to international transporters (road, air). It is assumed here that customs (in the receiving country) have their own responsibility, directly to Customer Service. Depot to Hub transport (and vice versa) belongs to the responsibility of TNT Domestic, as is the exploitation of Depots. The Depots themselves have the responsibility for pick up and delivery, route planning, consignment note data entry and sorting for PUD. PUD routes are possibly subcontracted to local transporters.

Logistics requirements on workflow management systems
The above scenario is a perfect example of a cross-organisational workflow. There are several autonomous TNT organisations involved as well as independent organisations such as customs and PUD parties. In the current implementation of the process the consignment note plays a central role. All information concerning a shipment is on that note, and the note is available both in electronic form and as hard copy.

Now suppose we want to support the above scenario by means of a WfMS. A first option would be to use a centralised WfMS that governs the overall chain. Since the Customer Service organisation is in charge of the overall chain, it would be natural to put this organisation in control of the central WfMS. This means that all other organisations would have to allow the Customer Service WfMS to control their internal processes. For the TNT organisations this might be achieved since they belong to the same company: TNT. However, for the external PUD parties (subcontractors) and definitely for the Customs this would be out of the question.

Since having control over its own processes is an important aspect for organisations, we have to look for WfMS support that respects this. A possible way to achieve this is to let each organisation have its own WfMS supporting its own local processes. The global process is then supported by a chain of co-operating WfMSs. In our scenario we would have at least 4 autonomous WfMSs: one for each PUD party, one for the Customs, and one for TNT, assuming that all TNT organisations share the same WfMS. However, it is more realistic to assume different WfMSs for different TNT organisations.

In order to support the overall chain, the WfMSs need some means of co-operating. An important issue is the overall co-ordination of the logistics chain. One can have a situation where a single WfMS acts as the overall co-ordinator. In our scenario this could be the Customer Service WfMS. This means that apart from supporting the local process within Customer Service this WfMS also needs an overall process description, where the other participating WfMS support subprocesses. The internals of these subprocesses do not need to be disclosed to the co-ordinating WfMS. In the example scenario the Customer Service WfMS would start, then initiate the subprocess at the PUD party WfMS. After the PUD party WfMS has finished it hands control back to the Customer Service WfMS. Another possibility is to have no co-ordinator, but to hand over control from one WfMS to another. In this case none of the WfMSs has a complete description of the overall process, each has a local process model with external entry and exit points that described the link with the surrounding WfMSs. So in our scenario, the Customer Service WfMS would start, then hand over the control to the PUD party WfMS, which after completion hands over the control to the TNT International WfMS. In our opinion both control models, i.e. with and without central co-ordinator, should be supported.

As can be seen from the above, a minimal level of interfacing required is the ability for one WfMS to initiate a process within another WfMS. For example the TNT Customer Service WfMS should be able to initiate the pick-up process at the PUD party. Of course such an initiation should be augmented with the ability to pass relevant data from one WfMS to another, in our case for example the consignment note.

However, there is more. In our scenario a customer wants the ability to monitor the progress of his shipment. Let us assume that the customer communicates with his own WfMS that initiates the process chain. First, this WfMS needs to keep track of which WfMS is currently active on the shipment, and second, this WfMS needs the ability to get status information on the process from the active WfMS. So co-operating WfMS should have the ability to exchange status information about processes. How this should be done depends on the information WfMSs are prepared to disclose about their internal processes. Before addressing this issue we first discuss another need, that of active control from one WfMS over processes run by another WfMS.

Apart from just monitoring progress of his shipment, the customer may want to have active control over (parts of) the shipment. The motivation for this being flexibility. For example, the user may want to change the pick-up address at a point in time where the Customer Service has handed over the process to the PUD party. Instead of informing at the Customer Service, which in turn has to check with the PUD party, the customer may directly interact with the PUD party to see whether the pick-up vehicle is already on its way, and if not, change the pick-up address. In terms of WfMSs this means that the customer WfMS has the ability to change the process at the PUD party WfMS while the process at the PUD party is already in progress. Although organisations want control over their own processes, they may be inclined to give up some control in order to improve the flexibility of the overall process chain. Especially in the case of subcontractors, like the PUD parties, the level of control that is allowed can be negotiated when giving out the subcontract.

A last word on the issue of how to report on process progress. This very much depends on the level of detail a WfMS is allowed to disclose of its process description. If the process description can be totally disclosed, the progress can be reported by handing over the process description and indicating the process step under execution. Of course in this case the receiving WfMS must be able to 'understand' the process description. In general this will require a language to communicate process models between WfMSs as well as means to map the semantics of a process description from one WfMS context to another WfMS context (this is a problem similar to schema mappings in federated databases). In the case that process descriptions can not be disclosed, some kind of progress reporting schema needs to be negotiated. For example, in our scenario, it is likely that the customs do not want to disclose their internal process of checking shipments. In this case they may be willing to give some global information like notifications that the consignment note has been checked, or the shipment has been physically inspected, without disclosing the details of the checks or inspections. Note that now progress is not reported in terms of process progress, but in terms of milestones.

Conclusions

By using a concrete cross-organisational logistics example we have formulated a number of requirements on WfMSs to support cross-organisational logistics workflows. The requirements state that chained processes should be supported by co-operating WfMSs, where each single WfMS has the ability to initiate, monitor, and control processes executed by another WfMS. Also such co-operation should support various control models for the overall chain.

Given that current WfMSs only have limited interfacing capabilities (cf. The WfMS - WfMS interface defined by the WfMC) there is a need for further research on and development of architectures and mechanisms for supporting co-operating WfMSs, covering issues like level of control and process progress reporting as discussed above.