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Interface Specification for a Supply Chain Simulation

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ABSTRACT

This paper describes the scope and configuration of the simulation model that is under development for a manufacturing supply chain. An information model that serves as a neutral interface specification is also presented in the paper. The supply chain simulation model described here is being developed to validate interface specifications as part of the Intelligent Manufacturing Systems (IMS) Modeling and Simulation Environments for Design, Planning and Operation of Globally Distributed Enterprises (MISSION) project [1]. This simulation model is largely based upon the practical business operations of a U.S. power-tools manufacturing company. The information model has been developed using the IDEF1X information modeling language [2]. The information model can ultimately be used to integrate distributed simulation models that are developed by other manufacturers to model their supply chains.

KEYWORDS

Data exchange, IMS, information modeling, MISSION, simulation, supply chain, supply chain system

1.0 Introduction

The Manufacturing System Integration Division (MSID) of the United States National Institute of Standards and Technology (NIST) participates in the Intelligent Manufacturing Systems (IMS) Modeling and Simulation Environments for Design, Planning and Operation of Globally Distributed Enterprises (MISSION) project [1]. "The goal of MISSION is to integrate and utilise new, knowledge-aware technologies of distributed persistent data management, as well as conventional methods and tools, in various enterprise domains, to meet the needs of globally distributed enterprise modelling and simulation" [1]. Currently, there are three MISSION project teams: the U.S. team, the Europe team, and the Japan team.

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[1] Research performed while the author was a guest researcher at the National Institute of Standards and Technology.

A distributed manufacturing simulation architecture has been developed by the NIST MSID to support the MISSION project. The architecture describes the major system modules, data elements or objects, and interfaces between modules [3]. The purpose of the architecture is to identify the software building blocks and interfaces that will facilitate the integration of distributed simulation systems and enable the integration of those systems with other manufacturing software applications. The architecture, however, does not address the detailed design of individual modules and the information models for shared data elements or objects. The emphasis of our current research is to develop an information model and to build a prototype simulation.

A prototype supply chain simulation is being developed as a test case for MISSION by the U.S. project team. In an early planning meeting by the U.S. team, a common interest in the supply chain simulation was expressed by the simulation software vendors participating in the project. A major objective of MISSION is to enable the development of distributed supply chain simulations for globally distributed enterprises. The test case focuses on modules, data structures, and interfaces that require an information model.

The goal of supply chain management is to integrate suppliers, manufacturers, warehouses, and stores efficiently, so that merchandise is produced and distributed in the right quantities, at the right locations, and at the right times [4]. This is done to minimize system-wide costs while satisfying service level requirements. In a supply chain system, an individual member exchanges data with other members to synchronize their business operations. These exchanged data generally include product specification data, planning data, ordering data, and inventory data, among others. These data are often used to control operations in an individual firm, and are also used for negotiation among chain members that form a virtual organization to provide products and services to customers.

There are several different information modeling methodologies, modeling languages, and implementation methods available to support the development of such a communication mechanism [5]. Our approach to developing this communication mechanism and the data specification are listed here:

- Perform a case study to investigate a real supply chain system.
- Identify the scope of the target application.
- Identify core processes of supply chain management.
- Design the prototype supply chain simulation.
- Design the distributed simulation system.
- Analyze communication data flow and identify data requirements.
- Verify the data requirements using the prototype system and the distributed system.
- Layout the data specification.
- Implement the data specification.

This paper first presents a case study of a supply chain company group. It then describes the objective, the scope, the scenario, and the tasks that are supported by our prototype supply chain simulation. An information model that describes the data requirements to support data sharing within the simulation is presented before the conclusion section.

2.0 Case Study

Successful supply chain management is extremely complex. The complexity is due to the fact that different supply chain partners may have different and possibly conflicting objectives, and that the supply, demand, and partner-to-partner relationships may change over time. A case study of a supply chain company group that manufactures power tools has been performed with the following goal:

- to understand the organization of an entire supply chain system,
- to understand the operation process within a supply chain system, and
- to identify the supply chain management strategy options.

2.1 Organization and Functions

Our example supply chain consists of suppliers, manufacturing centers, warehouses, distributors, and retailers, as well as raw materials, parts, finished products, and outsourcing companies, such as transportation providers. In this study, attention is aimed at the main contract company. This main contract company includes a headquarters, a final assembly plant, and several warehouses. The headquarters of this contract company manages the information flows and provides the products to the customers through the retailers. The final assembly plant manufactures products by using the parts provided from the parts suppliers, and the finished products are then sent to the warehouses or the distributors. The warehouses store the distribution inventories and supply the products to the retailers. Other supply chain members, including the part suppliers, distributors, retailers, and transportation providers, are independent firms. The part suppliers provide manufacturing parts to the final assembly plant. The distributors provide finished products to the retailers as required or according to other independent contracts. The retailers receive the finished products from the warehouses or from the distributors, and the finished products are then shipped to the customers. The transportation providers deliver the parts or finished products to the required destinations. These transportation services are performed by third-party logistics service companies, in other words, the transportation providers are outsourcing companies.

The headquarters, a final assembly plant, and the warehouses belong to the same company. They can share management information at any time by using a common management database. The other chain members are basically organizations of the other companies, which are independent of each other. This is a typical example of a supply chain system in discrete manufacturing.

2.2 Planning and Operations

The supply chain members form a business partnership. Therefore, all chain members are business partners who carry a common goal to provide products to customers on time. However, these partners have independent management policies and they pose different management strategies to make their own profit. The headquarters, in this case, plays an important role in managing information flows and product flows in the entire supply chain.

The operations discussed in this case study use a short-range planning strategy. The short-range planning usually deals with issues for three months or less in duration. The general concern for short-range plans is in the area of production planning. The planning in this study uses computer-based tools such as MRP (Material Requirement Planning or Manufacturing Resource Planning), MPS (Master Production Schedule), or CRP (Capacity Requirement Planning); and taps the knowledge of the manufacturing practitioners. This study uses a preliminary production plan with rough estimates provided by the manufacturers or supervisors. The study does not include product design operations and maintenance operations.

The finished products are provided to the retailers from either the distributors or the main contract company's warehouses. Thus, the supply chain system shows two streams of product flows:

- Type 1: the finished products flowed through the distributors.
- Type 2: the finished products flowed through the warehouses.

The final assembly plant *pushes out* the type 2 products to the warehouses, and then the retailer *pulls* these type 2 products *from* the warehouses. On the other hand, the type 1 products are *pulled* from the final assembly plant to the distributors, and then *pulled* again to the retailers. This distribution system is the typical hybrid push-pull system. About 80% of the products are type 2 products, and the rest are type 1 products.

2.3 Observations

In the case study, the outsourcing companies provide the transportation services. Today, many supply chain companies use third-party logistics service providers. Dell, IBM, and Toyota are successful examples that use prime contractors to manage chain operations. Third-party logistics is simply the use of an outside company to perform all or part of the company's logistics responsibilities, such as material management or product distribution. The range of activities performed by the third-party logistics service providers has expanded from warehousing, transportation, to a full range of logistics services since the 1980's. Third-party logistics service providers allow a company to focus on the company's particular area of expertise, and leave the logistics activities to the logistics experts. Loss of control, however, is the most outstanding disadvantage.

The hybrid push-pull distribution system is used in this case. Supply chain systems may use two types of distribution systems: push and pull systems. In a push system, production decisions are based on long-term forecasts, while in a pull system, production decisions are based on customer demands. It was suggested that if possible, it is usually more effective to implement a pull-based system, and many firms are taking or have taken this pull approach [5]. However, it is not always practical to implement a pull system throughout the entire supply chain. Therefore, there are cases, the combination of push and pull systems, or the hybrid push-pull distribution system, is applied within a single supply chain. In this strategy, the initial stages of the supply chain use a push system, and the remaining stages use a pull system. This is accomplished by producing a good amount of products in the first stages, and then the production takes place as a reaction to market demand. A hybrid push-pull system is often a good alternative distribution method.

The supply chain members, in this study case, form a partnership. The headquarters manages and controls communication information and product flow. The model uses the concept of the centralized control distribution system. In a centralized system, all decisions are made at a central location for the entire supply chain system. All chain members can have access to the same data, if not proprietary. Information can also be accessed from any location in the supply chain. Very often a centralized system cannot be implemented, because different chain members in the supply chain may have different, conflicting objectives. Forming business partnerships may be a way to take advantage of a centralized distribution system.

3.0 Supply Chain Simulation

The U.S. MISSION project team has been working on the development of a supply chain simulation as a test case for evaluating the quality of the supply chain model and validating interface specifications for MISSION. This supply chain simulation will be a prototype, global supply chain system. This section provides a description of the objective, the scope, and the scenario of the system.

3.1 Simulation Objective

Successful supply chain management is extremely complex. There are multiple reasons for this complexity. Different supply chain partners may have different, and possibly conflicting, objectives. The supply and demand for goods may change over time. The nature of partner-to-partner relationships may also change over time. The advantage of having a simulation of either a proposed system or existing system is that it can be used to design and optimize the system. The use of simulation allows a manager or engineer to analyze and to view system-wide effects of proposed changes, in a ranging level of detail. The analysis results can then be used to support tradeoff studies, management and engineering decisions, and, consequently, enhance the system. The simulation also allows the validation of the interface specifications defined by the MISSION project.

The objective of the supply chain simulation is to examine issues specific to globally distributed simulation systems through the use of the supply chain simulation. Issues that may be examined include:

1. How information is exchanged within the supply chain?

   The facilitation and control of information exchange, both internally and externally, is extremely important to synchronize the business operations within a supply chain. An information model that supports the communication within the supply chain simulation is being designed and developed. With the supply chain simulation, this information model will be tested and enhanced for it's correctness, completeness, and effectiveness.

2. What is the expected performance of the system?

   There are many possible measures of performance for a system. Four categories of such measures are important in practice:

   - Time

- Cost
- Quality
- Inventory

The performance issues addressed here includes:

- cost study: use transportation cost, and manufacturing cost as the measures of performance,
- time-in-system study: use assembly time, time that parts/products spend waiting for transport, time that parts/product spend in transport, time that parts/products spend in queues, and time spent between process steps as the measures of performance,
- throughput study: use the throughput as its measure of performance, and
- inventory study: use inventory duplication and safety stock as the measures of performance.

Some process chain planning may use the above study results to perform the decision making on various supply chain business operations, such as location planning of inventory bases, resource capacity planning, volume planning of inventories, and others.

Several possible performance factors or decision variables that might have the greater impact on the performance measures of interest are building into this supply chain simulation and the proposed information model. The key decision variables included in the information model are as follows:

- the projected product volume of demand,
- each product's quantity and cost in a manufacturing order,
- the transportation requirements, including upstream and downstream company locations, estimated starting and ending dates, and maximum weight allowed,
- each product's weight and quantity, and total weight and cost in a transportation order, such as the order from the retailer to the distributor,
- the status of the transportation activity, including on time, days and reason of delay, and cancellation,
- part's quantity, time requirement, and estimated cost in a parts delivery order,
- the quantity of parts delivered from the supplier,
- total weight, total products cost, shipping cost, time requirement, and each product's weight and quantity of the order sent to the transporter for delivering the products,
- each product's safety stock criteria in the warehouse,
- the total cost, time requirement, each product's quantity and cost in a purchase order,
- the replenishment point of the products for the warehouse,
- the time requirement and the quantities of the products that shipped from the warehouse to the retailer, and
- throughput data for the manufacturing execution report.

3.2 Simulation Model Scope

The characteristics of the scope of the supply chain simulation are:

- Span across multiple businesses and organizations.
- Simulate multiple levels of manufacturing systems.
- Use a hybrid push-pull distribution system for product distribution.
- Include multiple software simulation modules in different geographical locations.
- Comprise multiple functional modules, such as simulation engines, display systems, and analysis tools.

The following manufacturing activities are within the scope of the supply chain simulation:

- Production planning, scheduling, and control.
- Transportation planning and scheduling.
- Materials/parts/products flow within the final assembly plant (and possibly suppliers).
- Inventory control.
- Cost control.
- Data communications between business functions.

The following are outside the scope of the supply chain simulation:

- Product design.
- Cost estimation.
- Process flow.
- Facility layout.
- Equipment requirements.
- Legal, tax, and regulatory requirements.
- Human resources requirements.
- Human communications.

3.3 Demonstration Scenario

In this section, the configuration of the supply chain simulation is described. The configuration is based on a previous case study of a U.S. power-tools manufacturing supply chain. The chain includes supply chain members, information flows, and product flows. There are seven major types of organizational units included in the supply chain:

- A supply chain headquarters.
- Parts suppliers (3).
- Warehouse.
- Retailers (3).
- Distributor.
- A final assembly plant.
- A transportation network.

Figure 1 shows the configuration of this supply chain simulation. The simulation system consists of suppliers, manufacturing centers, warehouses, distributors, and retailers, as well as raw materials, parts, finished products, and outsourcing companies, such as transportation providers. The headquarters monitors the information flows and provides the products to the customers through the retailers. The final assembly plant assembles finished goods from the components provided by the suppliers. At least three production lines within the assembly plant will be modeled in detail. The final assembly plant manufactures products by using the parts provided from the parts suppliers; the finished products are then sent to the warehouse or to the distributor. The warehouse stores inventory and supplies products to the retailers. Other supply chain members, including the part suppliers, distributors, retailers, and transportation providers, may be independent firms. The part suppliers provide manufacturing parts to the final assembly plant. The distributors provide finished products to the retailers as required or according to other independent contracts. The retailers receive the finished products from the warehouses or from the distributors, and the finished products are then shipped to the customers. The transportation providers deliver the parts or finished products to the required destinations. This supply chain simulation uses a hybrid push-pull distribution system. Simulation models of the above supply chain components are being developed using the U.S. MISSION partners' simulation tools such as Arena, AutoMod, Microsaint, ProModel, and Quest.

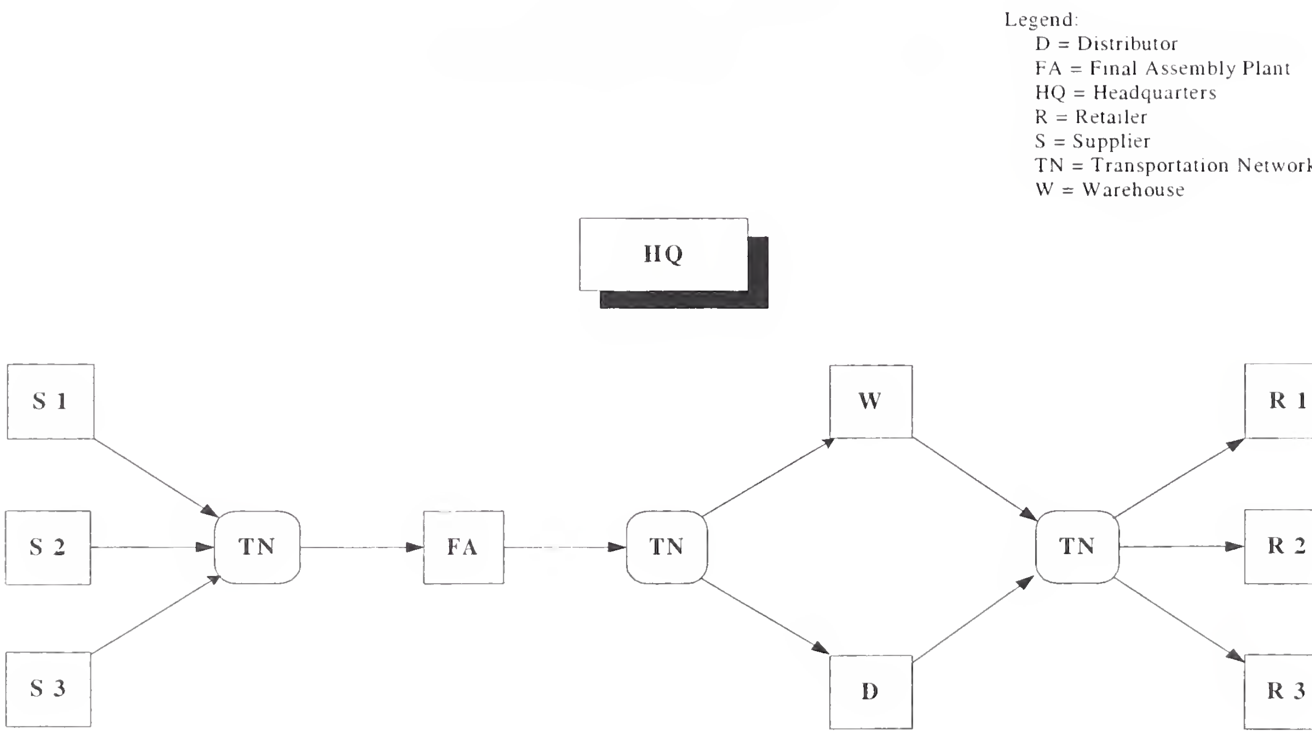

Figure 1. The configuration of the supply chain simulation

3.4 Data Requirements

This section specifies the information required for communicating among the supply chain simulation. A communication data flow analysis of the supply chain simulation was performed. This analysis focuses on the minimal set of data that needs to be exchanged between members of the supply chain. As a result, a set of data requirements used to communicate among the supply chain members has been identified. Local data required by supply chain members is not contained within the requirements list. These data requirements are a set of messages or entities; they are grouped into nine units of functionality:

- Generic Order.
- Generic Order Response.
- Shipping Order.
- Shipping Order Response.
- Product Forecast.
- Product Forecast Response.
- Manufacturing Production Report.
- Truck Dispatch Order/Log.
- Shipment Report.
- Transport Request.
- Transport Request Response.

The structure of each message/object is presented in the Appendix. Nine tables are included in the Appendix, each shows the attribute name, data type, and sample data of each attribute included in the message.

4.0 Information Model

This section presents an information model that describes, with the IDEF1X methodology, the data requirements listed in Subsection 3.4. This model represents the structure of the data requirements that support the communication data interchange within the supply chain simulation. IDEF1X is a graphical representation and has been designed using the entity-relationship approach and the relational theory. The information model is presented in Diagrams 1-6 (refer to pages 11-16.)

- Diagram 1 defines the entities of Generic Order and Generic Order Response.
- Diagram 2 defines the entities of Shipping Order and Shipping Order Response.
- Diagram 3 defines the entities of Manufacturing Production Report and Shipment Report.
- Diagram 4 defines the entity of Product Forecast.
- Diagram 5 defines the entity of Truck Dispatch Order and Log.
- Diagram 6 defines the entities of Transport Request and Transport Request Response.

5.0 Conclusion

The manufacturing industry has become much more interested in supply chain management over the past several years. At the same time information technology becomes an important enabler for effective supply chain management. With appropriate information models that support information sharing among supply chain members, the supply chain can be integrated seamlessly. Thus, communications among chain members may go directly, and better customer value performance, shorter lead time, and even lower production and manufacturing costs can be expected.

The paper specifies a prototype system of a supply chain simulation. It also presents an information model that provides a framework of communication data in the prototype supply chain simulation.

The prototype system is developed to support the international MISSION project to demonstrate the feasibility of a globally distributed virtual enterprise. The prototype system and information model specified in this report has been implemented using an NIST-developed Distributed Manufacturing Systems Adapter [3]. It is anticipated that the implementation of this prototype system will be carried out at multiple geographical locations simultaneously.

The prototype system is intended for the MISSION project only and will not be generic enough for the general purpose application. NIST is currently working on the design and development of a simulation model for a virtual supply chain enterprise. The goal of this model is to support the users to make strategic decisions for improving the performance of the supply chains. This decision support will serve many supply chain activities, such as physical distribution, physical supply, and manufacturing planning and control.

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The authors thank Chuck Mclean, Swee Leong, and Frank Riddick of NIST, and Mike Weaver of Black and Decker for their technical assistance.

Certain commercial software and hardware products are identified in this paper. This does not imply approval or endorsement by NIST, nor does it imply that the identified products are necessarily the best available for the purpose.

6.0 References

[1] MISSION Consortium, "Intelligent Manufacturing System (IMS) Project Proposal: Modelling and Simulation Environments for Design, Planning and Operation of Globally Distributed Enterprises (MISSION), Version 3.3," Shimuzu Corporation, Tokyo, Japan, March 1998.

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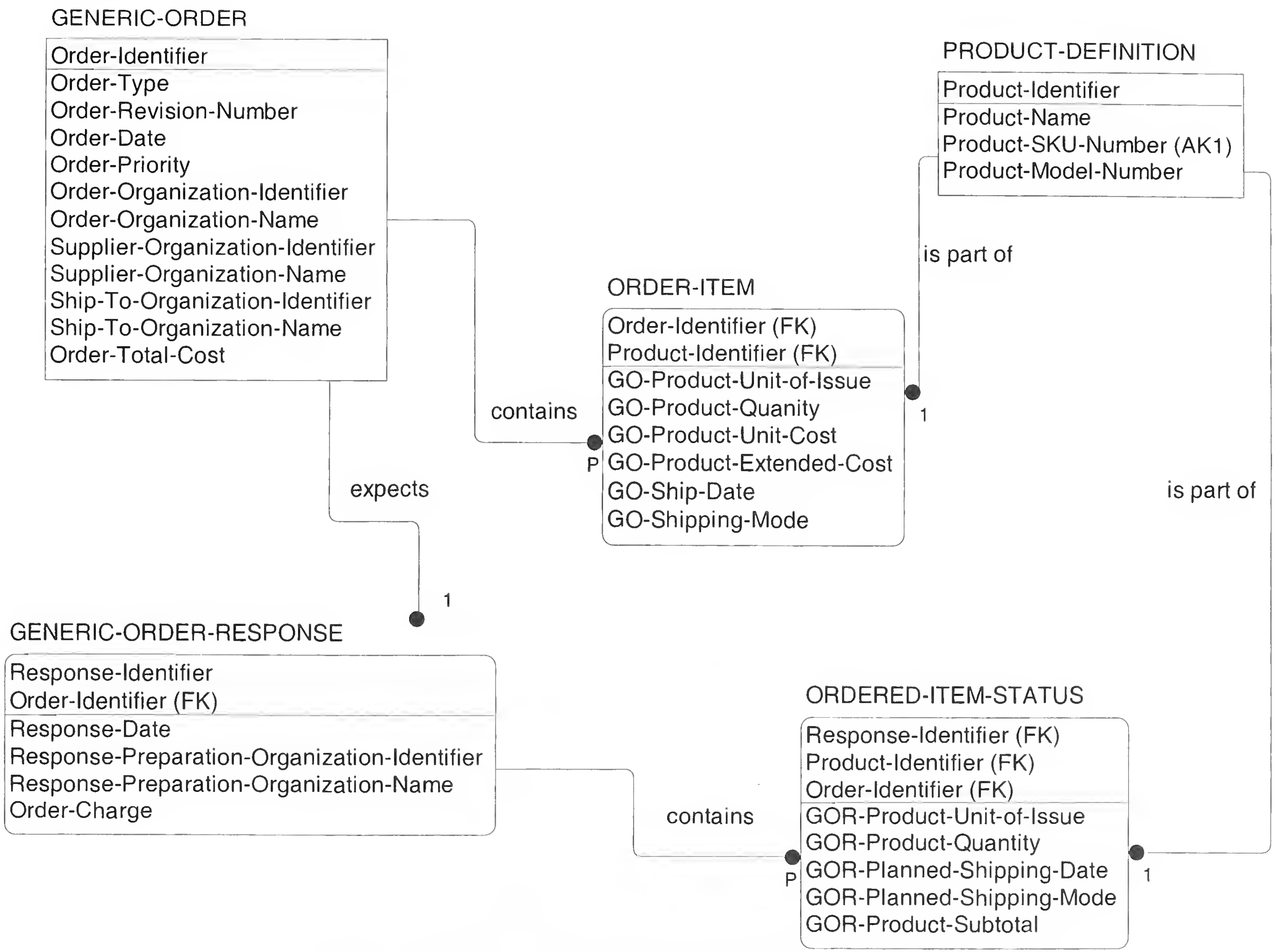

Diagram 1: Data Structures of Generic Order and Generic Order Response

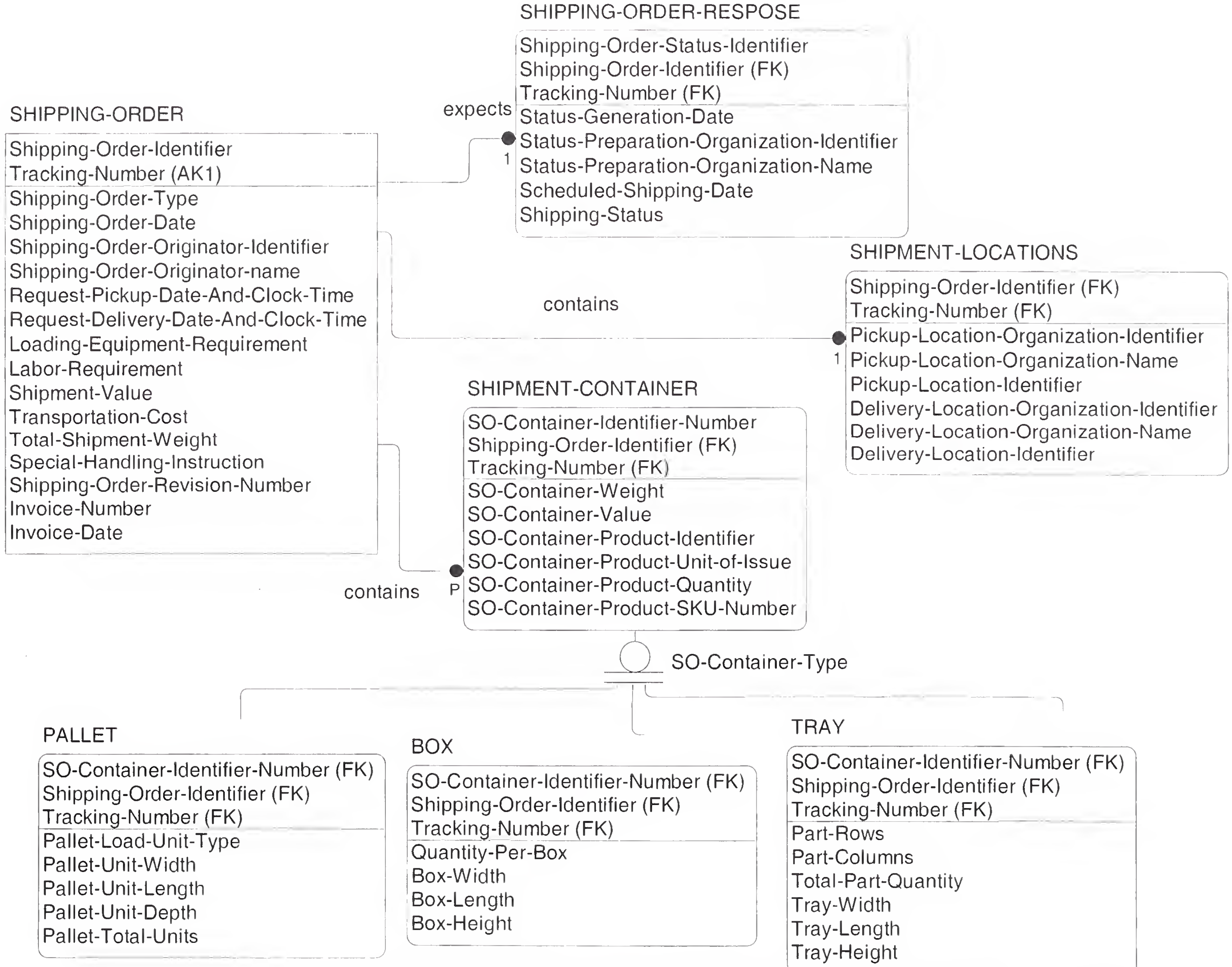

Diagram 2: Data structures of Shipping Order and Shipping Order Response

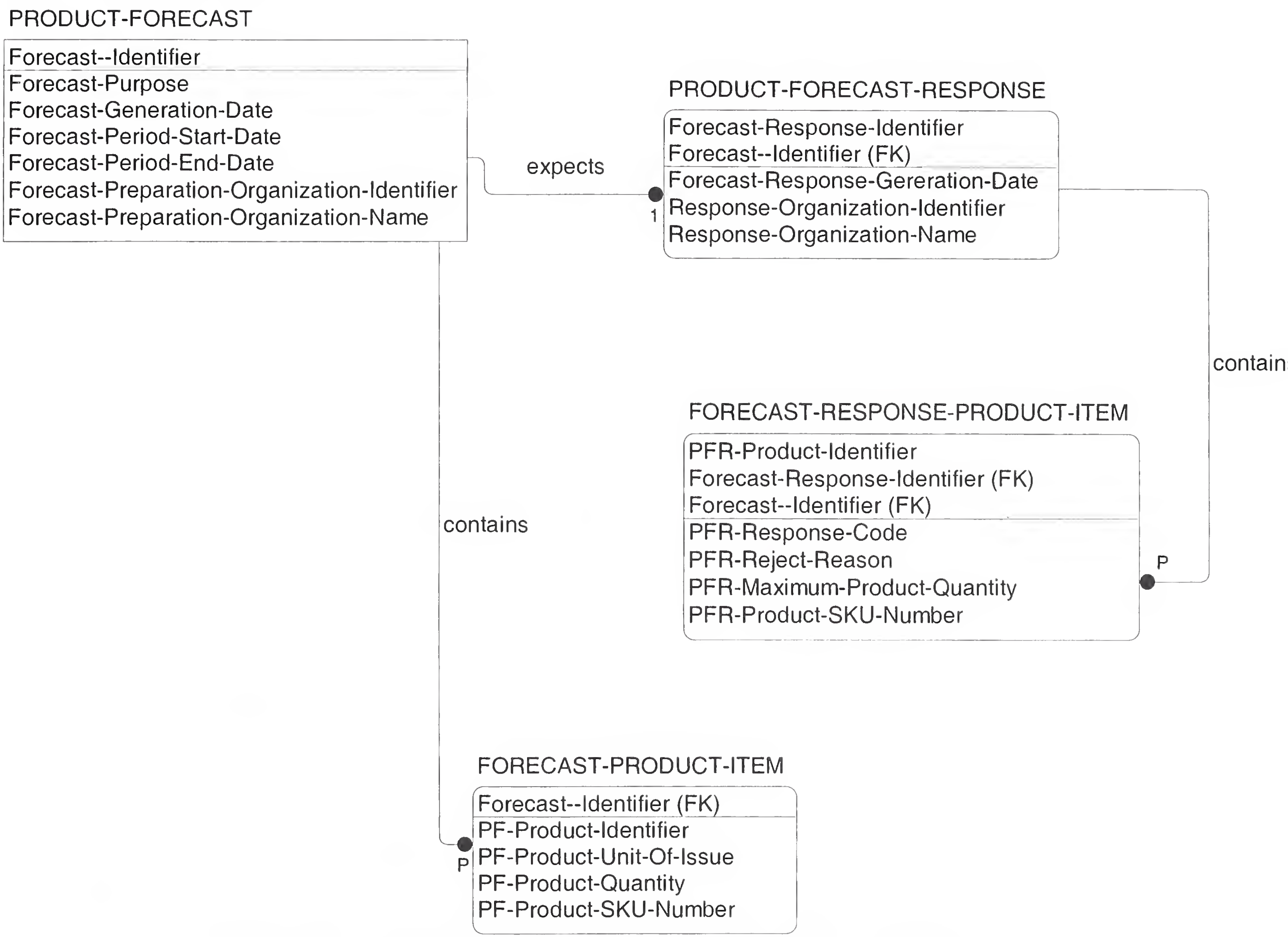

Diagram 3: Data structures of Product Forecast and Product Forecast Response

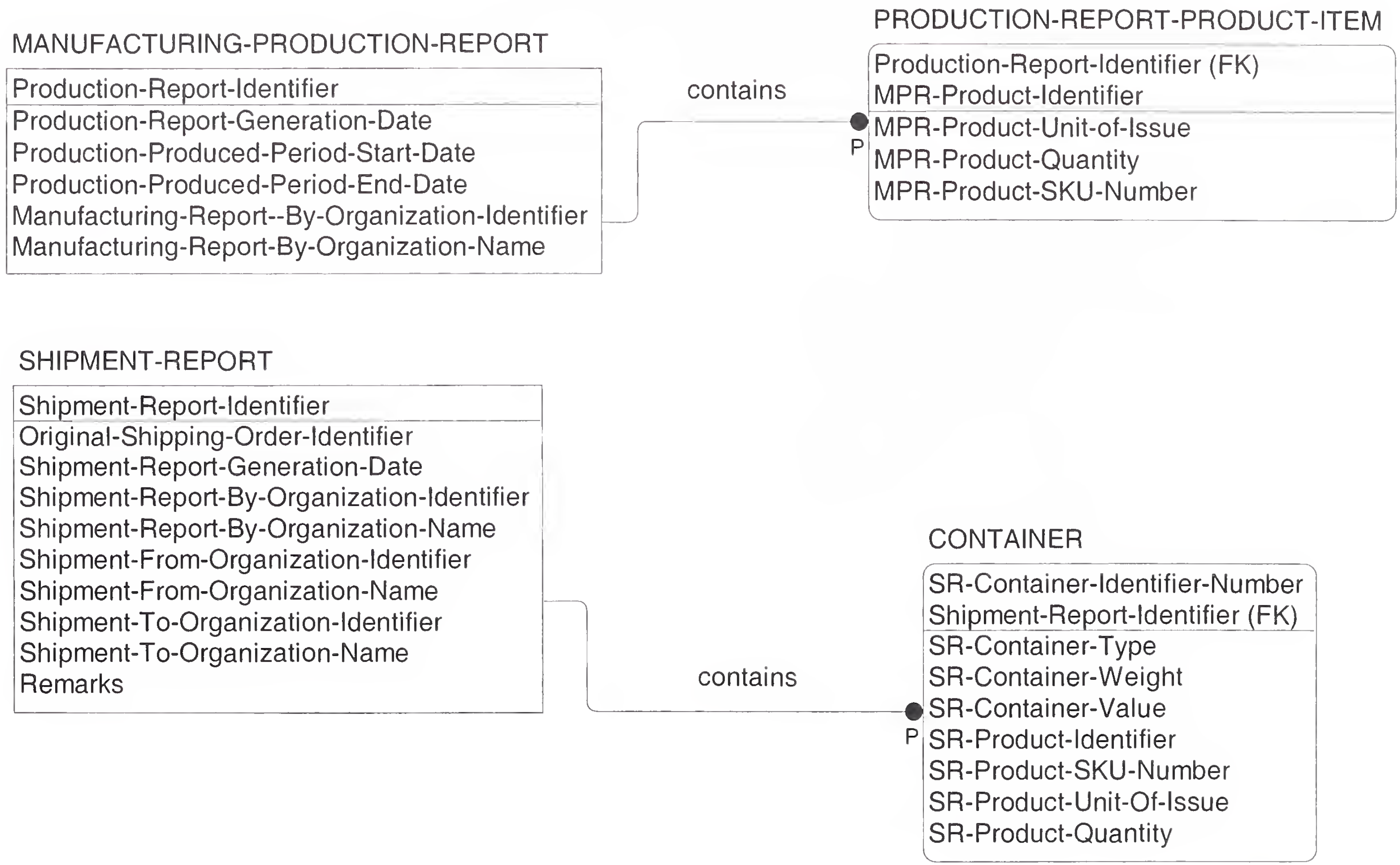

Diagram 4: Data structures of Manufacturing Production Report and Shipment Report

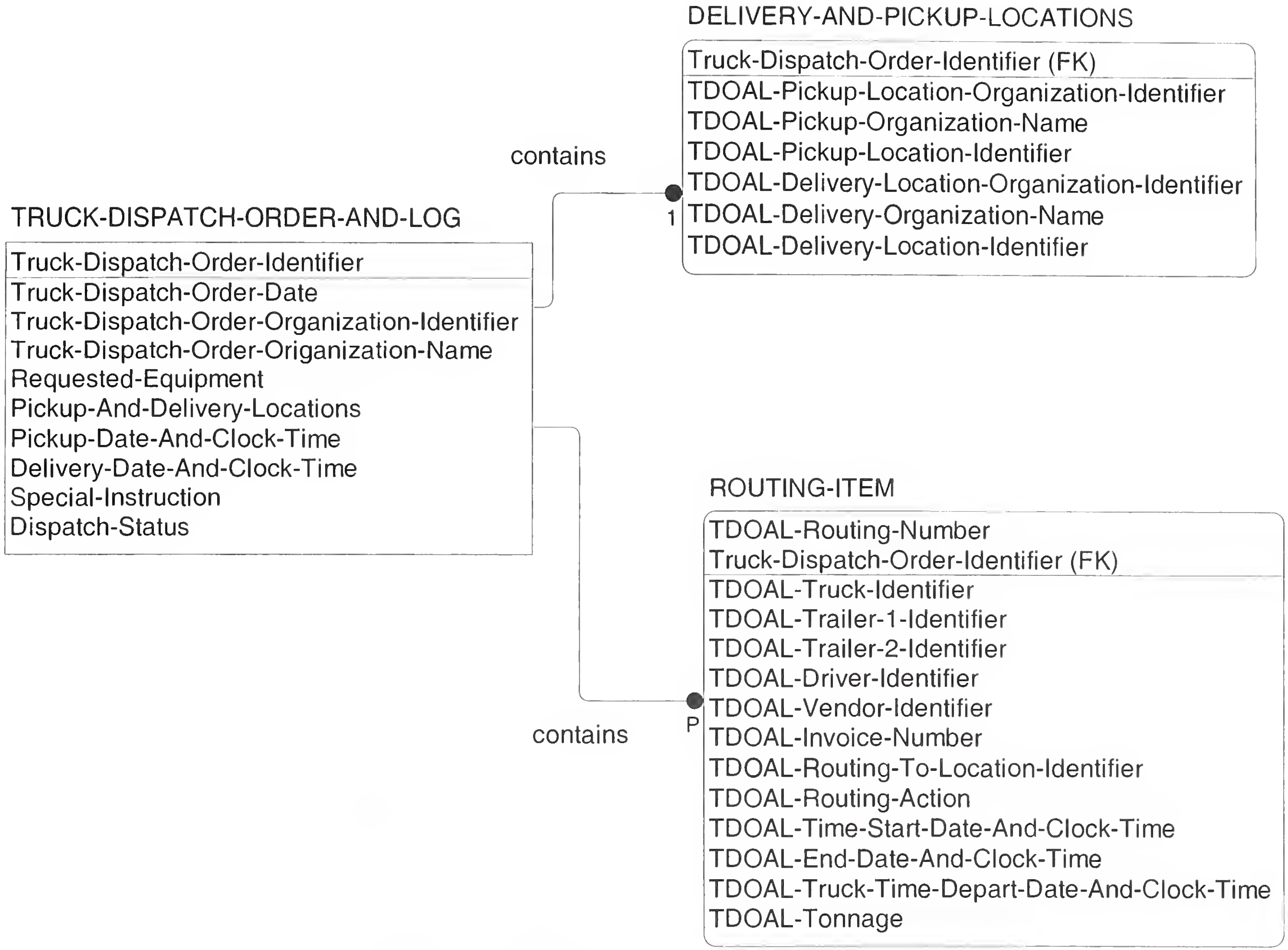

Diagram 5: Data Structure of Truck Dispatch Order/Log

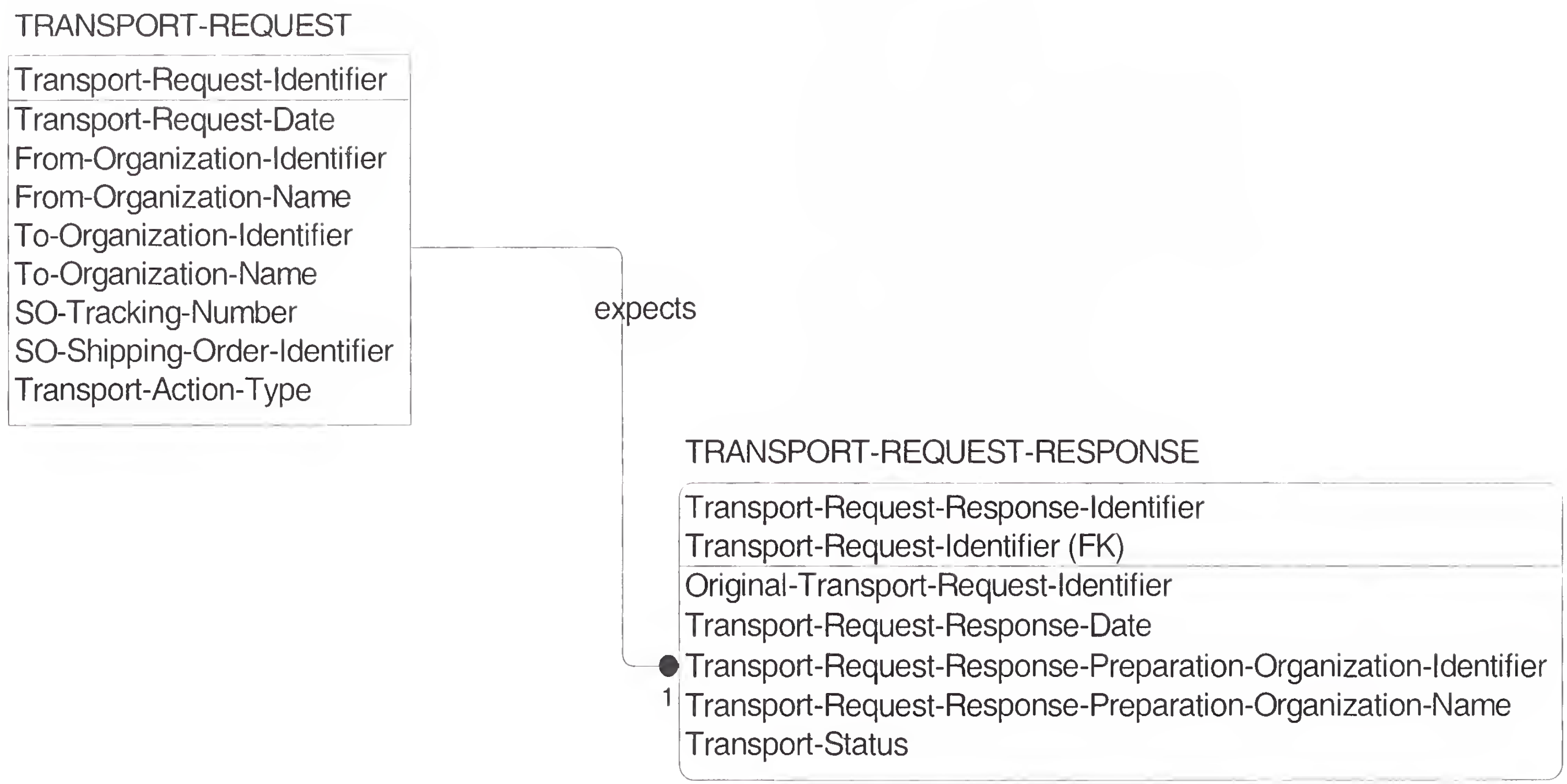

Diagram 6: Data Structures of Transport Request and Transport Request Response

7.0 Appendix

This appendix contains nine tables. Each table lists the data structure of one entity that is presented in the data requirement list. Three columns and several lines are presented in each table. The number of lines in each table is determined by the number of attributes included in the entity. The columns identify the name, the data type, and an example of the attribute.

1. Generic Order

STRUCTURE	DATA TYPE (format) [enumeration]	EXAMPLE	
Order Type	[MANUFACTURING, PURCHASE]	MANUFACTURING	
Order Identifier	INTEGER	125	
Order Revision Number (O)	INTEGER	0	
Order Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-05-07	
Order Priority (O)	[REGULAR, URGENT]	REGULAR	
Order Originator			
Organization Identifier (O)	INTEGER	1	
Organization Name	STRING	SupplyChainHeadquarters	
Supplier			
Organization Identifier (O)	INTEGER	5	
Organization Name	STRING	AssemblyPlant1	
Ship To Organization			
Organization Identifier (O)	INTEGER	7	
Organization Name	STRING	Warehouse1	
Number of Order Items	INTEGER (n)	2	
Table of Items			
Product Identifier	STRING	FS500	JS200
Product SKU Number (O)	INTEGER	2887340500	2887320200
Product Model Number (O)	INTEGER	1	1
Product Name (O)	STRING	Palm Grip Finishing Sander	Variable Speed Jig Saw
Product Unit of Issue	INTEGER	1	1
Product Quantity	INTEGER	1500	2500
Product Unit Cost	REAL (ddddddd.cc)	49.99	59.99
Product Extended Cost (O)	REAL (ddddddd.cc)	74985.00	149975.00
Ship Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-15	2001-06-22
Shipping Mode (O)	[FEDEX, TRUCKER1]	TRUCKER1	TRUCKER1
Order Total Cost (O)	REAL (ddddddd.cc)	224960.00	

2. Generic Order Response

STRUCTURE	DATA TYPE (format) [enumeration]	EXAMPLE	
Response Identifier	INTEGER	225	
Original Order Identifier	INTEGER	125	
Response Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-05-22	
Response Preparation Organization			
Organization Identifier (O)	INTEGER	5	
Organization Name	STRING	AssemblyPlant1	
Number of Status Items	INTEGER (n)	2	
Table of Items			
Product Identifier	STRING	FS500	JS200
Product SKU Number (O)	INTEGER	2887340500	2887320200
Product Unit of Issue	INTEGER	1	1
Product Quantity	INTEGER	1500	2500
Planned Shipping Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-15	2001-06-22
Planned Shipping Mode	[FEDEX, TRUCKER1]	TRUCKER1	TRUCKER1
Product Subtotal (O)	REAL (ddddddd.cc)	74985.00	149975.00
Order Charge (O)	REAL (ddddddd.cc)	224960.00	

3. Shipping Order

STRUCTURE	DATA TYPE (format) [enumeration]	EXAMPLE		
Shipping Order Identifier	INTEGER .	325		
Tracking Number (O)	INTEGER	1001		
Shipping Order Revision Number (O)	INTEGER	0		
Shipment Order Type (O)	[NEW, REVISED, CANCEL]]	NEW		
Shipping Order Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-05-15		
Shipping Order Originator				
Organization Identifier (O)	INTEGER	1		
Organization Name	STRING	MotorSupplier1		
Pickup Location (O)				
Organization Identifier (O)	INTEGER	1		
Organization Name	STRING	MotorSupplier1		
Pickup Location Identifier	INTEGER	401		
Delivery Location				
Organization Identifier (O)	INTEGER	5		
Organization Name	STRING	AssemblyPlant1		
Delivery Location Identifier (O)	INTEGER	501		
Request Pickup Time				
Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-14		
Clock Time (O)	ONE OF {AM-PM, HOUR}	AM		
Request Delivery Time				
Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-15		
Clock Time (O)	ONE OF {AM-PM, HOUR}	PM		
Loading Equipment Requirement (O)	[NO, FORKLIFT, CRANE]	NO		
Labor Requirement (O)	[YES, NO]	NO		
Number of Shipment Containers	INTEGER (<= 10)	7		
Table of Shipment Containers				
Container Identifier Number	INTEGER	1	2	3
Container Type	[PALLET, BOX, TRAY]	BOX	BOX	BOX
Container Weight (O)	REAL	750	750	750
Container Value (O)	REAL	24995.00	24995.00	24995.00
Product Identifier	INTEGER	FS500	FS500	FS500
Product SKU Number (O)	INTEGER	2887340500	2887340500	2887340500
Product Unit of Issue	INTEGER	1	1	1
Product Quantity	INTEGER	500	500	500
Invoice Number (O)	INTEGER	39		
Shipment Value (O)	REAL	74985.00		
Transportation Cost (O)	REAL	1000.00		
Total Shipment Weight (O)	REAL	2250		

Special Handling Instruction (O)	STRING	NONE

4. Shipping Order Request

STRUCTURE	DATA TYPE (format) [enumeration]	EXAMPLE
Shipping Order Status Identifier	INTEGER	425
Status Generation Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-05-17
Status Preparation Organization		
Organization Identifier (O)	INTEGER	1
Organization Name	STRING	SupplyChainHeadquarters
Tracking Number (O)	INTEGER	1001
Shipping Order Identifier	INTEGER	325
Scheduled Shipping Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-15
Shipping Status	STRING	Shipped

5. Product Forecast

STRUCTURE	DATA TYPE (format) [enumeration]	EXAMPLE
Forecast Identifier	INTEGER	10
Forecast Purpose (O)	[DEMAND-PROJECTION, UTILIZATION-REQUIREMENT, INVENTORY-PLAN]	DEMAND-PROJECTION
Forecast Generation Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-01-10
Forecast Preparation Organization		
Organization Identifier (O)	INTEGER	3
Organization Name	STRING	Distributor1
Forecast Period		
Start Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-01
End Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-12-31
Number of Forecast Product Items	INTEGER (<= 10)	1
Table of Forecast Product Items		
Product Identifier	STRING	FS500
Product SKU Number (O)	INTEGER	2887340500
Product Unit of Issue	INTEGER	1
Product Quantity	INTEGER	150000

6. Product Forecast Response

STRUCTURE	DATA TYPE (format) [enumeration]	EXAMPLE
Original Forecast Identifier	INTEGER	10
Forecast Response Identifier	INTEGER	11
Forecast Response Generation Date	*Use ISO Format for Date(yyyy-mm-dd)	2001-01-19
Response Preparation Organization		
Organization Identifier (O)	INTEGER	1
Organization Name	STRING	SupplyChainHeadquarters
Number of Forecast Product Items	INTEGER (<= 10)	1
Table of Forecast Product Items		
Product Identifier	STRING	FS500
Product SKU Number (O)	INTEGER	2887340500
Forecast Response	[ACCEPT, REJECT, PARTIAL]	ACCEPT
REJECT		
Reason	STRING	
PARTIAL		
Maximum Product Quantity	INTEGER	

7. Manufacturing Production Report

STRUCTURE	**DATA TYPE (format) [enumeration]**	**EXAMPLE**
Production Report Identifier	INTEGER	17
Production Report Generation Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-04-16
Manufacturing Report By		
Organization Identifier (O)	INTEGER	1
Organization Name	STRING	SupplyChainHeadquarters
Production Produced Period		
Start Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-01-15
End Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-03-16
Number of Report Items	INTEGER (<= 10)	1
Table of Report Items		
Product Identifier	STRING	FS500
Product SKU Number (O)	INTEGER	2887340500
Product Unit of Issue	INTEGER	1
Product Quantity	INTEGER	20000

8. Truck Dispatch Order/Log

STRUCTURE	DATA TYPE (format) [enumeration]	EXAMPLE
Truck Dispatch Order Identifier	INTEGER	31
Truck Dispatch Order Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-05-30
Truck Dispatch Order Originator		
Organization Identifier (O)	INTEGER	1
Organization Name	STRING	SupplyChainHeadquarters
Requested Equipment	[NO, FORKLIFT, CRANE]	NO
Pickup Location		
Organization Identifier (O)	INTEGER	5
Organization Name	STRING	AssemblyPlant1
Pickup Location Identifier (O)	INTEGER	501
Pickup Time		
Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-13
Clock Time (O)	ONE OF [AM-PM, HOUR]	AM
Delivery Location		
Organization Identifier (O)	INTEGER	7
Organization Name	STRING	Warehouse1
Delivery Location Identifier (O)	INTEGER	701
Delivery Time		
Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-15
Clock Time (O)	ONE OF [AM-PM, HOUR]	PM
Special Instruction (O)	STRING	NONE
Dispatch Status	[ON-TIME, DELAY, CANCEL]	ON-TIME
Number of Routings	INTEGER	1
Table of Routings		
Routing Number	INTEGER	1
Truck Identifier	INTEGER	1001
Trailer1 Identifier (O)	INTEGER	1
Trailer2 Identifier (O)	INTEGER	0
Driver Identifier (O)	INTEGER	101
Vendor Identifier (O)	INTEGER	102
Invoice Number (O)	INTEGER	401
Routing To Location Identifier	INTEGER	11
Routing Action	[PICKUP, DELIVERY]	DELIVERY
Time Start		
Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-15
Clock Time (O)	ONE OF [AM-PM, HOUR]	1300
Time End		

Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-15
Clock Time (O)	ONE OF [AM-PM, HOUR]	1600
Truck Time Depart		
Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-06-15
Clock Time (O)	ONE OF [AM-PM, HOUR]	1630
Tonnage (O)	REAL	2250

9. Shipment Report

STRUCTURE	**DATA TYPE (format) [enumeration]**	**EXAMPLE**
Shipment Report Identifier	INTEGER	11
Shipment Report Generation Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-04-16
Original Shipping Order Identifier	INTEGER	125
Shipment Report By		
Organization Identifier (O)	INTEGER	1
Organization Name	STRING	TruckOrganization
Shipment From (O)		
Organization Identifier (O)	INTEGER	4
Organization Name	STRING	Supplier1
Shipment To		
Organization Identifier (O)	INTEGER	5
Organization Name	STRING	AssemblyPlant1
Number of Containers	INTEGER	1
Table of Containers		
Container Identifier Number	INTEGER	1
Container Type	[PALLET, BOX, TRAY]	BOX
Container Weight (O)	REAL	750
Container Value (O)	REAL	24995.00
Product Identifier	INTEGER	FS500
Product SKU Number (O)	INTEGER	2887340500
Product Unit of Issue	INTEGER	1
Product Quantity	INTEGER	500
Remarks (O)	STRING	

10. Transport Request

STRUCTURE	DATA TYPE (format) [enumeration]	EXAMPLE
Transport Request Identifier	INTEGER	525
Transport Request Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-05-18
Transport Request From		
Organization Identifier (O)	INTEGER	1
Organization Name	STRING	TruckOrganization
Transport Request To		
Organization Identifier (O)	INTEGER	1
Organization Name	STRING	AssemblyPlant1
Tracking Number (O)	INTEGER	1001
Shipping Order Identifier	INTEGER	325
Transport Action Type	[PICKUP, DELIVERY]	DELIVERY

11. Transport Request Response

STRUCTURE	DATA TYPE (format) [enumeration]	EXAMPLE
Transport Request Response Identifier	INTEGER	625
Original Transport Request Identifier	INTEGER	525
Transport Request Response Date	*Use ISO Format for Date (yyyy-mm-dd)	2001-05-18
Transport Request Response Preparation Organization		
Organization Identifier (O)	INTEGER	1
Organization Name	STRING	AssemblyPlant1
Transport Status	STRING	Complete