Logistic Core Operations with SAP

Inventory Management, Warehousing, Transportation, and Compliance

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1. Auflage 2012. Buch. viii, 296 S. Hardcover
ISBN 978 3 642 18201 3
Format (B x L): 15,5 x 23,5 cm
Gewicht: 619 g

Chapter 2
Transport Logistics

Transport logistics refers to the transport of goods of all kinds using a variety of means, such as trains, trucks, airplanes, ships or parcel services.

Transport logistics is a major component of business process networks. Its significance has increased in recent years due to increasing globalization. Whereas companies in the 1980s and 1990s frequently focused on reducing internal costs by introducing ERP systems, among other measures, now rising energy costs are shifting that focus to logistics outside the company. In recent years, we have seen similar cost optimization tendencies in the realm of transport.

2.1 The Fundamentals of Transport Logistics

The topic of transport can be considered from the perspective of various business models, such as that of logistics service providers and carriers, or from the view of a producing or trading company (called the *shipper view* in this context). Both business models exhibit their own special features in the business process. The cooperation of business partners in the network has its own character and set of rules. In addition, goals can be different. Figure 2.1 illustrates the transportation relationships between various business partners. The transport logistics involved in external logistics can be organized by the shippers themselves as well as by logistics service providers.

From the perspective of transport logistics, we generally differentiate between local and long-haul transport. Local transport involves a vehicle executing pick-up or delivery and returning to the starting point on the same day. This category generally includes the delivery of cargo that has been fed from a long-haul into a local transport network (*on-carriage*), and pick-ups that have been transferred from the local to the long-haul transport network (*pre-carriage*). The truck is the most commonly used vehicle in local transport.

Long-haul transport is either carried out as direct long-haul transport (*direct leg*) or via line haul. For direct long-haul transportation, a means of transport containing the goods to be conveyed is sent directly from the shipper to the recipient over a

J. Kappauf et al., *Logistic Core Operations with SAP*,
DOI 10.1007/978-3-642-18202-0_2, © Springer-Verlag Berlin Heidelberg 2012

long distance. For line-haul processing, goods picked up on local transport routes are transferred to another means of transport (airplane, ship, train or truck) in a logistics center and transported along with goods from other shippers. Several transfer processes are also possible along the entire transport route. Figure 2.2 illustrates the transportation lanes and the transportation network in local and long-haul transport.

For long-haul transport, organizational processing efforts are generally much higher than for local transport. Depending on the type of transportation (air, sea, etc.), the type of goods (dangerous goods, foodstuffs, etc.) and geographic circumstances of the origin, points of transit and destination, long-haul transport can require the following additional tasks:

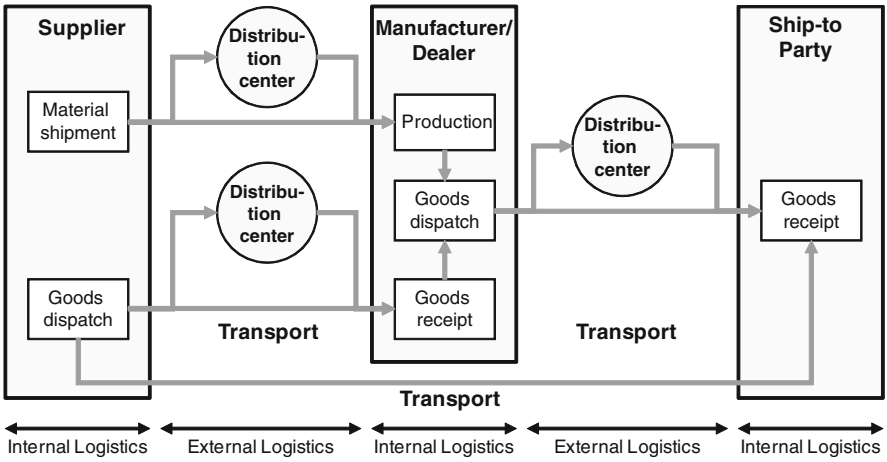


Fig. 2.1 Transportation relationships between various business partners

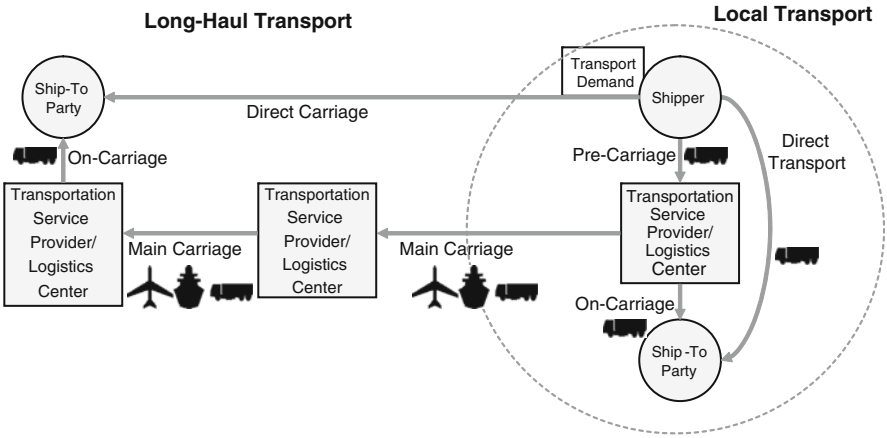


Fig. 2.2 Transportation network in local and long-haul transport

- Shipping space reservation on ships or airplanes
- Foreign trade processing with export and import permits, customs fees and embargo checks
- Dangerous goods processing with various national or transport mode-specific regulations
- Coordination and seamless planning of goods movement at the various load transfer points and on various modes of transport
- Cost calculation, processing and risk responsibility according to various Incoterms

International air and sea transport can become very complex as a result.

2.1.1 Business Significance

Transport logistics does not occur in an isolated fashion. It is always connected to other business processes, whether they be in one's own company or at a business partner's location. It organizes the exchange of goods between business partners. Bad organization can harm or impede the subsequent business processes. In times of very advanced internal process optimization, a well-functioning, optimized transport logistics is becoming ever more important. Here, even greater savings potential, total process optimization and service advantages can be achieved.

The optimization goal of transport logistics is to process all planned goods transports in such a way that:

- Existing transport means are used as optimally as possible
- As few empty runs as possible occur
- Available service providers can be contracted economically and in close observation of agreements
- All goods are transported according to laws and regulations (dangerous goods regulations, trade regulations, etc.)
- Operating supply, human resources and service provider costs are minimized
- Service times and stipulated service grade and levels (such as 24-h delivery) are observed

Many of these optimization opportunities can be utilized to their fullest with the aid of a suitable software system.

2.1.2 Transportation from the Shipper View

From the view of a shipper, there are three major process types that must be supported in transport logistics:

- *Incoming shipments*, in which ordered goods are picked up or material replenishment is acquired for production
- *Outgoing shipments*, in which produced or deliverable materials or goods are transported from one plant or warehouse to a goods recipient
- *Third-party transactions*, in which the shipper has the goods transported directly from a supplier to the recipient, without the shipper physically receiving the goods.

The desired direction of the transport demand, that is, where the goods to be shipped are staged and where they are ultimately delivered, is virtually insignificant for actual processing. However, you need to observe the stipulated tariffs and any related Incoterms.

A forwarding agent can conduct transport logistics in three different ways:

- **Completely autonomous transport logistics**
  The shipper maintains his own fleet and drivers, and, with them, attempts to achieve optimal capacity utilization with the goods to be transported. Cost minimization is a primary goal. The objective is to execute all goods shipments using as few vehicles as possible. This type of organization can be observed more often in smaller producing enterprises or retail companies. Transport logistics is primarily in the form of local transports to and from factories and distribution centers.
- **Internal transportation planning with external logistics service providers**
  The shipper can master the planning of the shipments in an optimal manner. However, he does not own his own fleet, and thus commissions a logistics service provider or carrier to execute the shipments according to precise instructions. This type of organization is often seen in companies in which a number of independent suborganizations transmit their transport demands to one central planning office.
- **Complete outsourcing of transportation tasks and services**
  The shipper transfers the individual transport demand tasks to a logistics service provider and has that agent decide on their processing. In a more extreme form, the service provider is given further tasks for the external logistics chain (warehouse management, order processing, and inventory control) and takes on increased responsibility.

2.1.3 Transportation from the View of the Logistics Service Provider

Logistics service provider is the collective term for carriers as well as freight forwarding agents. In both types of companies, the core process and value creation

concern the processing of shipments. For the purposes of this book, freight forwarding agents refers to companies that organize the transportation of goods, while carriers execute the physical transport of goods.

Both kinds of companies work closely together. Freight forwarders who do not own their own fleets are dependent upon carriers who act as the executing business partner. Larger logistics enterprises often comprise both types of companies; the logistics service provider organization accepts, plans and processes aggregated orders, and then passes them on to internal carriers and other external carriers.

Carriers have responsibilities in the following realms:

- Provision of mode-specific transportation capacities (on rail, air, sea, and road)
- Optimized use of an internal fleet and thus the opportunity to offer attractive prices for transportation services and the provision of transport means (such as containers)

The responsibilities of a logistics service provider include the following:

- The consolidation of goods from various customers to achieve maximum profitability
- Complete processing of goods transport for a customer, including the performance of all legally required services (customs clearance, dangerous goods treatment, paper printouts, import/export processing, goods movement) and the professional subcontracting of all involved carriers

Consolidation and profitability. The consolidation of goods from various customers gives the logistics service provider the opportunity to optimize profits. For instance, he can commission a carrier to execute a container shipment (full container) for $1,000 and subsequently resell the available 24 pallet spaces to a customer for $100 each. The service provider turns a profit from the 11th sold pallet space. Of course, he also carries risk of incomplete capacity utilization.

2.1.4 Shipper and Service Provider Hybrids

From the viewpoint of the shipper, transportation processing is generally not a core competence upon which he wishes to concentrate, but rather a necessary task in the completion of the process chain. Instead of completely outsourcing all transportation services, the shipper can outsource his shipping department (with or without a fleet) in order to optimize his own competences and also provide them to other business partners for their transportation processing needs. With such efforts, outsourced logistics departments of larger enterprises increasingly represent direct competition to logistics service providers.

2.2 SAP Systems and Applications

Especially in the realm of transportation, several transpiration solutions have been developed in the history of SAP systems, each of which had a certain user group and focus (see Fig. 2.3):

1. In 1987, the first transportation solution in the mainframe system SAP R/2 was introduced to the market (*Realtime Vertrieb*, RV, with *Realtime Transport*, RT), whose functions were strongly influenced by shippers in the chemical industry.
2. In 1993, with SAP R/3, the transportation processing solution SD-TRA entered the market, which represents a generic solution from the view of the shipper. Release SAP R/3 4.6 saw the categorization of the solution in the *Logistic Execution System* (LE-TRA).
3. In 2000, as a supplement to SAP ERP Transport, SAP introduced transportation planning and optimization for shippers in SAP APO (APO-TP/VS, *Transportation Planning/Vehicle Scheduling*).
4. *SAP Event Management* (SCM-EM) was introduced to the market in 2001 as a tracking and tracing solution for shippers as well as logistics service providers and integrated into ERP Transport for purposes of tracking shipments.
5. With *SAP Transportation Management* (SAP TM) in 2007, SAP supplied a comprehensive, independent transportation solution that served the needs of logistics service providers as well as shippers.

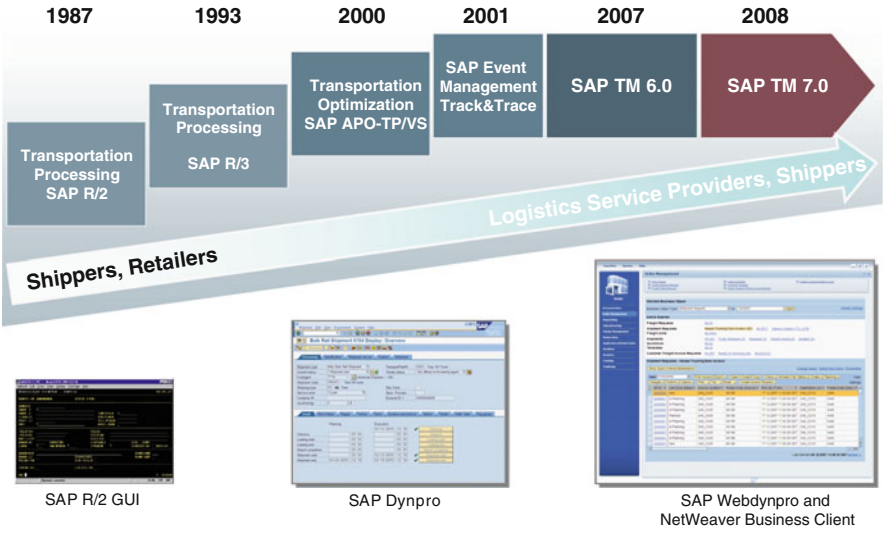


Fig. 2.3 History of transportation solutions in SAP

2.2.1 Subprocesses and Components of SAP Transportation Solutions

An overview of the transportation solution components is illustrated in Fig. 2.4. It shows how the components and individual subprocesses are integrated to enable transportation processing.

The main components of this transportation solution include:

- **SAP ERP: Sales and Distribution (SD) and Logistics Execution System (LES) for sales orders and delivery**
  The sales order (see Volume 1, Chap. 6, "Distribution Logistics") represents the starting point for the outgoing transport demands of a shipper. The goods purchased by a customer stemming from one or more points of departure generate the transport or individual shipment requirements. These individual requirements are defined in the deliveries that are put together based on the sales order.
- **SAP ERP: Materials Management (MM) and LES for purchase orders, stock transport orders and incoming deliveries**
  The purchase order (see Volume 1,, Chap. 4, "Procurement Logistics") is the source document for the transport demand of a shipper, in which the goods to be procured are defined along with their procurement locations. A purchase order can lead to deliveries, which then represent the individual shipment

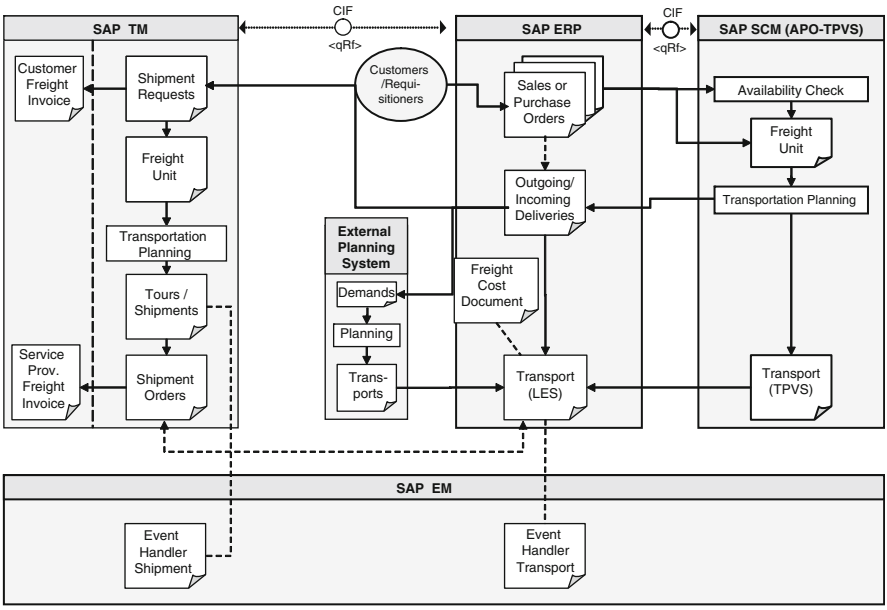


Fig. 2.4 Overview of SAP transportation components and their integration

requirements. Stock transfer orders (see Volume 1,, Chap. 4, "Procurement Logistics") between plants are a special type of order. In SAP ERP, they are treated similarly to a normal order, with the single exception that, in addition to an incoming delivery, an outgoing delivery is also generated, which represents the outgoing side from the stock view.

- **SAP ERP: Logistics Execution System (LES) for shipment and freight cost documents**
  The ERP shipment document and corresponding freight cost document are planning, execution and billing documents for transportation processing. With the component *Logistics Execution System*, you can create shipments and transportation chains, consolidate deliveries either manually or in a rule-based way, and document the process. Shipping costs can be calculated here as service provider costs from the shipper view and can be invoiced. In the customer order, you have the opportunity to access transport costs and pass them on to the customer in the normal invoice of that particular order.
- **SAP APO: global Available-to-Promise (gATP)**
  The global Available-to-Promise (see Volume 1, Chap. 6, "Distribution Logistics") in the APO system supports sales order processing by determining the best source for the materials ordered by a customer (sourcing). A customer's requested delivery dates, as well as shipping times, available and reserved material quantities, and available material alternatives, are also taken into consideration. SAM SCM 5.0 and later releases include this global availability check in APO Transportation Planning, where you can consult a detailed transportation plan to schedule shipments.
- **SAP APO: Transportation Planning/Vehicle Scheduling (TP/VS)**
  APO Transportation Planning is an optimization tool for transportation planning that consists of several subcomponents. Transport demands are sent to the optimizer along with information on the utilized transportation network and existing vehicle resources. The optimizer calculates an optimal cost solution for the respective transport demands: Routes with consolidated transport demands are generated and are executed using the most economical resources. Via the service provider selection, you can find the best service provider(s), which can be determined according to a variety of criteria (price, allocation, quality, preference, etc.)You then have the opportunity to conduct a service provider bid invitation to confirm the selection.
- **SAP Transportation Management (SAP TM)**
  SAP TM is a complete solution for the processing of transportation processes as a logistics service provider or shipper. It offers comprehensive functions for quotation and order management, transportation planning, posting, route determination and subcontracting to service providers or internal organizations. In addition, flexible functions are integrated for transportation cost calculation for the sale and purchase of transportation services, and for the calculation of internal transportation costs. Integration with SAP ERP (FI/CO) is available as a standard feature for billing customer and service provider freight costs.

- **SAP Event Management**
  SAP Event Management (see Chap. 5, "Controlling and Reporting") is a universal and very flexible tool that supports all types of visibility and status tracking processes (Tracking & Tracing: Shipment Tracking). It enables you to record performance data on your own and your partners' processes and thus generate a performance evaluation in connection with SAP NetWeaver BW.
  SAP Event Management is integrated with ERP transportation processing as well as SAP TM, and a variety of standard tracking scenarios are configured.
- **Special components for particular industries**
  Within the framework of the SAP portfolio, you can use further components for special industrial requirements that are not depicted in Fig. 2.4. These components include:
  - *SAP Oil & Gas Traders and Schedulers Workbench* (TSW) to plan and execute tanker transports while especially considering the raw material sale of in-transit stock.
  - *SAP Oil & Gas Transportation and Distribution* (TD) for the processing of bulk commodity transports in the downstream realm (such as for the supply of gas stations). Meter readings, temperature-dependent volume changes of bulk commodities and the compatibility of previous and subsequent tank loads are among the elements taken into account.
  - *SAP Rail Car Management* (RCM) for the processing of rail transports with a company's or a railway's freight cars. RCM, which is used by several companies in the chemical industry, is based on SAP Event Management, which it uses for freight car tracking. In addition, you can plan and execute the individual activities of the cars and manage your own loading railway stations and marshaling yards with *Onsite Event Management* (OSEM).

The number of resulting solutions is a direct reflection of the diversity of the transportation industry.

2.2.2 Transportation Processing Scenarios and Their Integration in Procurement and Distribution Logistics

Using the subcomponents and processes mentioned above, you can select various approaches for transportation processing with SAP. Each of these approaches offers a basic transport functionality that can be tailored through add-ons and integration mechanisms and is thus especially suited to support the demands of its respective user groups. The following rough guidelines can aid in the selection of the transportation solutions, described subsequently in more detail:

- **Traditional transportation processing for shippers (SAP ERP, Logistics Execution System)**
  Production or commercial enterprises with general transport demands that do not need complex strategies for source determination or availability check processes involved in transportation planning.
- **Traditional transportation processing with add-ons (SAP APO Transportation Planning and Service Provider Selection)**
  Production and commercial enterprises that have increased demands on transportation planning and optimization or service provider selection and bid invitation processes, but do not require the integration of an availability check.
- **Shipper solution with global availability check and transportation optimization (SAP APO-TP/VS)**
  Production and commercial enterprises for whom optimal transportation processing and minimized transport costs play a great role and for whom transportation is strongly dependent upon source determination and the availability of goods. This is especially true where issues such as material substitution or decisions regarding international source determination and supply sources are of great importance.
- **Traditional shipper solution with support by SAP TM**
  Production or commercial enterprises that already use the traditional SAP shipper solution for transportation processing can use this variant when transitioning to a new SAP TM system. The sales order integration with freight cost billing has been preserved, but transportation planning is transferred to the much more powerful TM system. Processing of transports can either be done in SAP ERP or directly in SAP TM.
- **Shipper solution with service provider reference (SAP TM in combination with SAP ERP Distribution Logistics)**
  Production or commercial enterprises where transportation processing is a multidepartmental or outsourced function. Such companies often have their own transportation departments that receive transport demands from several company divisions (or, under certain circumstances, from various ERP systems). However, the processing of these requirements should be consolidated to keep costs down. The transport departments often serve as a transportation service provider within the company.
- **Transportation service provider solution (SAP TM in combination with SAP ERP Financials)**
  Transportation service providers who sell transportation as a service to other companies and purchase transportation services from other companies (carriers).

  Now we will take a closer look at these transportation solutions.

2.2.2.1 Traditional Transportation Processing for Shippers (SAP ERP, Logistics Execution System)

The traditional SAP transportation solution for shippers, used by more than 2,000 SAP customers around the world, is transportation processing with the SAP ERP

component *Logistics Execution System*. It supports the shipments of outgoing goods, goods to be picked up and to be transferred. Figure 2.5 provides an overview of this transportation solution. The standard process for sold goods begins with an order initiated by the customer (see ❶ in Fig. 2.5). The customer order documents the goods sold that are to be transported and have to be delivered from one or more plants. Based on the customer order, one or more deliveries are generated (Distribution/Shipping) ❷. Through manual or rule-based planning, you can then put together shipments that contain one or more deliveries. You can also consolidate deliveries from various plants. To map long-haul transports, you have the opportunity to create individual shipment documents for pre-carriage, main and on-carriage legs, each of which reflects different legs of the same delivery. For each shipment document, you can create an *event handler* in SAP Event Management that enables tracking of the shipment ❸. With reference to the data cited in the shipment document and the indicated delivery dates, you can create a freight cost document and calculate the freight charges to be paid to the service provider ❹.

The sales price calculation based on the sales order for a material and the subsequently generated invoice can include the conditions used for the freight charges. This allows you to pass the charges paid to the transportation service

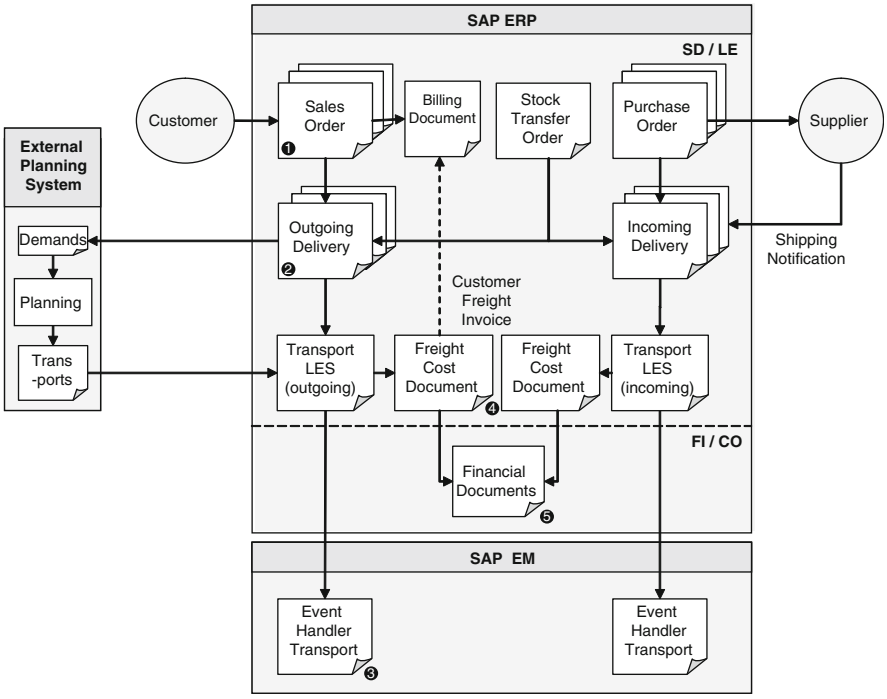


Fig. 2.5 SAP ERP transportation processes for sales orders and purchase orders

provider on to the customer. You can then use the freight cost document to trigger the transfer of the service provider costs to Financial Accounting, including the accrual of reserves ❺.

The process described above is the same for incoming deliveries whose transport demands result from purchase orders; in this case, charging the customer with freight costs is not possible. For an order initiated from within your company that is sent to a supplier, one or more deliveries are generated. Each incoming delivery can be organized into shipments in the same way as outgoing deliveries.

Special case when forming shipments with ERP Shipment Processing. Please note that for transportation processing using the component *Logistics Execution System* it is not possible to consolidate incoming and outgoing deliveries into a single shipment. A shipment is thus always *only in one direction*. If both incoming and outgoing deliveries must be planned, you need to create separate shipments for them.

Stock transfer orders between plants are created as a special type of order. From these stock transfer orders, outgoing deliveries are generated from the issuing plant on the goods issue side, and incoming deliveries to the receiving plant on the goods receipt side. Because the shipment is often necessarily based on the transport demand of the issuing side, stock transfer order shipments are created on the basis of outgoing deliveries. They can be consolidated with normal outgoing deliveries into a single shipment, but not with incoming deliveries. In the case of stock transfer orders, there is no customer invoicing of freight costs.

2.2.2.1 Traditional Transportation Processing with Add-Ons (External Transportation Planning System or Bid Tendering Function)

Transportation processing in SAP ERP offers you the options of manual or rule-based transportation planning. Optimization with regard to the shortest route, the best vehicle utilization or the lowest costs is not possible. To achieve such optimization, you can link to an external planning system via a *standard interface for external transportation systems* (SD-TPS) (see Fig. 2.5). Outgoing and incoming deliveries are divided according to a selection process based on preset rules or several specialized, external transportation planning systems. For instance, it is possible to link a planning system for road transport in Germany and a planning system for Europe-wide rail transport and supply them with the respective delivery documents. The shipments planned – and, depending on functionality, optimized – in the external planning systems are then sent back to ERP Shipment Processing, where they trigger the respective shipment documents. You can determine whether the external planning system should maintain the planning authority over the shipments from that point on or whether they are allowed to be edited in ERP

Shipment Processing. A resynchronization of changes made in the ERP system does not take place.

2.2.2.2 Traditional Shipper Solution with Extended Tendering Function

Another add-on to the traditional shipper solution for transportation processing with SAP ERP is the linkage of SAP TM with the use of the new service provider selection and bid tendering functions. Shipments that have been planned in the ERP system are tendered to a "pseudo" service provider, supplied by SAP TM, via the bid tendering interface. Shipment and freight orders as well as routes and freight units are created in Transportation Management based on the ERP shipments (see Fig. 2.6).

You can now use the service provider selection in SAP TM in order to determine the best service providers. You can then use the new tendering functions in SAP TM to conduct either sequential, simultaneous or open tendering. SAP Event Management controls the tendering process and, if necessary, the required reactions when a tendering deadline has been reached. In the case of a positive response to a tender, the respective shipment and freight orders are synchronized back into the ERP shipping documents.

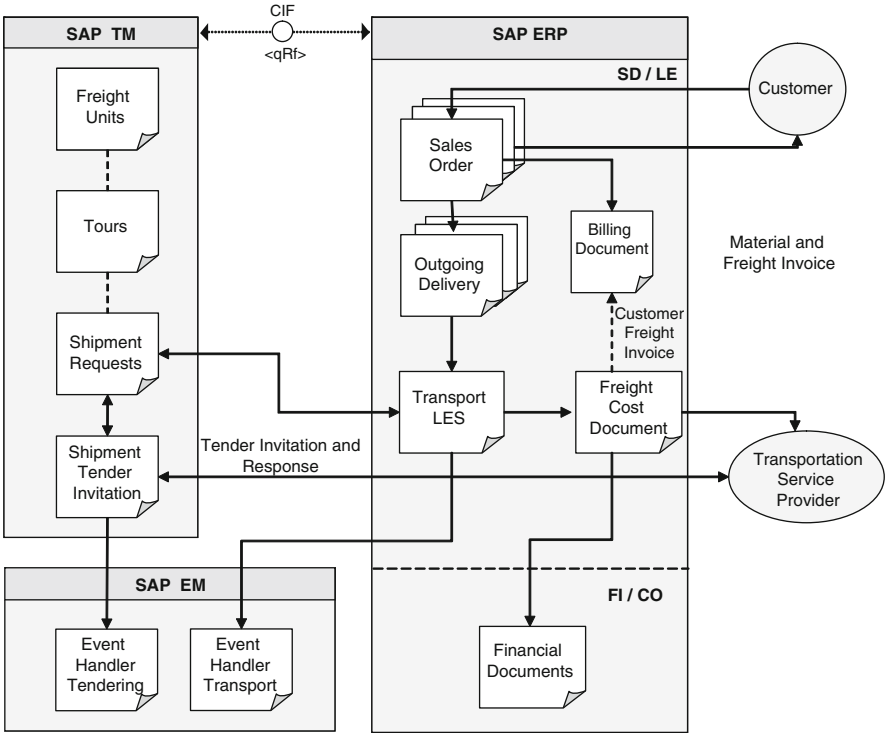


Fig. 2.6 SAP ERP shipment processing with tendering via SAP TM

2.2.2.3 Shipper Solution with the Global Available-to-Promise (ATP) Availability Check and Transportation Optimization (SAP APO-TP/VS)

If a shipping company has high demands with regard to transportation optimization and close integration with source determination and global availability, a transportation solution can be employed from SAP ERP Logistics and SAP APO. This solution can be used for purchasing- as well as sales-based processes. Figure 2.7 shows an overview of the process flow for the sales and distribution process.

Based on the *sales order*, a global Available-to-Promise (ATP), or availability check, is performed in the APO system. Within the context of this availability check, freight units can be generated with the *Routing Guide*, which can then either be scheduled forward or backward. The schedule determined by the availability check is then transferred back into the sales order. The planning remains in the APO system as a temporary plan until the sales order is saved. When it is saved, the temporary transportation plan is saved along with it. Based on this plan, a service provider selection and tendering process can be performed. Subsequently, outgoing deliveries and shipment documents are generated in the ERP system. Actual processing is performed on the basis of the ERP shipment documents.

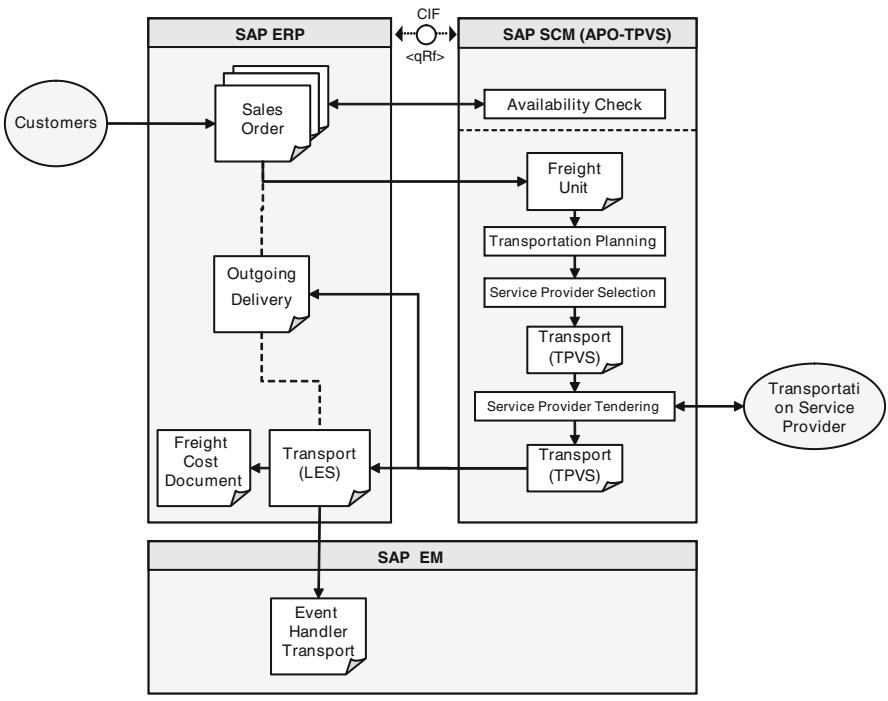


Fig. 2.7 Transportation process with SAP APO for sales order processing

Just as in the traditional shipper solution, you can also calculate and pay service provider costs and pass them on to the customer.

2.2.2.4 Traditional Shipper Solution with SAP TM Support

If a company is already employing the traditional SAP ERP transportation solution and is considering the transition to the new SAP TM, there is the possibility of doing so incrementally by transferring functions such as shipment planning to the SAP TM systems. Figure 2.8 shows the process.

Sales and purchase order processing and the creation of deliveries are conducted in the component *Sales and Distribution* (SD). The generated incoming and outgoing deliveries are then communicated as transport demands via the service interface to the TM system. In SAP TM, transportation planning and optimization, route determination, delivery creation and finally the creation of delivery and freight orders are performed. The freight orders are then sent back to the ERP system via the service interface, where they generate shipment documents. Transportation processing ultimately takes place in the *Logistics Execution System*, where freight cost calculation and customer freight billing are generated.

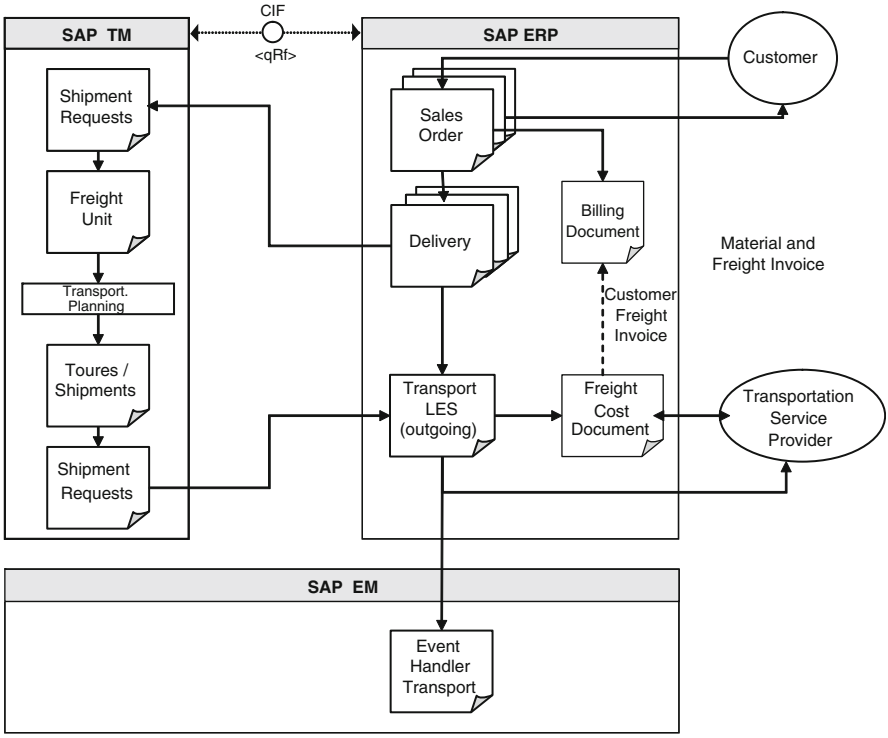


Fig. 2.8 SAP ERP transportation processing with SAP TM as a planning tool

2.2.2.5 Shipper Solution with Service Provider Reference (SAP TM in Combination with SAP ERP Logistics)

A shipping company with an outsourced transportation planning department generally requires transportation functionality that enables cross-ERP system transportation planning or has a strong relationship with a service provider. The transport demands can be generated in various systems, depending on the business area, such as in several ERP systems in which distribution logistics is processed separately. If a reduction in costs is targeted through a consolidation of transport demands from various systems, it is not possible with the traditional shipper solution, because the shipments created there each require references to delivery documents that are distributed among several systems.

Here, *Transportation Allocation* is generally used when processing is done through SAP TM. Sales orders, purchase orders and delivery documents are generated in several systems and sent to SAP TM via the service interface (see Fig. 2.9). In contrast to the previously described solution, the shipment and freight orders created no longer need to be sent back to the ERP system. This would

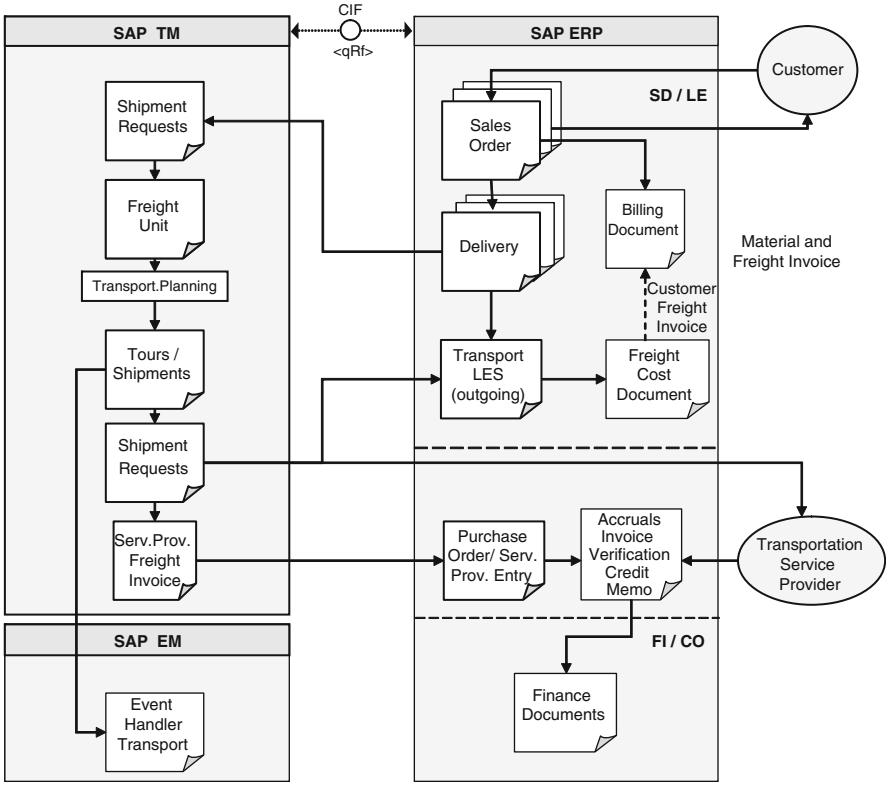


Fig. 2.9 Transportation processing for shippers with SAP TM and SAP ERP as the order processing system

only be done for purposes of customer freight calculation. However, freight cost calculation in SAP TM and SAP ERP must be done separately.

All steps in transportation planning, allocation and processing are then executed in SAP TM, whose flexible planning and freight cost tools offer a higher performance level than those of SAP ERP. Shipment tracking in this case is also accomplished via integration of the SAP TM business object "Shipment" with the respective event handler in SAP Event Management.

2.2.2.6 Transportation Service Provider Solution (SAP TM in Combination with SAP ERP Financials)

Transportation service providers who execute logistics for other companies can utilize a solution based on SAP TM that offers a flexible basis upon which to map their processes. Unlike transportation processing with SAP ERP, SAP TM does not require a reference to delivery documents or material master records, but rather can be employed for the entire transportation processing independent of master records and sales and distribution processing. The basic procedure is illustrated in Fig. 2.10.

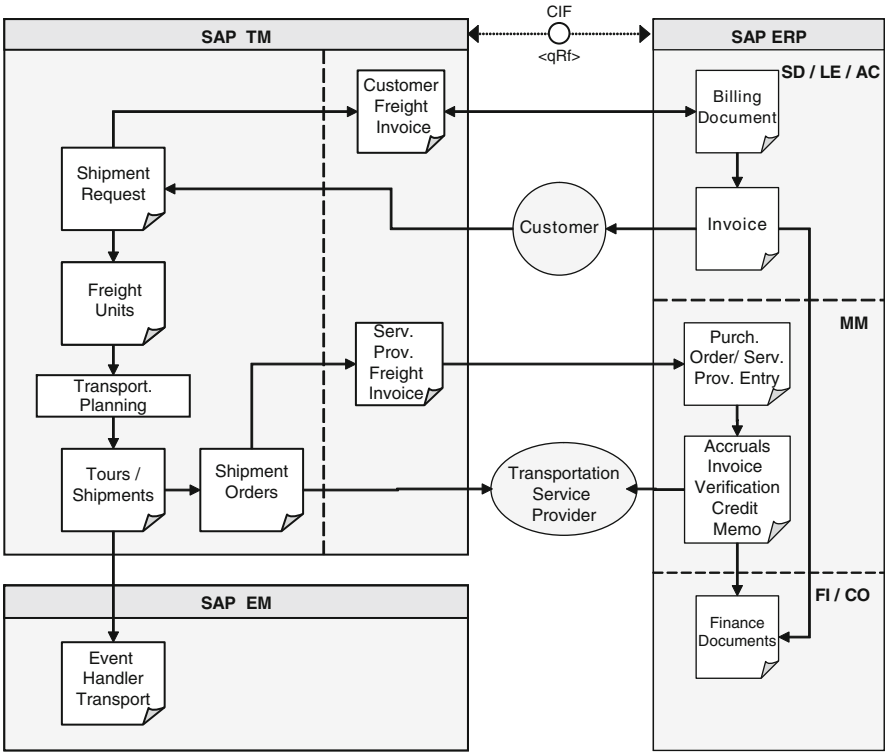


Fig. 2.10 Transportation management process with SAP TM

The transport demand is transferred directly by the customer as a transport request and made into a *shipment request*. Based on this, freight units are assembled that are consolidated, routed and scheduled in Transportation Planning. After optimized or manual planning, tours and shipments are formed that ultimately culminate in shipment orders, which are used to subcontract jobs to additional service providers and freight carriers.

Based on shipment requests, which also contain cost segments for the invoicing of services, customer freight invoice requests can also be created. They can be printed as pro-forma invoices as well as transferred to Billing in the ERP system, where customer invoices are generated and data is transferred to Financial Accounting.

The *shipment orders* form the basis from which you can create service provider freight invoice requests, which, once transferred to the ERP system, generate service provider orders and data sheets. Via accounting integration, you can then check incoming service provider invoices or, using the credit procedure, pay the invoiced amounts.

2.3 Master Data in Transport Logistics

The master data used in transportation processing can be divided into four types, which cover the following aspects of logistics information:

- **Business partner master data**
  Business partner master data defines the business partners that are directly or indirectly involved in the transport process. Examples include shippers, ship-to parties, sold-to parties, bill-to parties, customs agents and carriers.
- **Material master data**
  Material master data either defines the goods to be transported in a more or less detailed or categorized form, or, in the case of logistics service providers, maps shipping containers or services. Examples for data categories would be Yowai XVR-2030 video recorders, automobile chassis parts, 20-ft standard containers and 24-h delivery service.
- **Organizational master data**
  Using organizational master data, the units of a transportation or distribution organization can be defined. In the case of a shipper, they can be relatively simple (only one transport allocation organization), but in the case of a logistics service provider, they can get very complex (several business areas, national organizations, sales offices, distribution channels, etc.).
- **Transportation network master data and resources**
  Transportation network master data includes information about pick-up, delivery and load transfer points, about the connections between these points that can

be used as transport routes, and about transport means (resources) that travel between these points and can move goods.

One could consider freight cost data (such as installment tables) as a fifth type of master data. However, they are only treated as application data here. Table 2.1 lists the master data and their system applications, of which there are three types:

- **Obligatory**
  The *obligatory* use of master data means that transportation processing cannot be carried out without the respective master data.
- **Recommended**
  A *recommended* use indicates that the transportation process is significantly easier and more consistent with the respective master data. One example would be the use of customer master data in connection with ERP invoicing from the SAP TM system.
- **Optional**
  An *optional* usage means that this master data is integrated into the process in a reasonable manner, yet must only be used as needed.

The SCM master data listed in Table 2.1 is a technical component of SAP SCM and serves as the basis for APO Transportation Planning (TP/VS) as well as for SAP TM. Although the data is used by both systems, SAP TM exhibits more comprehensive functionality. Master data integration between ERP and SCM is accomplished via the CIF (Core Interface; for more information, see Volume 1, Chap. 3, "Organizational Structures and Master Data").

Table 2.1 Master data in transportation and its use in transportation solutions (use: ● obligatory, ◉ recommended, ○ optional)

Master data entity	Type	System	Transportation solution		
			ERP	TM	TP/VS
Customer, vendor	Partner	ERP	●	◉	●
Vendor	Partner	ERP	●	◉	●
Material	Material	ERP	●	○	●
Packaging material	Material	ERP	○		
Route, leg	Network	ERP	●		
Plant, warehouse location	Network	ERP	●		●
Shipping point	Network	ERP	●		●
Transport allocation point	Organization	ERP	●		●
Freight conditions	Costs	ERP	●		
Business partner	Partner	SCM		◉	
Location	Network	SCM		●	●
Product	Material	SCM		○	●
Resource	Network	SCM		○	●
Timetable	Network	SCM		○	

2.3.1 Customers and Vendors in SAP ERP

The significance of *customers* and *vendors* in SAP ERP was discussed in detail in Volume 1, Chap. 3, "Organizational Structures and Master Data"; Chap. 4, "Procurement Logistics"; and Chap. 6, "Distribution Logistics". For this reason, we will only refer to their transport-specific aspects here.

In transportation processing, customers can take on several roles. They are predefined in the ERP customer master as *partner roles*. You can expand these partner roles via Customizing settings. A customer, for instance, used in a transport process can serve as a sold-to party (who places an order that triggers a transport demand), a ship-to party, bill-to party or payer. Customer master maintenance enables you to maintain the necessary data for every role a customer has. A ship-to party does not require bank transfer data, and you need not keep shipping information for a payer. Important information that you can define in the customer master includes:

- Address information including international versions
- Payment transaction and bank transfer information
- Customer unloading points
- Export data
- Contact person

The address information and unloading points are significant to actual transportation allocation, the contact person and export data are used in the realm of logistics processing, and payment information is used for invoicing.

By defining partner roles in the customer master, you can establish a relationship between various customer master records. For instance, Sold-To Party A (the branch office of a car dealer in Chicago) can submit an order to be delivered to Ship-To Party B (a repair shop in St. Louis), yet have the invoice sent to the head office in Detroit (Bill-To Party C), which is ultimately paid by Payer D.

In the ERP system, you can allocate customers to various sales areas. This function is used for shipper processing in which a specific customer is served by a certain part of the sales organization. However, this data is not transferred to the SCM system. You can also save other shipping-specific attributes of a customer in the sales-related data, such as delivery priority and delivering plant.

Vendors can primarily take on two functions in transportation processing. To categorize vendors in one or both functions, you have to allocate them to an account group:

- **Transportation service provider**
  You can not only allocate freight forwarders and shipping companies to transportation service providers, but also customs agents, packing services, cleaning companies or other service providers in the transportation industry.
- **Supplier of goods**
  From a logistics standpoint, suppliers of goods mainly serve to determine the pick-up address for purchase orders and incoming deliveries.

The vendor master data functions similarly to the customer master data. Here, too, several views are available in which you can enter transport-related data.

2.3.2 Plants, Storage Locations, Shipping Points and Loading Points in SAP ERP

Plants, storage locations, shipping points and loading points form the logistical structure of a company in SAP ERP (see also Volume 1, Chap. 3, "Organizational Structures and Master Data"):

- **Plant, storage location**
  Organizational unit of logistics that categorizes a company in the views Production, Procurement, Maintenance and Planning. In a plant, materials are produced and/or goods and services are provided.
- **Shipping point, loading point**
  Organizational unit of logistics that executes shipping processing. Plants, shipping points and their subunits are technically not master data, but defined by SAP Customizing as basic organizational structures. Nevertheless, they are still considered master data from a logistics standpoint, and are matched in the same way as customers and vendors with the locations to be created in the SCM master data.

The primary characteristic of the organizational units mentioned here is their location, which is defined as an address and, in the case of a factory, is used for incoming and outgoing deliveries as a delivery or outflow address. In the case of a shipping point that is only used for outgoing deliveries, it is defined as the outflow location of a shipment. A further characteristic is the allocation to a plant calendar that defines the "active" work days. In the case of a shipping point, the respective loading and pick/pack time is also defined as a general, that is, material- and quantity-specific value.

2.3.3 Business Partners in SAP SCM

Business partners are organizations, companies and people that have a permanent or independent work or order relationship with a shipper or logistics service provider. The business partners defined in SAP SCM are used exclusively in SAP TM. For the default process, these business partners are automatically generated through master data transfer of customers and vendors from SAP ERP. Manual entry into SAP TM is thus only necessary in special cases.

In Table 2.1, you can see that SAP TM offers the opportunity to perform logistics processes to a large extent without the presence of business partner master data. However, a business partner master is practically essential for efficient billing and invoice management.

You can create business partner master records for business partners of the category *Customer* for a sold-to party, shipper and ship-to party of goods or for payers. Supplier-type business partners can be defined as forwarding agents, carriers, customs agents or operators of load transfer sites. The respective role is determined in the business partner master via the role definition function. You also have the option of assigning more than one role to a partner (for instance, "General Business Partner", "Financial Services Business Partner" and "Payer"). Figure 2.11 shows the respective entries for such a business partner.

For every general business partner, you can enter the following information:

- The main address of the business partner and additional addresses with notes (such as that it is a postal address or delivery address)
- Additional identification numbers to identify a business partner (such as the IATA agent code of an air freight service provider or Standard Carrier Alpha Code)
- Business hours and tax classification
- Information regarding payment transactions with bank transfer data and payment card information
- Status information and lock flags

Business partner for new customers. If you have to accept an order by telephone from a new customer for whom you do not yet have a business partner master record, you can create a special business partner as a new customer. You can then use it in a TM shipment order (shipment request) and

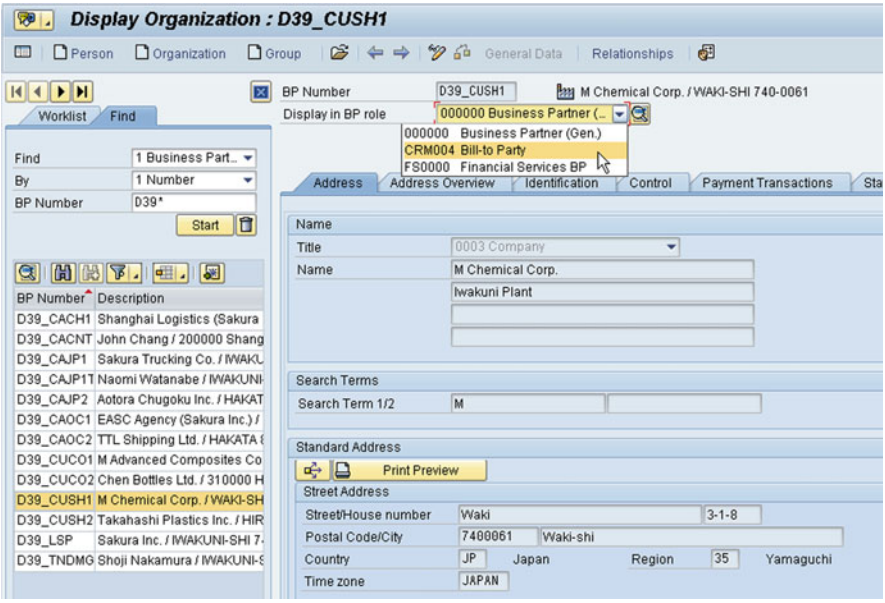


Fig. 2.11 Definition of a business partner SAP TM with several roles

provide it with the individual data from the order as a one-time address. After the new business partner is centrally generated and distributed, the partner *New Customer* can be easily replaced in the order.

2.3.3.1 Business Partner and Transportation Service Provider Profile for Vendors

Business partners that are defined as transportation service providers require additional, logistics-relevant attributes for efficient execution of transportation planning, allocation, tendering and subcontracting in SAP TM. These attributes define the authorization and service level of the service providers. You can maintain a *transportation service provider profile* with the following attributes for your business partners:

- Routes served in the transportation network
- Types of goods handled, product freight and transport groups
- Utilized/available transport equipment
- Fixed and dimension-based transport costs for transportation optimization

You can define an employee of a business partner as the type *Person*, as subordinate to a business partner. These employees are users in SAP TM for Internet collaboration in the transport bid tendering process.

If you maintain organizational units in SAP TM (see Sect. 2.3.8, "Organizational Data in SAP ERP and in SAP SCM"), a business partner of the type *Organizational Unit* is automatically generated for each unit. You can use these business partners directly in SAP TM to perform such tasks as recording the subcontract of a transportation job to a local company.

2.3.4 Materials in SAP ERP

From the shipper view, the material master data defined in SAP ERP includes the deliverable, producible and sellable goods that a transport demand can produce in a logistics process. The materials can be maintained here with their attributes and various quantities, and allocated to organizations.

In addition, you can define various types of transport materials and equipment in the material master (such as pallets, pallet cages and cardboard boxes), which can also represent transport demand through their use in packaging one or more other materials.

Packing hierarchy and transport demand. The actual transport demand can be created on various levels. If 9,600 bags of flour are to be sold and transported, the transport demand might look like this:

9,600 bags of flour, 960 cardboard boxes, each containing 10 bags of flour, 20 pallets of 48 cardboard boxes each or a 20-ft container with 20 pallets.

The bags and boxes of flour each represent their own sales quantity unit, and the pallets and containers are defined as packaging materials.

The basic characteristics of the material master were described in Volume 1, Chap. 4, "Procurement Logistics". In this chapter, we refer to their transport-specific attributes.

In addition to the obligatory definition of material number and description, you also have to define the *base unit of measure* (such as count, box or kilogram). Via the base unit, you can also define further quantity units with the conversion factors. The

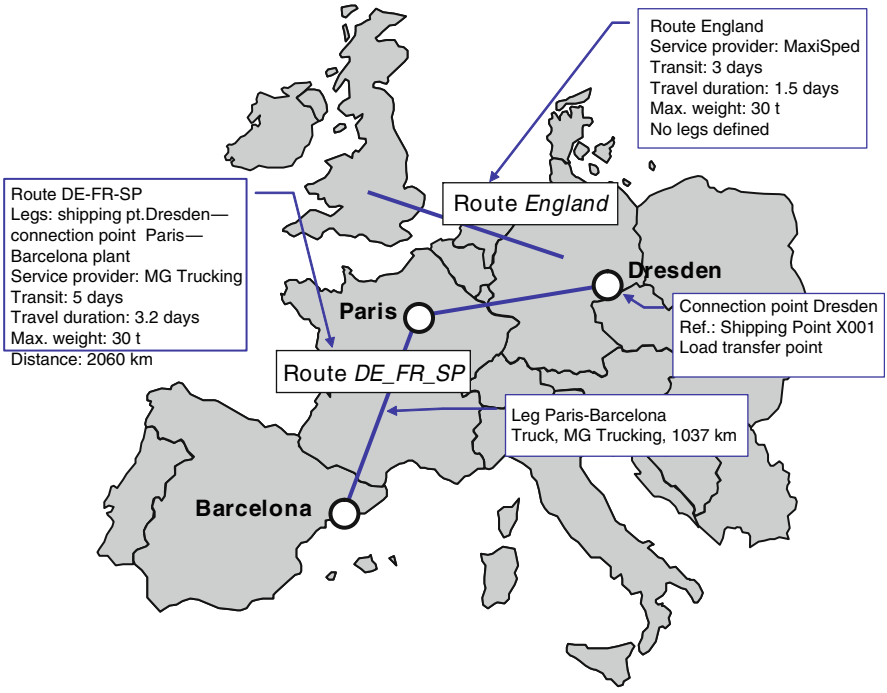


Fig. 2.12 Geographic elements of the transportation network in SAP ERP

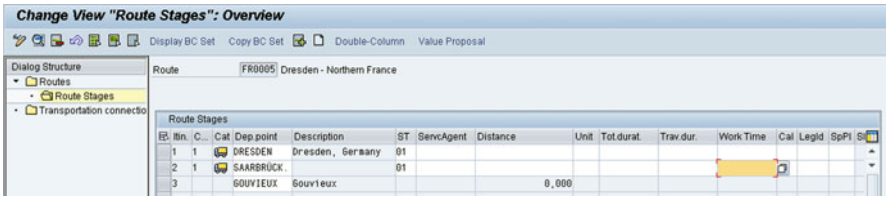


Fig. 2.13 Route definition in SAP ERP

indication of the gross and net weights as well as volume is especially important for logistics processing, because these values are taken into account for the capacity calculation of combined shipments. Volume refers to the volume occupied by a material during transport, not the net contents of a unit of material (for instance, a cardboard box with six 5-L canisters of a cleanser can have 40 L of volume). Fig. 2.14 shows the material master maintenance screen in SAP ERP

In the material master, there is also a *sales view* in which you can define the delivering plant and transportation group as transport-relevant attributes. The *transportation group* is a categorization criterion that allows you to categorize materials having the same defined processing conditions. Examples for values in the transportation group include *palleted goods*, *refrigerated goods* or *dairy products*.

If the material is classified as dangerous goods, you need to create a *dangerous goods master record* for transportation processing. The component *EHS Management* (Environment, Health, and Safety) in SAP ERP lets you save the necessary identifications and definitions for the various norms and carriers. Here, you can store dangerous goods classes and codes, material characteristics, rules for loading together, paper print definitions and other details for dangerous goods definition. A separate dangerous goods master record must be created for each material classified as a dangerous good.

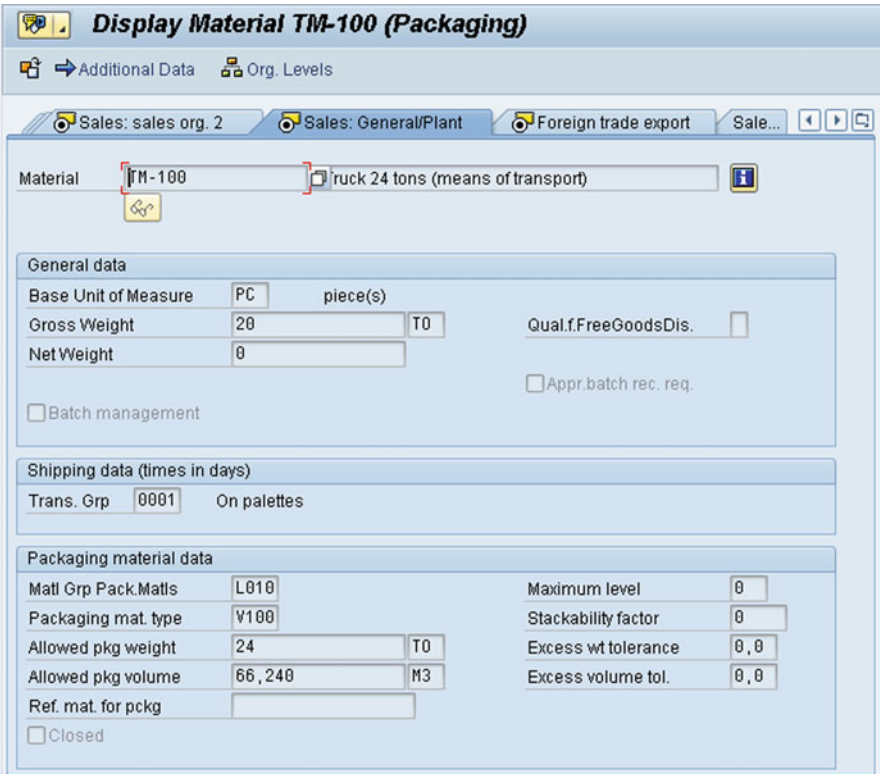


Fig. 2.14 Definition of a packaging material, in this case for a truck, 24 t

2.3.5 Products in SAP SCM

The *product master data* in SAP SCM, which is also be used by SAP TM, is of two basic types:

1. Product master data that maps precisely defined materials that are sold, purchased or transported in connection with a logistics agreement
2. Product master data that constitutes a classification or grouping of various materials or represents a service

The first type is generally used in shipper processing of transports (the exception being contract logistics), and is similar to the material master definition of the ERP system. It is employed in the traditional shipper solution and supported by APO Transportation Planning or SAP TM.

The second type is the product view of a logistics service provider, in which the situation regarding the product master is considerably more multifarious. You can only effectively use this type of product master when employing SAP TM as a service provider solution.

The following possibilities for using the product master exist:

- **Exactly defined products in contract logistics**
  The definition of the product is done the same way as in the shipper view.
- **Standard material types and material groups**
  Standard material types or groups defined by a company are used (for instance, a commodity code) to accurately group and classify products.
- **Categories of transport equipment**
  Products only represent the outer packaging of the materials being transported.
- **No product master representation**
  All goods to be transported are only recorded as text in the transport request; all load-specific and transport-relevant data is indicated directly in the order.

Transport service by a logistics service provider is often commissioned with reference to *standard material types* or *material groups* as product master records. Such grouping can be done in the necessary granularity (with three to eight digits), using such elements as the commodity or HS (harmonized system) code, UN hazardous materials number or other standards. The material group can be used to define generally valid characteristics for all shipments with reference to a particular material group (for example, freight group or description). Other data (such as weight) can only be depicted in a general way, and must be individually entered in the transport request.

In transport processes in which full loads are frequently requested and transported (as in container line operation or railway operation with full rail cars), the product master records are usually defined based on *transport equipment*. The content of the transport equipment is often only roughly specified and not precisely known at the time of the initial order. However, the type of transport equipment

must be precisely defined (for instance, a 20-ft standard container or a 67-ft, high-sided gondola). The order then only states the desired number of transport equipment products as the goods to be conveyed. More precise information on the nature of the transported goods is added at a later time.

2.3.6 *Transportation Network and Transport Equipment in SAP ERP*

The transportation network in SAP ERP is the basis for determining the transportation relevance of shipments and for route determination in ERP Transport. It consists of three major elements: routes, legs and transportation connection points.

The *route* is a fairly detailed, possible transportation route that can consist of one or more legs (see Fig. 2.12, Route *DE_FR_SP*), but which can also be defined without any geographic reference (see "Route *England*"). A route is characterized by its *route identification* and can contain the following attributes, among others:

- Transportation service provider that executes a route
- Shipping type along the route
- Transit duration (total duration including breaks), pure travel duration (not including breaks) and distance
- Permissible total weight
- For dangerous goods shipments, there is the option of including a transit country table.

Route definition without a geographic reference enables you to conduct a pure transit calculation for the shipment without referencing geographic circumstances. For instance, you can define a route called *North Atlantic* in which you define shipments from Europe to the United States with a transit time of 14 days. The ports of departure and arrival remain undefined. If you wish to define ports, you can create one or more legs for that route.

A *leg* is either a connection between two transportation connection points or an individual connection point via which a transportation activity is performed (such as customs clearance). For each leg of a route, you can define a section type (transportation, load transfer or border point), a shipping type, the distance, service provider, travel and transit times as well as details on freight cost relevance. Figure 2.13 shows you a sample route that follows part of Route *DE_FR_SP* from Fig. 2.12.

A *transportation connection point* is a place where goods are dispatched, received, transshipped or processed. Such processes can include activities like customs clearance or railway car cleaning. For each transportation connection point, you can define the type (e.g. load transfer point, airport or seaport), the responsible customs office, calendar and stopover time, as well as a reference to an

organizational unit (such as a plant or shipping point), a partner (customer or vendor) or any address.

Transport equipment is generated in SAP ERP as packaging materials (of the material type VERP). The packaging materials define the capacity and characteristics of the means of transport that will subsequently be used in a handling unit for a particular transaction.

2.3.7 Transportation Network and Resources in SAP SCM

The transportation network and resourcesare crucial for executing transportation options. A transportation network represents the geographic circumstances for the transportation of goods, and is modeled using locations, transportation lanes and transportation zones.

Executing a transport is done with one's own or third-party resources which move the goods between locations in a transportation network along transportation lanes. The following categories of *resources* are defined in SAP SCM: vehicles with capacity, tractor trucks, trailers, transportation units (containers, railway cars), and handling resources for goods movement to locations and drivers. *Itineraries*, which are a combination of transportation network and resource, are also significant. Figure 2.15 shows a schematic transportation network with the elements cited.

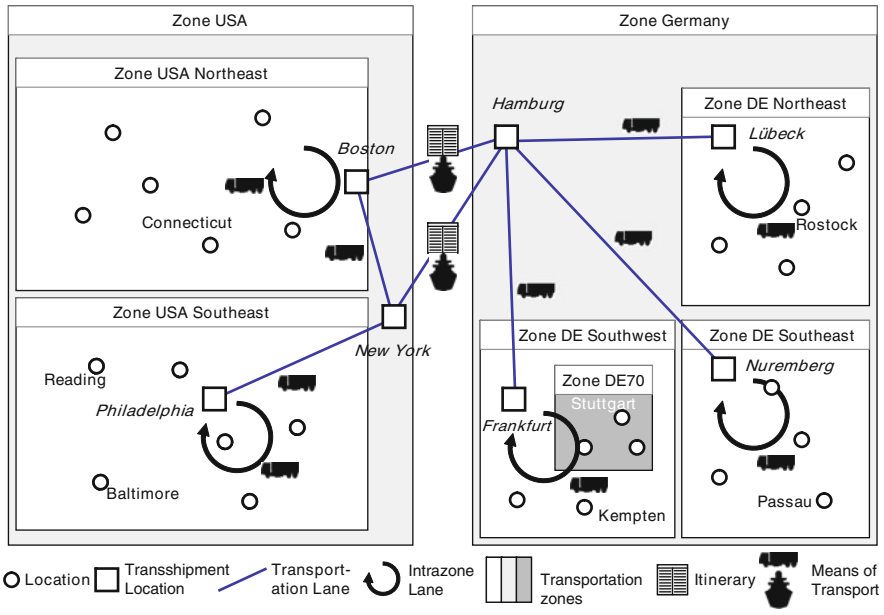


Fig. 2.15 Elements of a transportation network in SAP SCM

Locations are places in which goods are picked up, delivered or transshipped, or in which activities relating to the transportation process are performed (such as customs clearance). Each location is classified by its location type (for instance, a production plant, distribution center, customer, vendor or terminal). In addition to entering the description and address of a location, you have the option of entering further contact details and a reference to a relevant business partner.

A location possesses a *geolocation*, that is, geographic coordinates used by the transportation optimizer to calculate distances. You have the option of linking geocoding software with the SAP SCM system to enable the coordinates of created locations to be automatically determined with the added precision of the geocoder (for instance, down to the town or street number). You can use various geocoding software for a range of countries and regions to fit your transportation needs.

Other location attributes include:

- Minimal transshipment times at locations used for shipment scheduling
- Availability of handling resources such as the number of available forklifts at a hub to load and unload goods
- Alternative identification, with which you can also define the UNLOCODE or IATA airport code for the location

A transportation network generally includes several locations, which can be grouped into *transportation zones*. This is done to aid in the selection process, and to facilitate the definition of transportation lanes. There are three kinds of transportation zones:

- A *direct zone* can be allocated to explicit locations.
- A *postal code zone* contains all locations corresponding to the valid postal code areas of a particular country. You can define these zones with variability (such as ZIP 700xx-729xx and 750xx-753xx).
- A *region zone* is defined by entering a country and region, and contains all locations in that region.

A *mixed zone* is a combination of the above zone types. It is created by entering at least two different zone definitions.

For the selection process, it is possible to arrange the zones in a hierarchy. Figure 2.15 shows the postal code zone *DE-70* as a subzone of the regions *DE-Southwest,* which in turn is a subzone of *Germany*. This hierarchy enables you to process all loads from the areas of the city of Stuttgart, the state of Baden-Württemberg, or all of Germany.

Seen from the perspective of transportation planning, *transshipment locations* are special locations in which goods are allowed to be transshipped from one vehicle to another. A transshipment location can be defined for every location. As a rule, transshipment locations are distribution centers, ports, railway stations, airports or similar places where a change in transit carrier (such as from a truck to a ship) frequently takes place.

Transshipment locations enable the targeted guidance of the flow of goods via defined exit and entry locations. Figure 2.15 illustrates that goods transit from Germany to the United States is either processed through the ports of Hamburg and Boston or Hamburg and New York and that the pick-up and delivery traffic in the southwest of Germany is done through the distribution center in Frankfurt.

Transportation lanes define direct connections within a set of locations and zones. They can be defined between two locations (source and destination), a location and a transportation zone, or between two transportation zones. Important attributes of a transportation lane include a validity period, possible means of transport, duration and distance, cost parameters and data related to transportation service provider selection. Figure 2.15 shows an example of a transportation lane between a distribution center in Frankfurt and the port in Hamburg, and between the ports of Hamburg and Boston.

Of special significance are *intrazone lanes*. They refer to the reachability of a location within a zone from every other location. Thus, it is not necessary to create individual transportation lanes between pairs of locations within a zone; it suffices to define one intrazone lane. For instance, in the transportation network shown in Fig. 2.15, every location in southwestern Germany (within the zone *DE-Southwest*) can be reached by the Frankfurt distribution center. Goods coming from Hamburg, however, cannot reach Stuttgart directly, but must be transshipped in Frankfurt, since Hamburg does not lie in the zone *DE-Southwest*.

As in the case of locations, you can also use an external system to determine distances for transportation lanes. The distance and travel time of a transportation lane between source and location and the selected distance plant is then automatically determined using predefined location coordinates.

Itineraries indicates a predefined sequence of locations that serve as stops. They are used for regular water travel, train travel and in road traffic, such as for recurring trips in retail supply or regular main legs in system transit.

The heading *Resources* within the context of transportation planning in SAP SCM refers to all means of transport provided by a transportation capacity or the ability to move a loaded transportation capacity. Every resource has an identification number and a calendar that defines when it is not available (its downtime). *Downtimes* can occur due to such factors as maintenance or breaks. For transport equipment, you can also define attributes such as means of transport, registration number, owner, provided capacity (that is, how much can be loaded), consumed capacity (that is, how much is utilized when the resource itself is loaded onto another resource, such as when a container is loaded onto a truck), further equipment (loading cranes, accompanying forklifts) and a home location (supply chain unit). Via the means of transport, transportation lanes can be allocated.

Capacities can be maintained in a variety of dimensions, such as weight and volume capacities. Several nondimensional capacities can also be maintained, such as TEU (Twenty-foot Equivalent Unit for containers), loading meters and pallet storing position.

As we have already mentioned, the following types of resources are among the means of transport and transport equipment:

- **Vehicles with their own capacity**
  Vehicles with their own capacity are self-moving means of transport. Examples include a 40-t truck, a container ship, a freighter ship, a container ship with 5,390 TEU or a cargo-model Airbus 340.
- **Tractor trucks**
  Tractor trucks do not have their own loading capacity, but are capable of moving passive transportation capacities (such as trailers).
- **Trailers**
  Trailers have a transportation capacity (to the same extent as a vehicle resource), but they must be combined with a tractor to execute a shipment. If a trailer is available in transportation planning but not a tractor, the planning cannot produce a result.
- **Transportation unit**
  Transportation units (containers, railway cars), like trailers, have a capacity but cannot move autonomously. They have to be loaded onto a means of transport in order to execute a shipment.

Other types of resources include:

- **Handling resources for goods movement in locations**
  Handling resources provide goods movement capacities in a location. Examples include forklift operators, loading cranes, filling stations or traffic congestion workers. If, for example, only one forklift is available at a distribution center having 10 loading ramps, a bottleneck would automatically be created that needs to be considered during planning, since vehicles will have to wait longer for loading and unloading.
- **Drivers**
  Drivers can be allocated to a planned shipment as a resource. As attributes, they possess time availability and qualification credentials such as a driver's license or dangerous goods permits.

In order to further increase the flexibility of transportation resources, you can define *compartments* for every resource into which certain goods can be loaded, such as a truck with a dry and a refrigerated compartment or a tanker trailer with a diesel and a gasoline compartment.

You can create *vehicle combinations* from several means of transport and transport equipment elements. This would, for instance, enable you to combine certain tractor trucks and trailers, which are usually moved together.

You have the option of creating a *means of transport hierarchy*. Special means of transport can thus be made subordinate to generally defined means of transport. Since the characteristics of superior means of transport can be passed on to subordinate means of transport, a hierarchy can be useful for easy description of a transportation network. An example of a means of transport hierarchy would be a 12-t truck and a 40-t truck allocated to the superordinate means of transport "Truck." If you then allocate a transportation lane to "Truck," both 12 and 40-t trucks can be utilized without the need of further definitions.

2.3.8 Organizational Data in SAP ERP and in SAP SCM

The primary organizational element in the SAP ERP transportation solution is the *transportation planning point*. It is defined as an organizational unit of logistics that is responsible for the planning and execution of transportation activities. The transportation planning point organizes the responsibilities of a company into such categories as the type of shipment, carrier or according to regional departments. Thus, there can be a transportation planning point for New England or the Midwestern United States, or in other companies, for truck and ship transit. In addition to its function as a categorical and search criterion for shipment documents, the transportation planning point, via its company code assignment, enables logical allocation to the respective organizational areas in Accounting for freight cost invoicing.

Further organizational units in SAP ERP logistics, such as the sales organization or distribution channel, are only significant to sales and delivery processing, but are not utilized in ERP Transportation.

In SAP TM, the organizational structures are realized via *SAP Organizational Management*. It allows you to set up the organizational structure of your company in a flexible manner. In the simplest case, this means individual employees who perform various functions. In a larger enterprise or a logistics service provider, various organizational areas are needed:

- **Sales organization (logistics service provider-specific)**
  The sales organization structures the sale of logistics services and executes them. It can have several sales groups and sales offices as suborganizations. You can also allocate information to distribution channels and divisions. In SAP TM, the following processes, among others, are related to a sales organization:
  - Quotation generation
  - Order acceptance
  - Contracting of freight transit
  - Invoicing of sold freight services
- **Sales organization**
  The sales organization executes all sales procedures pertaining to logistics services of freight forwarders and carriers. It can have several purchasing groups. The following processes are among those related to sales organizations in SAP TM:
  - The sale and subcontracting of freight services
  - The purchase of freight capacity
  - Tendering of freight services
  - Contracting of freight purchasing
  - The settlement of purchased freight services

- **Planning and execution organization**
  The planning and execution organization arranges the planning and allocation of accepted shipping orders and the shipments to be transported, and performs any necessary activities or monitors them if they are subcontracted. The following procedures are related to planning and execution organization in SAP TM:
  - The distribution of regional and mode-specific planning responsibilities
  - MRP and transportation planning
  - The management of transportation resources

Figure 2.16 shows a comparison of these organizational structures with regard to transportation in SAP ERP and in SAP TM. APO Transportation Planning is a planning tool that is not dependent on an organizational definition.

Because no direct relationship to finance-related classification objects exists in SAP TM (such as to company codes, accounts or internal orders), for purposes of invoicing, organizational data is transferred to the ERP system or a connected account settlement system for financial allocation.

When SAP TM is used with SAP ERP as an account settlement system, you can set up analogous organizational systems in both systems to achieve a coherent categorization of sales and purchasing structures.

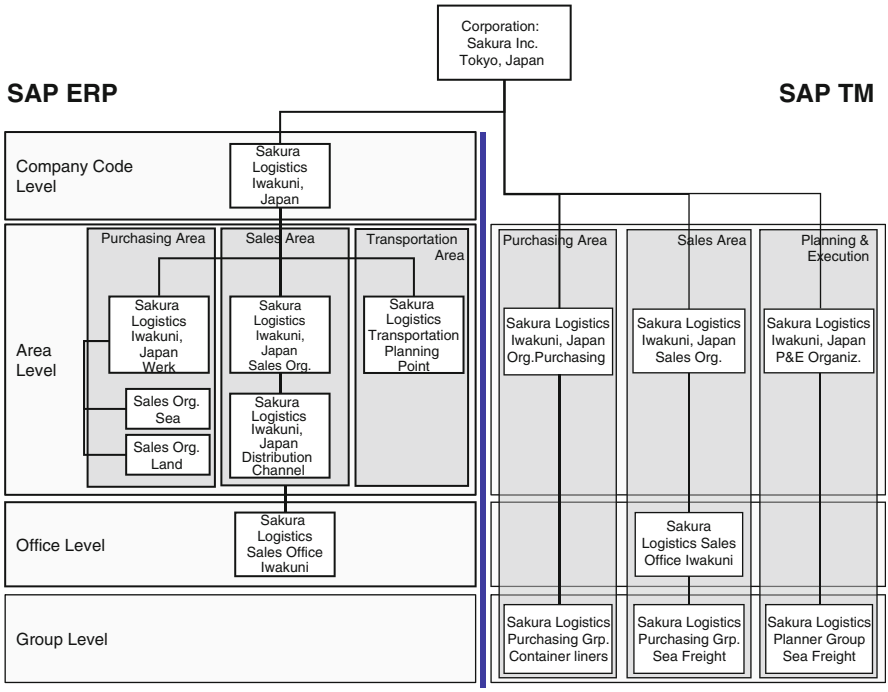


Fig. 2.16 Organizational structures in SAP ERP and in SAP TM

2.4 Transportation Management with SAP ERP

Transportation management in the SAP ERP Logistics Execution System (component LE-TRA) was developed as a traditional shipper solution primarily geared toward the transportation needs of SAP customers who also employ the modules for sales and distribution (SD) and procurement logistics (part of Materials Management, MM) (see Fig. 2.5).

Starting with sales orders in your Sales Department or purchase orders in Procurement Logistics, one or more delivery documents are generated that are to be allocated as transport demand. In ERP Transportation Management, you can now create one or more delivery documents that contain deliveries as shipments. SAP ERP planning tools can provide for efficient processing in this regard. Although optimized planning functionality is not a part of ERP Transportation Management, you can use external planning systems or SAP APO if optimization is desired. After transportation planning, you can create a freight cost document for every shipment document, which allows you to calculate and invoice service provider costs.

The main steps involved in SAP ERP Transportation Management include:

1. Determination of shipment types, carrier and means of transport
2. Execution of transportation planning and delivery allocation
3. Determination of transportation routes and stages
4. Planning of shipping dates
5. Determination of the forwarding agent, invitation of bids to and commissioning of forwarders
6. Definition of transportation packaging
7. Entering of transport details, texts and further partners
8. Printing of shipping and transfer documents
9. Posting of goods issue for shipments to be transported
10. Transmission of electronic notification regarding shipment
11. Determination and settlement of freight costs

All of these steps are possible with multiple modes of transport.

2.4.1 Types of Transportation Processing

In SAP ERP Transportation Management, you can process several types of shipments that are all supported by targeted transaction control functions. The most important types of transportation processing are:

- **Individual shipment with a single carrier as a direct carriage**
  A single shipment or set of shipments with the identical pick-up and delivery locations is transported by one vehicle directly from the pick-up location to the destination.

- **Consolidated shipment with a single carrier**
  Several shipments with various pick-up and destination locations are delivered with one vehicle in a sequence (delivery sequence) from their respective pick-up locations and delivered to their destinations.
- **Transportation chain with several carriers**
  One or more shipments are transported with several carriers sequentially (for example, truck – cargo ship – truck). Separate shipment documents are generated for each carrier, each of which displays the respective carriage identification (pre-carriage, main carriage and on-carriage). The transportation management system uses its process control to make sure a shipment is completely planned and allocated only when a seamless chain of individual shipments has been created in which that particular shipment is contained. Figure 2.17 shows such a transportation chain with two pre-carriages, two on-carriages and one common main carriage.
- **Empty run**
  A vehicle is transported empty from a source location to a destination.
- **Return shipment**
  Return shipment is a special type of processing for the transportation of return deliveries.

2.4.2 *Shipment Documents*

Shipment documents are frequently generated manually in SAP ERP. In every shipment document, there is a set of obligatory data that serves to control processes

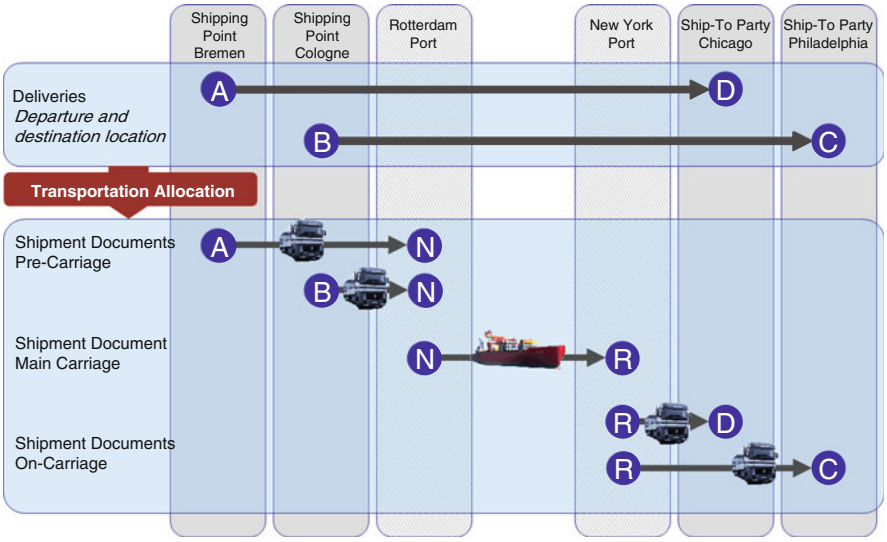


Fig. 2.17 Transportation chain with two pre-carriages, one main carriage and two on-carriages

and authorization behavior. The most important attributes that have to be defined when the document is created include:

- **Transportation planning point**
  Organizational unit responsible for the planning and processing of a shipment. The transportation planning point is allocated to a company code in the ERP system for cost accounting purposes.
- **Shipment type**
  Classification of the shipment with regard to carrier, means of transport and carriage identification (pre-carriage, main carriage, on-carriage and direct carriage). The shipment type as a central control attribute enables the following functions to be controlled in the shipment document, each of which can be configured in Customizing:
  - Number assignment for shipment documents (number range)
  - Text type definition, that is, what kinds of texts can be entered
  - Printed documents and electronic messages
  - The way to determine shipment stages (route determination), setting the way stages are adopted
  - The determination of attributes (such as individual or combined shipments)
  - Loading and packing functions

When you enter these two criteria, a new shipment document opens so that you can continue data entry. However, transportation planning points and means of transport cannot be subsequently changed. Figure 2.18 shows an overview of an ERP shipment document.

Important data that you can define and enter in the shipment document is explained below:

- **What is to be transported? – Shipment items (deliveries)**
  The shipment items are references to the deliveries to be allocated in the respective shipment. Each shipment must contain at least one delivery, otherwise it cannot be actively processed further. The delivery data is not copied directly into the shipment document, but rather read via a reference from the delivery. As such, for instance, the shipment weight will change if the weight of one of the contained deliveries changes. Each delivery can only be completely allocated to a shipment. Parts of deliveries cannot be allocated (see also Sect. 2.4.4, "Important Functions in the Shipment Document"). In such a case, a *delivery split* is necessary.
- **Along what route will the shipment run? – Transportation route and stages**
  The transportation route is an organizational criterion that describes the basic route of the shipment. It can be used for searches, for instance, to determine all shipments along a route in the next 3 days.The route can also provide information on the physical path if the route definition includes legs (see also Sect. 2.3.6, "Transportation Network and Transport Equipment in SAP ERP"). These legs are then assumed in the shipment as stages. Further stages can be defined, such

as for pick-up by the shipper or delivery to the goods recipient (see Fig. 2.19). In every stage, you can indicate the departure and destination location, shipping type, freight forwarder, distance and duration, as well as other data.

- **Who is shipping? – Freight forwarder**
  You can define a primary freight forwarder for the execution of a shipment on the overview screen. The forwarder must be defined as a supplier in the supplier master. Using the copying control, it is possible to copy a freight forwarder from a delivery document, if that delivery is allocated to a particular shipment. Depending on the forwarder selected, freight costs can be subsequently determined. A further use of the freight forwarder field is for tendering. Here, the freight forwarder serves as the recipient of bid invitation information and can either accept or decline the shipment job. For each shipment stage, you can indicate another forwarder for local performance.

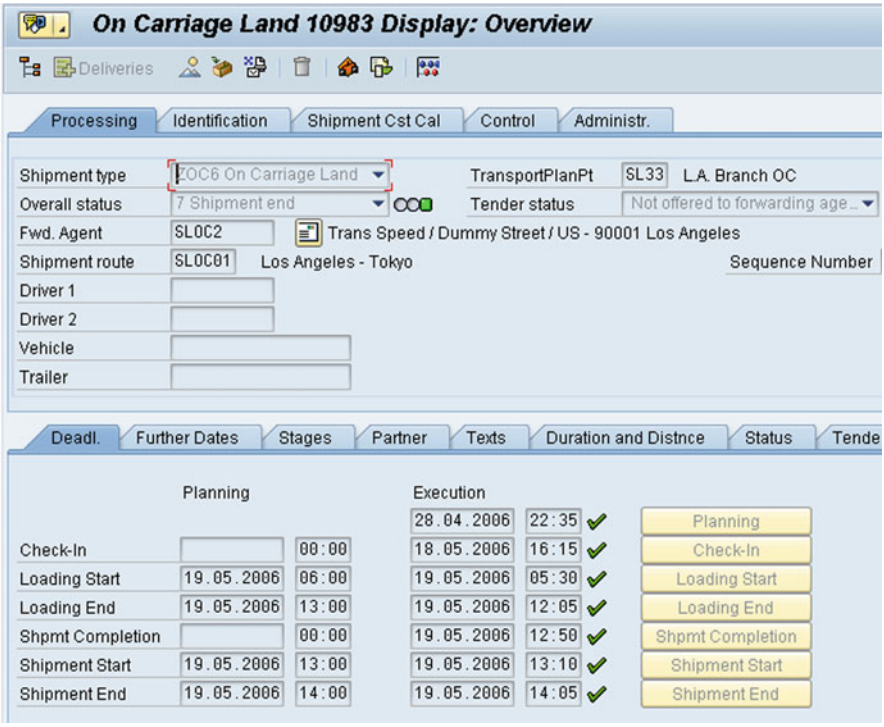


Fig. 2.18 Overview of a shipment document in the SAP ERP logistics execution system

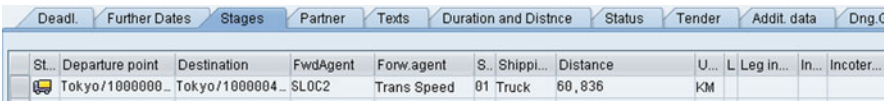


Fig. 2.19 Stages in an ERP shipment document

- **When is the shipment to be executed? – Dates**
  On the total shipment level (shipment header), you can define the planned dates and times for the following process steps:
  - Registration (arrival of the means of transport at the place of loading)
  - Loading start
  - Loading end
  - Shipment completion (departure of the loaded means of transport at the first place of loading)
  - Transportation start
  - Transportation end

  You can also enter free dates that can be used to schedule other process steps.
- **Where are we in the shipping process? – Shipment status**
  The shipment status values are closely related to the current dates on the header of the shipment document. The schedule information indicated also includes a space for a date and time in which you can document the current status by either entering data or pressing a button. This sets the current date as well as displays the shipment status (e.g. *Completed*). In addition to the seven dates named above, the Status area also shows the current *Planned* date. By defining the status as *Planned*, the shipment is set in the planning.

Shipment status "Planned". The shipment status *Planned* causes the shipment to become a fixed part of the transportation planning. This means you no longer have the opportunity to add or remove freight units from a shipment. In order to do so, you have to suspend the *Planned* status, which you can do with the simple push of a button.

- **With whom are we working? – Partners**
  The freight forwarder has already been named as the most important transportation business partner. In the Partner view of the shipment document, you can maintain further business partners, such as customs agents, cleaning agencies or packing service providers.

2.4.3 Transport Packaging

Similar to delivery processing, in transportation processing, you also have the option of defining packaging for the goods to be transported. This packaging can be simple or have multiple levels. In contrast to packaging in a delivery document, a shipment document allows you to assign packaging to more than one delivery, that is, several freight units can be assigned to a single transportation packaging.

Packaging in the shipment document is done as it is in the delivery document, with the aid of handling units (see Volume 1, Chap. 6, "Distribution Logistics", and Volume 2, Chap. 3, "Warehouse Logistics and Inventory Management"). If you

assign deliveries that are already packed (such as a delivery of three Euro-pallet handling units) to a shipment document, you will see the delivery handling units in the shipment document packing section and can pack these units further.

You can use transport equipment (such as pallets, sacks, crates, pallet cages or containers) as well as means of transport (like trucks, trailers, ships or railway cars) as transportation packaging. Depending on the packaging material types and capacities, you can then pack one into another.

2.4.4 Important Functions in the Shipment Document

In addition to editing the shipment document and its data, you can make use of helpful tools in ERP Transportation Management to support your processing efforts:

- Transportation planning
- Route determination
- Subsequent freight unit split
- Transportation tendering
- Freight cost estimation
- Shipment tracking
- Graphical shipment information system

For your transportation planning needs, you have access to a *planning list* with which you can freely select and allocate deliveries from a delivery due list for existing or new shipment documents (see Fig. 2.20). At that point or a later time, you can select criteria defined by you (such as all unplanned deliveries that must leave Hamburg for northern Germany the next day). In the Planning screen, you can create new shipment documents. The deliveries can either be individually or

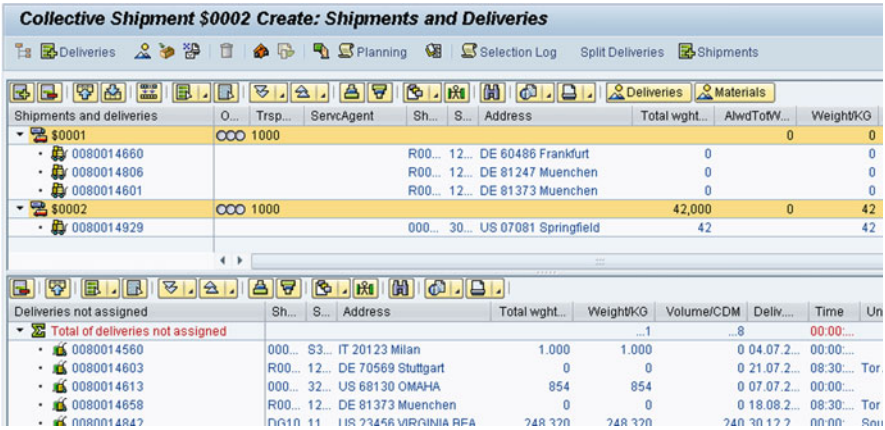


Fig. 2.20 Planning list with delivery allocations to shipments

collectively allocated to the shipment documents using the drag-and-drop function. For every individual shipment document, you can branch to its overview screen and edit details from there.

Interactive transportation planning. In Fig. 2.20, you can see an example of the interactive transportation planning screen. An existing shipment with a delivery was augmented by two other shipments ($0001, $0002), each of which has a delivery allocated to it. The temporary shipment numbers ($) indicate that documents have not yet been saved. In the delivery queue (in the illustration below), there are further deliveries that have not yet been planned.

Route determination is a function that you can start manually or automatically when the status *Planned* is set (see Fig. 2.21).

Starting with the details on the transport route and route determination settings in the shipment type, a route is generated according to the sequence of shipment stages. Subsequently, a stage sequence is generated that serves all pick-up locations

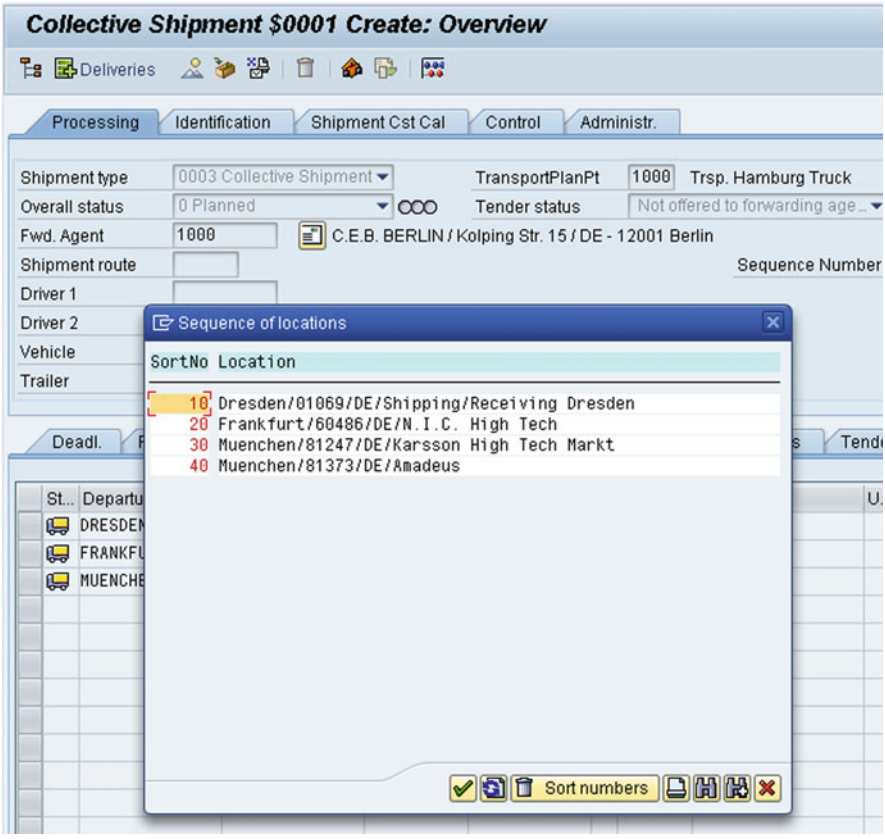


Fig. 2.21 Route determination in the ERP shipment document

before the route is begun. At the end of the route, further stages are added that lead to all ship-to parties. Following the route determination process, you have the opportunity to interactively alter the order of the stops along the route before the actual shipment stages are generated.

Route determination result. Figure 2.21 shows the result of route determination for a shipment of three deliveries (from Dresden to Frankfurt and Munich), for which no legs are defined.

Sometimes a vehicle cannot be loaded in such a way as planned in the transportation plan, because, for example, the dimensions of the vehicle or the load were incorrectly entered. In such a case, you can perform a subsequent freight unit split, to divide a partial delivery into a new freight unit. If, for instance, the rear door of a truck cannot be closed because the last two pallets are hanging out of the back of the truck by 5 cm, you can use the subsequent freight unit split function to reassign those pallets as a new delivery, to which you can allocate another shipment document. Then the two pallets can be unloaded. When the documents are printed out, you will then receive the correct shipping documents and the planning situation in the system corresponds to what has taken place.

Transportation tendering serves to obtain an offer from one or more freight forwarding agents. In order to perform the tendering process, the shipment document must indicate at least one stage and one defined freight forwarder, and have the status *Planned*. You can indicate the tender details and a target price in the tendering data. To determine a target price, you can use the freight cost estimation function, which you can access from the shipment overview screen. The freight cost estimation tool uses the shipment data to perform a cost estimation without, however, generating a freight cost document in the database (see Sect. 2.4.6, "Freight Cost Calculation"). Instead, the costs are temporarily calculated and presented as a decision-making aid in the context of the shipment document.

A bid invitation is then transmitted to the freight forwarder named in the shipment document header, either by sending a bid invitation message or placing it on a tendering portal, where the forwarder has direct access to the bid invitations directed at him. The forwarder can accept the bid invitation, accept it with alterations (such as an altered pick-up time) or reject it. He can also suggest a purchase price. The transportation planner can then check the tendering status in the ERP shipment document and either award the contract or send a bid invitation to another forwarder.

A *freight exchange* can also be used as a forwarding agent. This enables the transport demand to be placed on an open or closed marketplace for transportation services. If the offer is accepted by a forwarding agent or carrier on that market, that offer is assumed in the shipment document with the carrier's name, so that it is obvious who will perform the transport.

The ERP shipment document is linked to an event management process for the *tracking of shipments*. If a shipment document is created and given the status

Planned, the individual milestones and attributes of the shipment are transferred to Event Management, where they are used to generate an event handler. This event handler allows the status of the shipment to be tracked based on status messages that are transmitted via EDI, mobile device, the Internet or manual entry. The status messages can be viewed with a comparison of target/actual values in the tracking view of the shipment document. The standard process generates an event handler for the shipment and monitors all scheduled processing, departure and arrival dates of that shipment. If configured accordingly, you also have the option of tracking individual freight units or packaging units (such as pallets or containers) of the transport. More information on the topic of *Event Management* can be found in Chap. 5, "Controlling and Reporting".

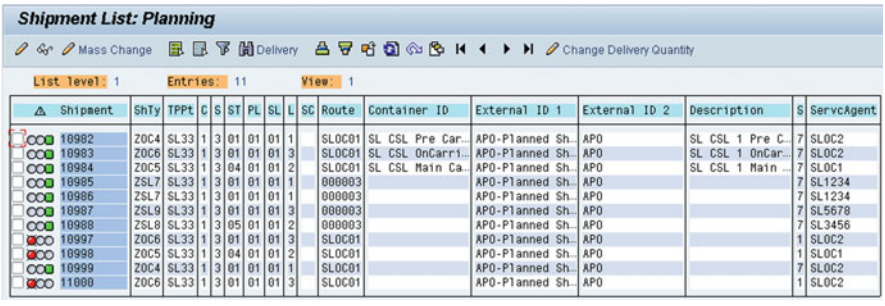
2.4.5 List Processing and Planning Functions

SAP ERP Transportation Management offers a selection of lists and collective functions to ensure an efficient overview and processability of your inventory of transport demands and shipment documents.

The transportation planning list (see Fig. 2.22) allows you to easily obtain an overview of all pending shipments possessing certain criteria. For example, it is possible to have the system display a list of all shipment documents that were generated the day before (date) from the Hamburg distribution center (departure location) as a road shipment (shipment type) but which have not yet been completely planned (do not have the status *Planned*). Using that work list, you can continue processing individual shipments in a targeted manner by following a link in the list that branches to the document editing screen. After editing a document, you can return to the list.

To enable more efficient transportation planning and allocation, you can employ the *transportation planning collective run*. Using it, you can select targeted transport demands (deliveries) for the collective run and configure it, thus automatically generating shipment documents. In addition to the generation of direct shipments, you can also create transportation chains.

The distribution of the transport demands to the individual shipments is done heuristically, and the system attempts to optimally utilize allocated maximum



Shipment	ShTy	TPPt	C	S	ST	PL	SL	L	SC	Route	Container ID	External ID 1	External ID 2	Description	S	ServcAgent
10982	ZOC4	SL33	1	3	01	01	01	1		SLOC01	SL CSL Pre Car...	APO-Planned Sh...	APO	SL CSL 1 Pre C...	7	SLOC2
10983	ZOC6	SL33	1	3	01	01	01	3		SLOC01	SL CSL OnCarri...	APO-Planned Sh...	APO	SL CSL 1 OnCar...	7	SLOC2
10984	ZOC5	SL33	1	3	04	01	01	2		SLOC01	SL CSL Main Ca...	APO-Planned Sh...	APO	SL CSL 1 Main ...	7	SLOC1
10985	ZSL7	SL33	1	3	01	01	01	1		000003		APO-Planned Sh...	APO		7	SL1234
10986	ZSL7	SL33	1	3	01	01	01	1		000003		APO-Planned Sh...	APO		7	SL1234
10987	ZSL9	SL33	1	3	01	01	01	3		000003		APO-Planned Sh...	APO		7	SL5678
10988	ZSL8	SL33	1	3	05	01	01	2		000003		APO-Planned Sh...	APO		7	SL3456
10997	ZOC6	SL33	1	3	01	01	01	3		SLOC01		APO-Planned Sh...	APO		1	SLOC2
10998	ZOC5	SL33	1	3	04	01	01	2		SLOC01		APO-Planned Sh...	APO		1	SLOC1
10999	ZOC4	SL33	1	3	01	01	01	1		SLOC01		APO-Planned Sh...	APO		7	SLOC2
11000	ZOC6	SL33	1	3	01	01	01	3		SLOC01		APO-Planned Sh...	APO		1	SLOC2

Fig. 2.22 SAP ERP transportation planning list

shipment amounts (such as truck load capacities). However, unlike in SAP TM, optimization does not place. The result of the collective run is presented in a report detailing the individual steps and results.

If you have created several shipment documents and need to make the same targeted changes to a large number of documents (such as changing the freight forwarder), you can use the Mass Maintenance transaction for shipments (see Fig. 2.23).

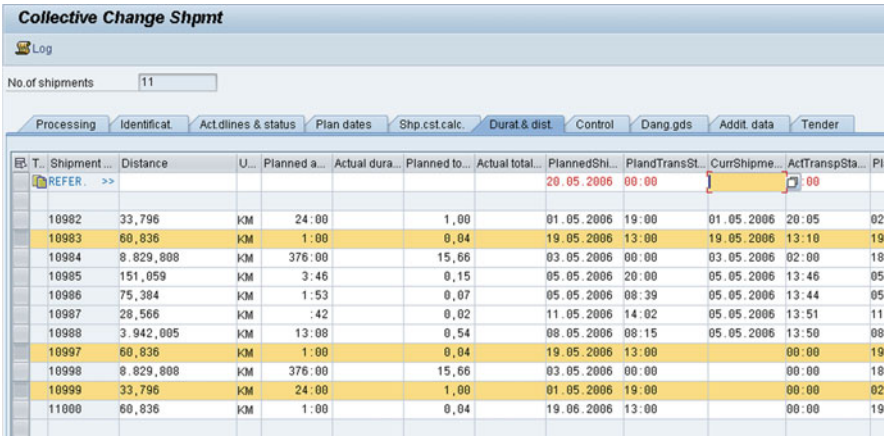
In Mass Maintenance, as in the case of the planning list, you can initially select shipment documents to be edited that have certain criteria. You can then select the shipments to be changed from a results list and edit them via the various tabs, such as process data, identification, durations and distances, schedules and other data. The changes are then adopted for the shipment documents marked.

Other work lists and overview lists available include a capacity list and a list for available freight room, with which you can evaluate a selection of shipments either based on their utilized or free capacity and process them further, as is done in the planning list.

2.4.6 *Freight Cost Calculation*

Freight cost calculation, which primarily deals with the calculation and settlement of the freight costs of service providers, has long been a component of Transportation Processing. It includes the following basic steps:

- Generation of freight agreements and prices
- Calculation of freight costs
- Settlement of freight costs with service providers



T..	Shipment ...	Distance	U...	Planned a...	Actual dura...	Planned to...	Actual total...	PlannedShi...	PlandTransSt...	CurrShipme...	ActTranspSta...	Pl
	REFER. >>							20.05.2006	00:00		00	
	10982	33,796	KM	24:00		1,00		01.05.2006	19:00	01.05.2006	20:05	02
	10983	60,836	KM	1:00		0,04		19.05.2006	13:00	19.05.2006	13:10	19
	10984	8.829,808	KM	376:00		15,66		03.05.2006	00:00	03.05.2006	02:00	18
	10985	151,059	KM	3:46		0,15		05.05.2006	20:00	05.05.2006	13:46	05
	10986	75,384	KM	1:53		0,07		05.05.2006	08:39	05.05.2006	13:44	05
	10987	28,566	KM	:42		0,02		11.05.2006	14:02	05.05.2006	13:51	11
	10988	3.942,005	KM	13:08		0,54		08.05.2006	08:15	05.05.2006	13:50	08
	10997	60,836	KM	1:00		0,04		19.05.2006	13:00		00:00	19
	10998	8.829,808	KM	376:00		15,66		03.05.2006	00:00		00:00	18
	10999	33,796	KM	24:00		1,00		01.05.2006	19:00		00:00	02
	11000	60,836	KM	1:00		0,04		19.06.2006	13:00		00:00	19

Fig. 2.23 Mass maintenance transaction of shipment documents

- Transfer of costs to Financial Accounting
- Transfer of freight costs to customers who generate transport demand (customer freight billing)
- Accrual of reserves for expected freight costs

Figure 2.24 illustrates the respective steps in a graph.

The freight cost documents generated from the shipment documents and their follow-on documents (such as service entry sheets and invoices) are linked with one another via the document flow, such that you can easily link from one shipment document to its freight cost document and other documents. From the document flow screen, you can open the respective documents. Figure 2.25 shows the document flow of a shipment document up to the invoice receipt.

A freight cost document can be generated from every shipment document. Thus, there is always a one-to-one ratio between the two document types. The prerequisites for generating a freight cost document are:

- The shipment must be identified as freight-cost relevant.
- The shipment must have the necessary overall status set in the definition of freight cost type.
- The shipment must at least have the status of *Planned*.
- The shipment must have a service provider.

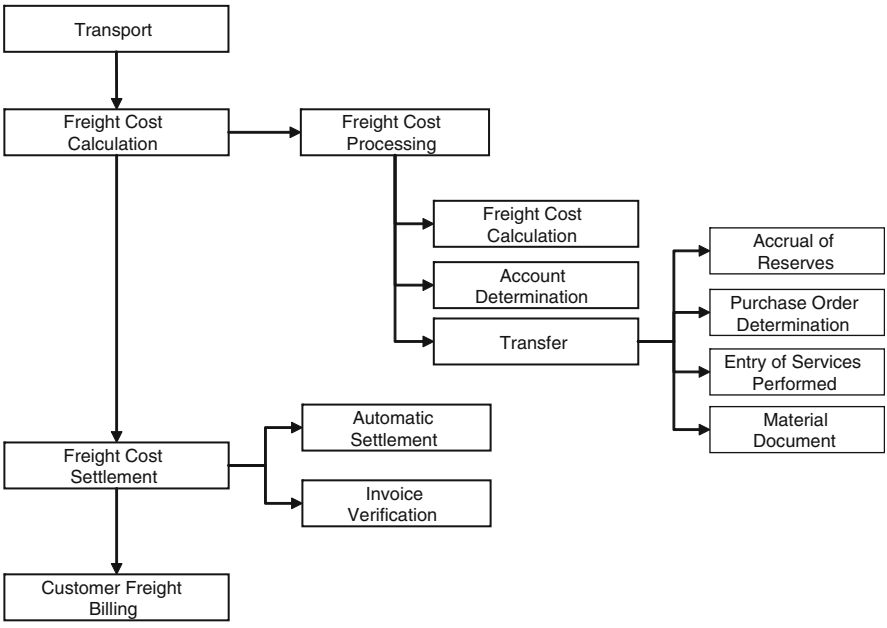


Fig. 2.24 Processing steps for freight cost calculation

The freight cost document contains header information, item information and subitems:

- **Freight cost header**
  In the freight cost header, you will find data pertaining to the freight cost type, document status and pricing date, as well as reference data and the processing report.
- **Freight cost item**
  This contains information on the item category, business partner (freight forwarder), utilized pricing procedure, the pricing date, tax amounts, settlement dates and references to the shipment and the service entry sheet. One freight cost item might, for instance, include costs for the total shipment (document charges, insurance), while another might indicate costs for the pre-carriage or main carriage.
- **Freight cost subitem**
  The freight cost subitems provide information on the calculation basis used and the calculation result, tax rates and references to the deliveries or freight units.

With regard to the calculated costs, the freight cost document offers several views that you can display depending on what information you need:

- An overview of all freight cost items and the calculated costs
- Costs per delivery item
- Costs per shipment stage

Figure 2.26 provides an overview of the freight cost document item view. Figure 2.27 shows the conditions of a freight cost item in detail, which illuminates the pricing procedure and tax determination.

You can define the automated processing of transportation information in freight documents with the respective customizing settings. The following process steps can be automated:

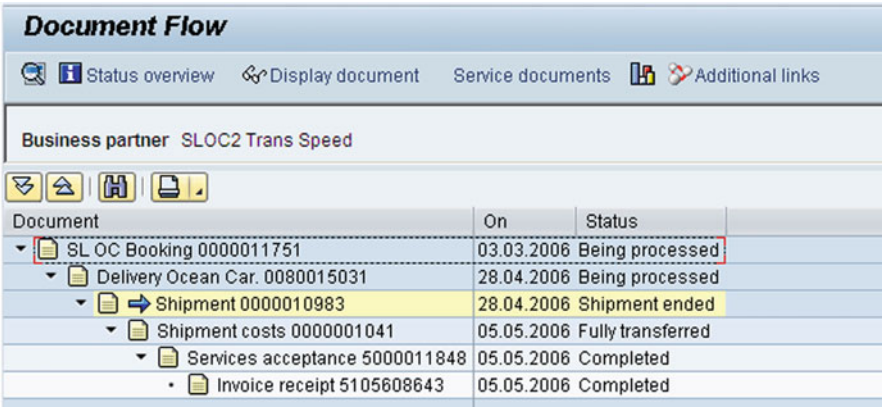


Fig. 2.25 Document flow between the shipment document and the service provider invoice

- The generation of freight cost documents with freight cost items
- The calculation of costs for freight cost items
- Determination of the accounts
- Transfer of costs to Financial Accounting, accrual of reserves

Calculation example for freight costs. In Fig. 2.28, you can see an example for the calculation of freight costs for a combined shipment from San Francisco via Detroit to New York. Two deliveries are transported, but they are only transported together in the first stage.

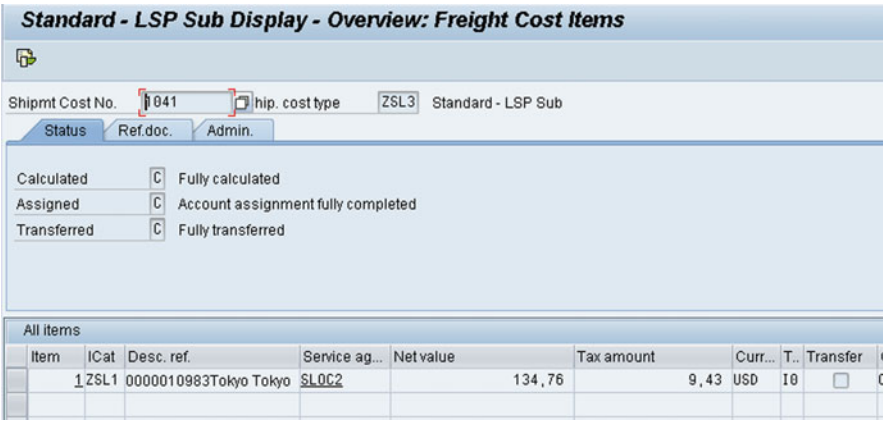


Fig. 2.26 Overview of the freight cost document

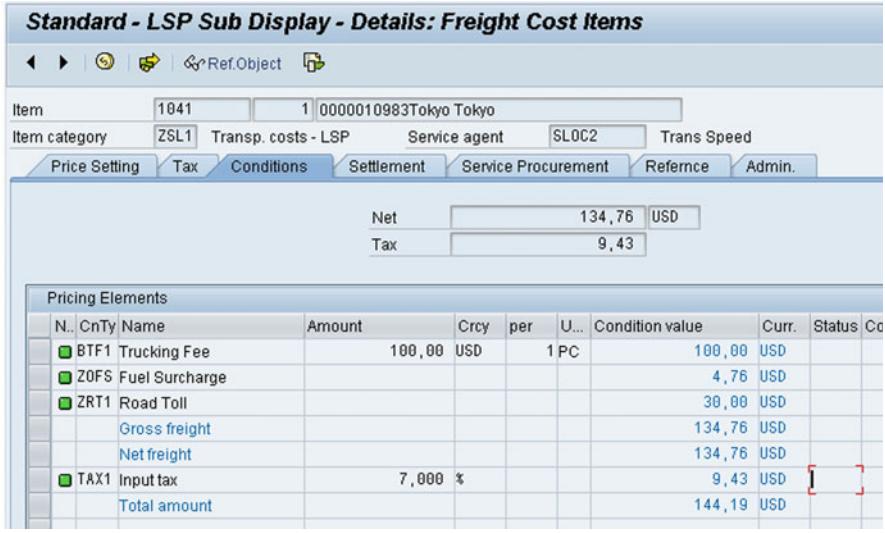


Fig. 2.27 Item and condition detail in the freight cost document

Settlement of costs is conducted with two service providers: a forwarding agent and an insurance company. The insurance costs represent a separate freight cost item with reference to the complete shipment. Two further items were generated for the stages; the costs for the first stage are calculated from the total freight of both shipments (subitems 2.1 and 2.2). The total freight of 10,000 kg is used to determine the scaled value of $0.40/kg.

The calculation, scaled values, applied individual conditions per shipment and other special calculations can be configured using Customizing and master data maintenance. Scales can be created and maintained in multiple dimensions. They can be defined as from-scales, to-scales or with an exact value. Table 2.2 presents an example of a three-dimensional scale table at a price per kilogram with the dimensions "From ZIP code" area and "To ZIP code" area as exact scale values and "Weight" as a to-scale value.

For the calculation procedure and schemes, special forms of freight calculation are also taken into consideration, such as:

- **Shortest main carriage**
  The costs are always calculated such that as short a main carriage as possible (direct carriage) is assumed.
- **Minimum and maximum value for freight cost conditions**
  For example, a freight price of $11.80 per ton with a minimum of $35.
- **Average weight calculation**
  If using the next scale up is cheaper, this value is used (for example, 9 t at $120 = $1,080 is replaced by 10 t at $100 = $1,000).

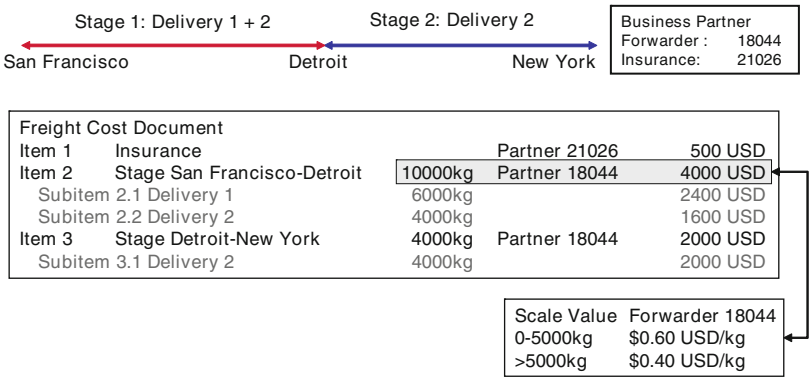


Fig. 2.28 Example for the calculation of freight costs

Table 2.2 Three-dimensional scale table

From ZIP code	To ZIP code	To 100 kg	To 200 kg	To 500 kg
69xxx	80xxx	$1.35	$1.25	$1.08
70xxx	80xxx	$1.14	$1.03	$0.97
20xxx	69xxx	$3.68	$3.32	$3.12

- **Freight comparisons**
  Conditions of a pricing procedure can be summarized in groups. These groups are then each calculated and then compared. The freight calculation can, for example, always select the least expensive group (such as: the freight calculation can either be done according to weight or volume).

Before the actual calculation, freight cost calculation first determines a *pricing procedure* per freight cost item for the calculation, determined in relation to the transportation planning point, service provider, freight cost item and shipping type.

An important criterion for the calculation is the calculation base, that is, the level on which individual freight prices are determined. You can employ the following levels in freight calculation as a calculation base:

- For each shipment stage
- For each shipping unit
- For every shipment
- For every delivery item under consideration of the freight classes (that is, goods type-specific)

Geographic circumstances of a shipment are determined in freight cost calculation by one of two options:

- **Distances**
  You can manually enter the distance into the shipment stage or shipment header, or it is automatically assumed from the leg.
- **Locations and zones**
  A few pieces of information from the address data in the shipment document (such as country, ZIP code, transportation zone), divided into departure and destination locations, can be used for cost determination. Based on this information, a price zone can also be determined, such as one that combines several locations within a ZIP code.

The pricing and billing data can be automatically determined. Using definable scheduling rules, you can set a series of transportation dates that can serve as recommendations. For the calculation of freight costs, you can also have the system automatically determine the respective tax.

In the functional area *Freight invoicing*, work lists are available that can give you an overview of the current operation queue.

The freight cost calculation list is a report that can be used to list freight cost documents for which the calculation has not yet been completed. You have such selection criteria as the status of the calculation, the date of the calculation and the pricing date to limit the selection of freight cost documents.

The list of scales allows you to obtain an overview of the existing scales and their applications. With the freight cost invoicing list (see Fig. 2.29), you have the opportunity to search for freight cost documents that have already been or must soon be settled.

If you as a shipper wish to transfer freight costs that you have paid to a service provider for the transport of goods stemming from a sales order to an ordering party, you have the option of performing *customer freight invoicing*. For this, through special conditions on the invoice of the sales order, the conditions of the freight invoice are accessed, and the individual cost elements can be assumed in the invoice of the purchasing document. This can be done without making any changes, but you can also apply a proportional charge or surcharge. The ordering party then receives an invoice for the freight costs together with the material costs.

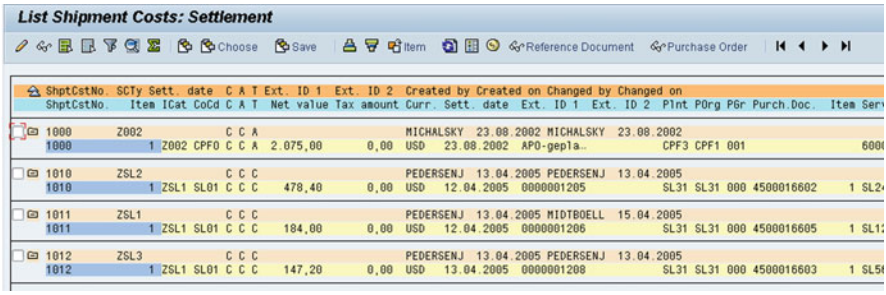


Fig. 2.29 Invoice list for freight costs

2.5 Transportation Planning with SAP APO

As mentioned in the previous section, the ERP transportation solution itself offers no option for optimized transportation planning, since SAP ERP does not include planning tools with an optimization function. In several cases, however, optimized planning is a method with which to improve efficiency and save money.

That is why Supply Chain Management includes the planning and optimization component APO (Advanced Planner and Optimizer). In combination with ERP logistics processes, it offers a few significant advantages for transportation planning:

- **Integration of order processing, global availability check and transportation planning**
  You have the option of optimizing the availability of products in all international divisions of your company as well as the planning of shipments between corporate locations and customers or suppliers in a combined process.
- **Cost-optimized transportation planning**
  The optimization process for shipments offers efficient models and strategies to influence overall transportation costs.

- **Multiple transportation mode planning**
  Optimization can be performed using several modes of transport, that is, you can plan complete transportation chains including transshipment in several distribution centers.

APO Transportation Planning (TP/VS) can be employed for purchasing as well as sales-based processes (see the process flow diagram for the sales side in Fig. 2.7).

2.5.1 Transportation Optimization with SAP APO (TP/VS)

The basic process when working with APO Transportation Planning consists of the following elements:

1. The documents that form the original transport demand (sales orders, purchase orders) are created in the ERP system and subsequently transferred to the APO system.
2. In the event that the *Routing Guide* (dynamic route determination) is used, a planning run is performed during the global availability check before the sales order is saved.
3. *Vehicle Scheduling* (VS) aids you in achieving a consolidation of transport demands and determining an optimal route and delivery sequence and creating the corresponding tours. It considers optimal resource exploitation as well as minimal procedural effort (such as for loading and unloading). Existing solutions can be taken into account for further planning runs and revised based on altered situations.
4. For service provider selection, you have the option of optimizing the allocation of transportation service providers to existing tours according to cost, distribution, quality or quota processing aspects. You can also determine additional shipments, to save money by dispatching two shipments at one time.
5. Collaborative transportation planning with service providers enables you to exchange data relating to expected transportation volume. You can provide service providers with short- and long-term planning data for your transport demands via a collaboration portal, to enable them to prepare enough transport capacity.
6. Shipment tendering serves to communicate planned shipments to service providers and, if necessary, plan for any requests for changes or rejections.
7. Release shipments can be transmitted back to SAP ERP after optimization and service provider allocation. Based on the data, ERP shipment documents and deliveries are then generated.
8. Transportation processing subsequently takes place in ERP Transportation Management.

The Optimizer in APO Transportation Planning is a universal tool for planning comprehensive transport scenarios.

2.5.2 *Documents and Transportation Optimization*

APO Transportation Planning primarily works with two transaction objects: The *freight unit* and the *shipment document*. Freight units represent transport demands created from sales orders or purchase orders. With the aid of master data objects such as resources, service providers and transportation lanes, freight units are planned in a planning run, consolidated and allocated to shipments. These shipments mainly correspond to tours that service several loading and unloading points and are processed with one resource.

Planning itself can either be performed in batch processing, as a report or as interactive planning with optimization support. Figure 2.30 shows an overview of the *TP/VS planning cockpit*, where you can select various planning views (resource view, shipment view, tabular planning, planning board, etc.).

The *Optimizer* is a software tool integrated into APO Transportation Planning via interfaces. Since the Optimizer was not developed in the SAP programming language ABAP, but rather in C++, it only supports selected operating system platforms (such as Windows and Linux). The Optimizer gets its data and results are provided via the preliminary and subsequent processing of master and movement data in Supply Chain Management.

The Optimizer conducts continual optimization of the transportation scenario under consideration of indicated transport demands, resources, incompatibilities, cost functions and transportation networks, until either a preset optimization duration has been reached or two sequential solutions have not resulted in an improvement in the overall result. As such, the Optimizer can provide a result at a very early stage – even if that result is still suboptimal. The progress of the optimization process can be monitored and checked in the optimization screen (see Fig. 2.31).

After optimization has been performed, the generated shipments can be analyzed and adjusted in the planning cockpit. The system also provides an *overview planning board* to help you evaluate not only the capacity-related but also the

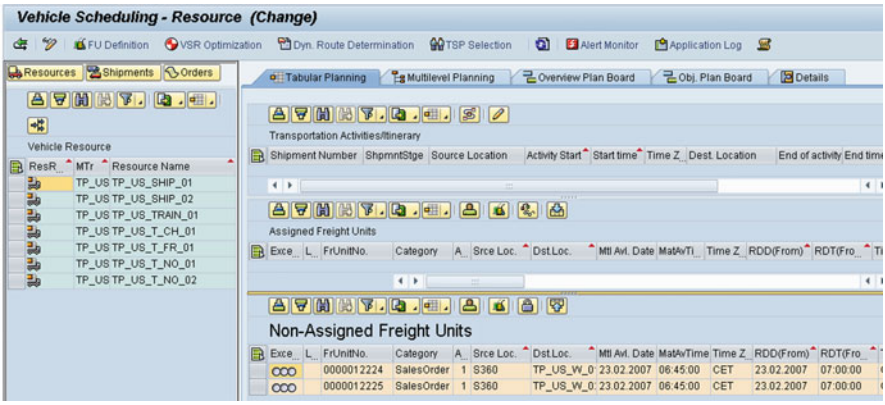


Fig. 2.30 Planning cockpit of SAP APO transportation planning

time-lapse-related aspects. It allows you to display the time lapse of the individual shipments in Gantt diagrams and evaluate them. For this, you have access to an order-based as well as a resource-based time display. Such displays clearly illustrate what resources are available or occupied at what times (see Fig. 2.32).

2.5.3 Scenarios with APO Transportation Planning

Multi-pick and *multi-drop* scenarios involve the optimization of load consolidation with regard to resources. In an overall scenario in which freight is picked up and dropped off at several loading points, transportation costs for resource employment is minimized, that is, the most economical resource selection and load combination is determined.

In order to be able to properly evaluate these networks, you can use the *Supply Chain Cockpit* tool, which provides a graphic display of network components such as plants, customers, suppliers, resources and transportation lanes in map form. Such a network in the Supply Chain Cockpit is shown in Fig. 2.33.

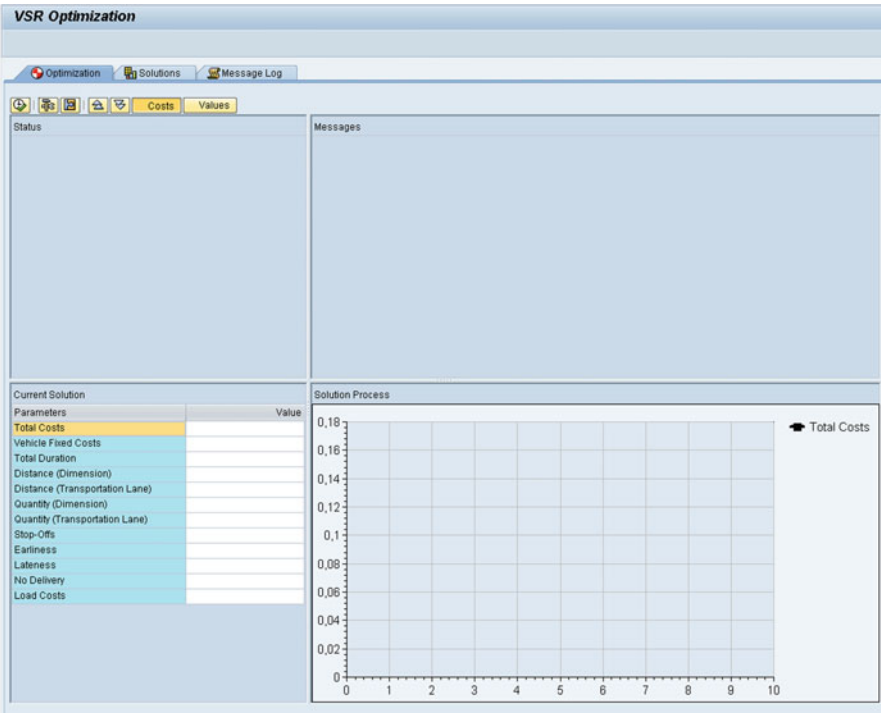


Fig. 2.31 Planning run with optimization progress and result report

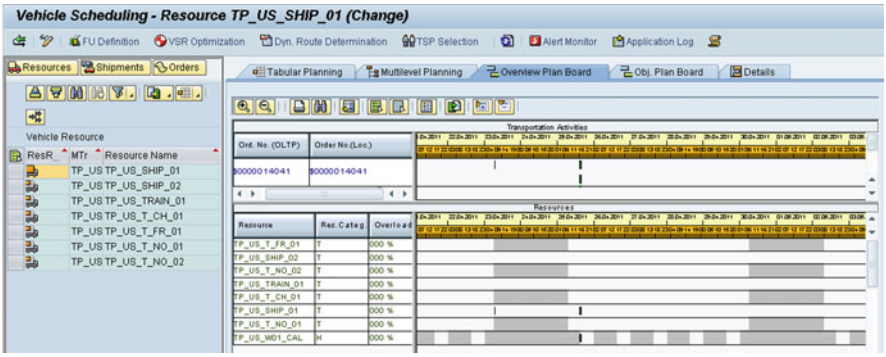


Fig. 2.32 Graphic planning board in SAP APO transportation planning

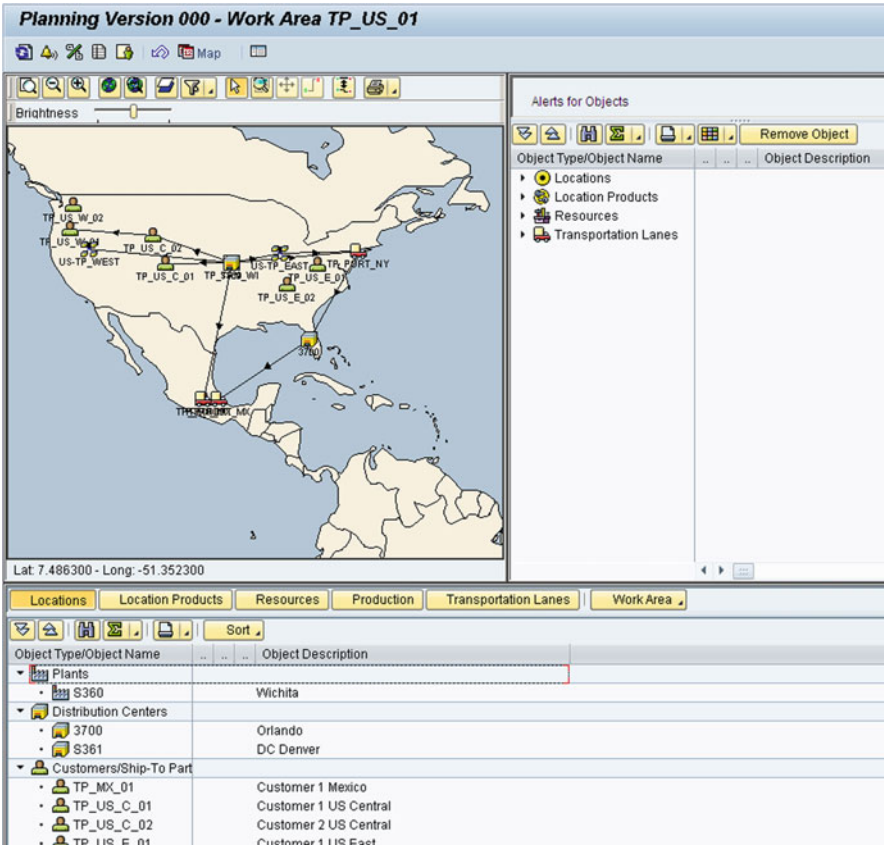


Fig. 2.33 Supply Chain Cockpit with graphic network display

The *Routing Guide* (dynamic route determination) is a planning tool that allows you to perform a complete transportation planning job including an integrated availability check directly during data entry.

Multi-modal planning with transshipment at terminals and load transfer points is supported, to achieve as realistic a process as possible. Based on the order data, the Routing Guide can generate several possible transportation plans and present the user with a solution list enabling interactive decisions.

The option of integrated service provider determination also makes it possible to establish the real freight costs for every transportation solution and present them in the decision-making process, using a special interface to ERP Transportation Management. The ERP system only temporarily generates shipment and freight cost documents to perform the calculation.

After the desired transportation route has been selected and the sales order saved, the shipment documents pertaining to the selected solution are also saved in the APO system. Transportation solutions that are not selected are automatically discarded. Figure 2.34 provides a graphic depiction of the dynamic route determination process.

Dynamic route determination can also be used as a *simulation* directly within the context of APO Transportation Planning. For this, you can open the transaction for

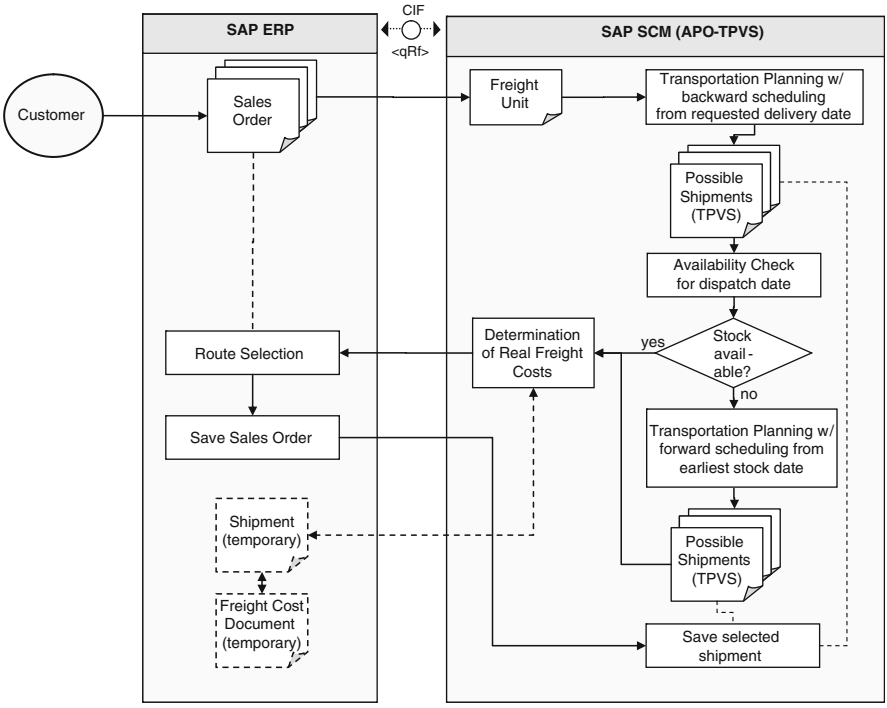


Fig. 2.34 Process in the determination of route recommendations using routing guide (dynamic route determination)

interactive route determination and directly enter the freight unit data. The planning function then immediately presents the desired route recommendation as a result. They are displayed in the transaction as shown in Fig. 2.35.

A *Continuous move* (additional shipment determination) allows you to optimally combine matching individual shipments that you can contract to a single service provider. This enables you to book longer freight routes per service provider and vehicle, often achieving a better freight price. This is especially true if you can offer the service provider return freight from the drop-off location of the first shipment.

Multiple ERP use of APO Transportation Planning. Multiple ERP use of a transportation planning system is a scenario that is necessary from time to time when several organizations of a company use their own ERP systems for order processing but plan transportation with a central planning system. The generated shipments then contain deliveries from several ERP systems but are only mapped in a single ERP system.

Unfortunately, this scenario cannot be executed with ERP Transportation Management and APO Transportation Planning without system modifications and extensions, since the necessary delivery references cannot be consistently mapped in the central ERP transportation system. SAP TM should be used for such scenarios.

2.6 Transportation Management with SAP TM

SAP TM is a software solution with which you can process transportation logistics processes in complex transportation networks. It supports you in basic business processes, ranging from the sales offer and order to planning, subcontracting and

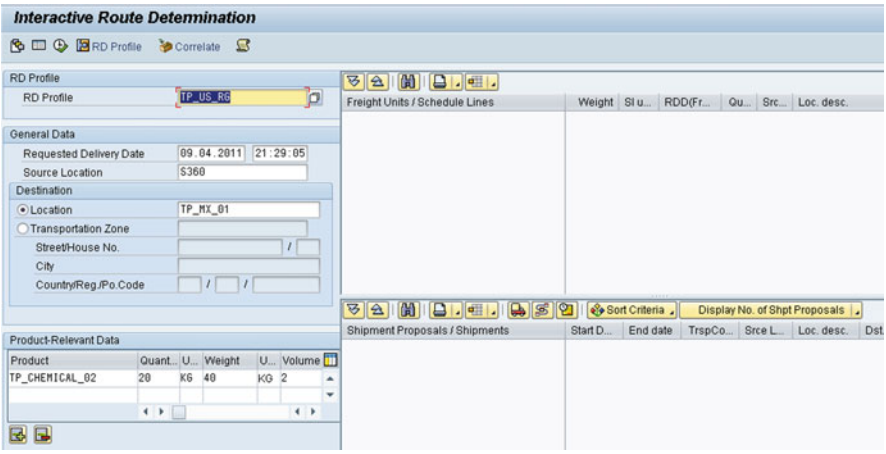


Fig. 2.35 Interactive route determination in SAP APO Transportation Planning

pricing to invoicing and settlement of transportation services. The solution is equipped with algorithms for shipment optimization and route determination

SAP TM is part of the supply chain management solution of SAP and is integrated with SAP ERP for financial settlement. In addition to SAP ERP, SAP Event Management is also employed for various tracking processes.

One significant difference to ERP Transportation Management is a strong emphasis on transportation processing from the service provider view and not only as a partial process of sales and distribution, production or procurement. Transportation is treated as an autonomous process that begins with the tendering procedure and ends with invoicing and settlement. In comparison with SAP ERP, SAP TM offers a considerable amount of additional functions:

- The opportunity to handle transportation processes with or without material master records
- Customer master data is not necessary (however it is helpful for invoicing); supports one-time customers
- Sales and purchase order management for transportation services
- Expanded functions for planning and allocation of complete and partial shipments in complex and also itinerary-supported networks
- Partial processing of transportation chains
- Division of the processing of a transportation order between various participating organizations (import/export view)
- Incoming and outgoing shipments are treated equally, which enables the planning of round trips with drop-offs and pick-ups
- Complex debit- as well as credit-related freight rate calculation and support of internal costs for a company's own fleet
- Calculation of the profitability of orders
- Support of EDI communication
- Complete transportation processing, even in multiple ERP environments

With SAP TM, SAP addresses existing markets, such as the shipper market, for which transportation processing had previously been the realm of SAP ERP, as well as the logistics service provider market, a new area for SAP.

2.6.1 Document and Process Overview

The documents and business objects in SAP TM are geared toward an efficient, service-oriented and distributed transportation management. That is why SAP TM not only includes *one* shipment document, such as in SAP ERP, but rather several application-oriented objects, each of which serves a special purpose in the realm of transportation processing. Figure 2.36 shows an overview of the business objects and their related subprocesses.

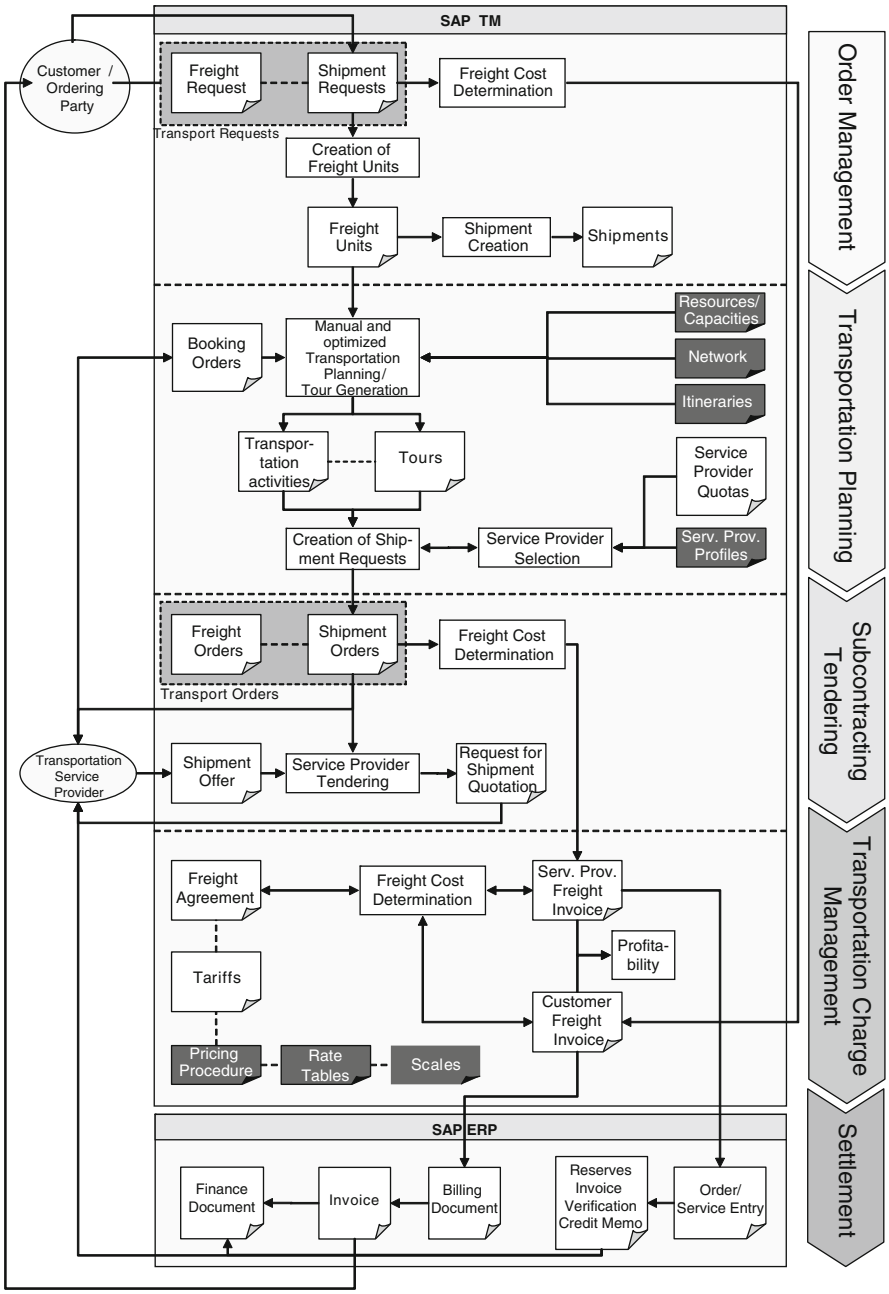


Fig. 2.36 Overview of the SAP TM object model

The overall process in SAP TM is divided into five major subprocesses and organizational functional areas:

- **Order Management**
  Order Management and order acceptance mark the beginning of an operative process in transportation management. When a transportation order is awarded, a contract is created between the customer and a transportation service provider. This process can take place within a company (such as a producing company that awards a transportation contract to its logistics department) as well as between companies (an order to a logistics service provider). Order acceptance is the most important function of Order Management in SAP TM.
- **Transportation planning**
  Transportation planning consolidates shipments into cargo loads under consideration of predefined conditions, such as volume, desired arrival time or compatibility of means of transport and goods to be transported. The planner also has the option of manual planning. In addition to transportation optimization, planning also enables the selection of a transportation service provider. In this step, the system aids in finding the most economical transportation service provider to execute a transport.
- **Subcontracting and tendering**
  Subcontracting is consigning transportation services to a shipper or carrier. The process includes transportation planning and consists of the further processing and forwarding to service providers of transport orders stemming from planning results. If several service providers are eligible for a subcontracting job, a tendering procedure can be performed. A second form of subcontracting is the booking of freight space, wherein freight space capacity is reserved and used in the course of further transportation planning. As soon as a freight space booking order is received, the shipment order consumes a portion of the volume of the booking.Booking as well as freight orders can be printed. In the realm of freight forwarding, these documents come in the form of a *bill of lading* (B/L) or *master air waybill* (MAWB).
- **Freight cost management**
  Freight cost management (TCM, *Transportation Charge Management*) can calculate debits as well as credits. It consists of several subcomponents that first determine all cost- and revenue-related logistics data and provide it to the calculation program. The program uses configuration settings to determine pricing calculation procedures and components along with the relative scales. Thus, even complex installment structures can be mapped in Transportation Management.
- **Settlement**
  Freight cost settlement links freight calculation with ERP Financing on the debit side and ERP Purchasing on the credit side.

Within these components, the system determines to which accounts, cost centers, etc., the freight order is to be booked. It can also perform allocation duties, such as distributing costs among all participating cost centers.

2.6.2 Cross-Divisional Functions

One significant characteristic of SAP TM is the option of distributing a general process among several processing employees. This enables various people in different organizations to perform transportation processing steps.

Two functions in SAP TM are used to do this:

- The *Personal Object Worklist* (Personal Object Worklist, POWL)
- SAP authorization control

The *Personal Object Worklist* is the central element for role-specific user access in SAP TM. Its basic elements are configurable queries and work lists. Depending on functional area, the Personal Object Worklist offers you access to the business objects and their directly subsequent business objects, such as:

- Personal Object Worklist for sales orders
- Personal Object Worklist for shipment requests (transport orders)
- Personal Object Worklist for tours
- Personal Object Worklist for shipment orders
- Personal Object Worklist for customer freight invoice requests (pro-forma customer invoice)

Depending on the business object and area, you have the opportunity to display, create, edit or delete objects.

You can configure POWLs for each user or for a user group through an administrator. This allows every user access to exactly those work lists with the objects that he or she needs upon entering the work area (such as order management). Figure 2.37 shows an example of the Personal Object Worklist for shipment orders.

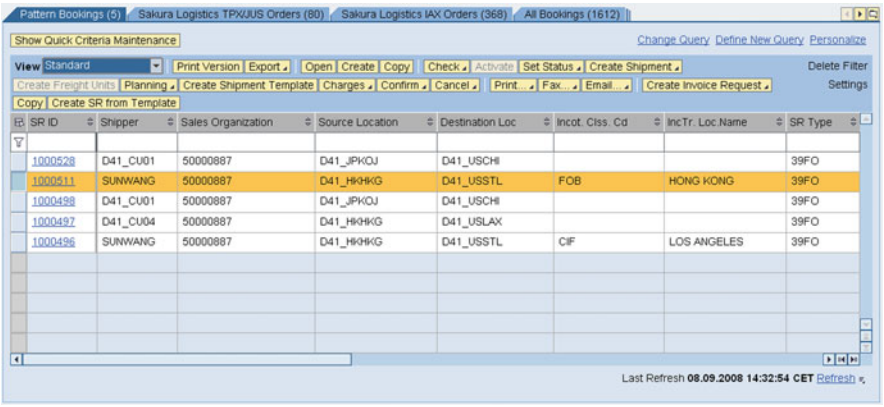


Fig. 2.37 Personal Object Worklist of a booking agent

The Personal Object Worklist can be configured by users in several ways and customized to task-specific needs. You have the following customizing options:

- Order of display and layout of the query view
- Selection of the table display
- Number and order of columns and number of lines in the table display
- Column order and selection in the table display
- Sorting, calculating and filtering in the table display

With the *authorization profile*, you have the opportunity to limit the access of certain users or user groups to business objects or those with certain semantic content. Using the respective settings, for instance, you can configure the following authorizations:

- A booking agent in a call center in Hamburg only has full access to sea freight orders dispatched from Germany. He only has reading access to other orders if they are processed via Germany.
- An import employee in a Singapore office only has access to freight orders that arrive in Singapore via air freight and on- and preliminary carriages within Singapore by truck.

2.6.3 Business Objects and Functions Illustrated in a Sample Process

We would like to highlight the business objects and detail functions of SAP TM with the aid of a sample process. This process, divided among several employees, involves full container processing for sea freight (*Full Container Load*, FCL), representing a standard process of a logistics service provider. A simplified process flow diagram can be seen in Fig. 2.38.

The simplification lies in the summary of process steps and the fact that all participating service providers and planners are displayed in a generic process track.

The process indicated includes the following roles:

- **Shipper**
  Issues the shipment order FOB port of departure (*Free on Board*, meaning that the shipper pays the pre-carriage and terminal fees up to and including loading onto the ship).
- **Ship-to party**
  Receives the shipment and pays the main carriage and on-carriage.
- **Transport booking agent (booking agent)**
  Receives the order and creates and processes the shipment requests.
- **Transportation planners (import/export)**

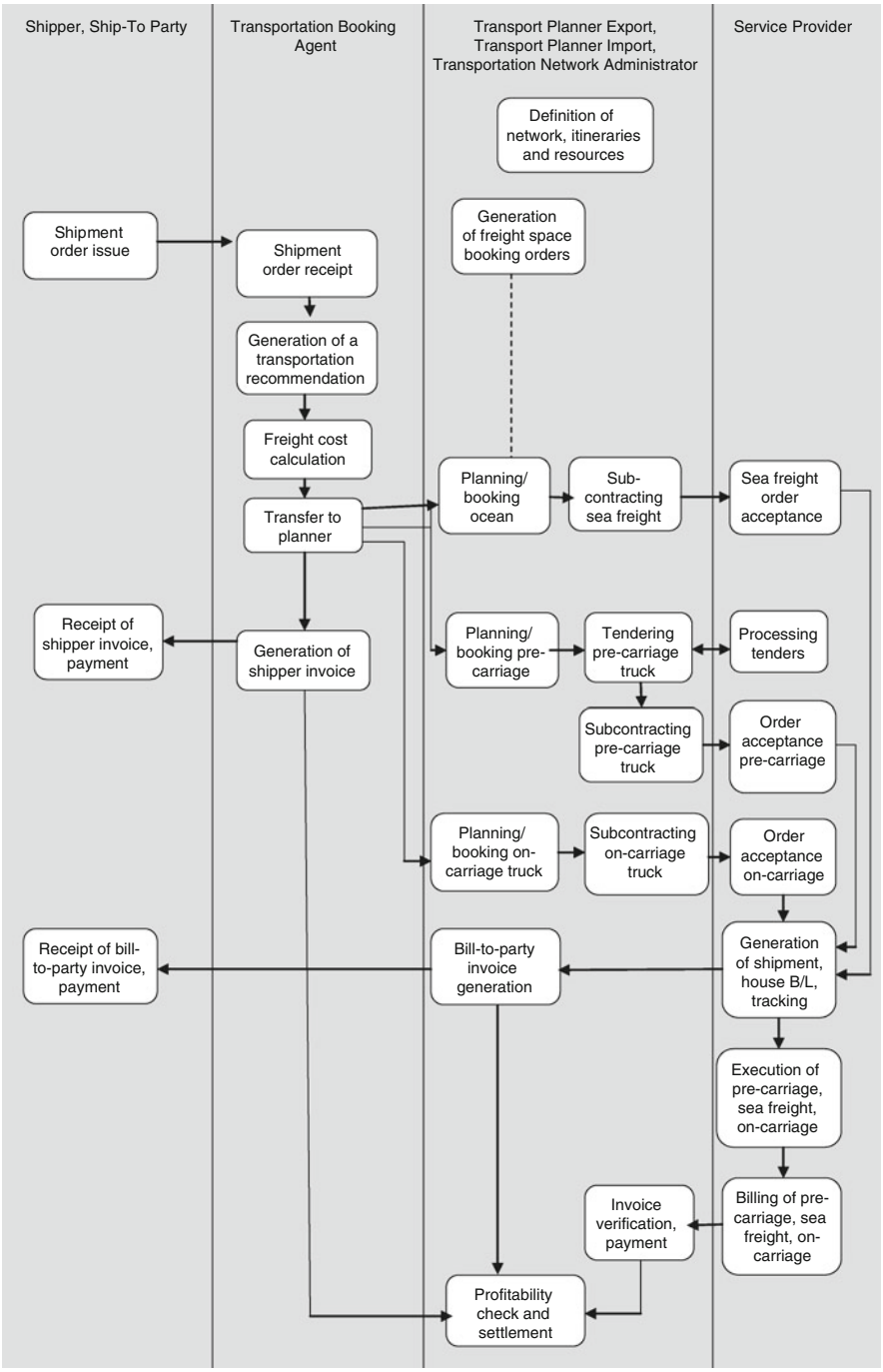


Fig. 2.38 Standard FCL sea freight process (simplified)

Several transportation planners can plan the import and export sections of a shipment, and tender it to and commission carriers.

- **Service providers**
  Create offers for tendered partial shipments and execute partial shipments based on subcontracts.

From a logistics view, the sample process has the following background: A chemistry company in Japan (shipper) commissions the shipment of a 20-ft standard full container with barrels of two types of elastomers from a production plant in Waki, Japan, to a finishing plant in Zhongshan, China. The transport request is subject to the Incoterm *FOB Iwakuni, Japan*, and is processed via the ports of Iwakuni, Japan, and Shanghai, China. The logistics service provider Sakura Inc. accepts the order and processes it completely for the shipper. Figure 2.39 shows the order environment.

Before the process for an individual sea freight order begins, the following preparatory steps are taken:

1. **Master data maintenance**
   The transportation network administrator tends to the transportation network and itineraries.
2. **Execute subcontracting**
   The sea freight planner books capacity on sea vessels in advance that will be filled with capacity requirements from transport requests in the course of planning.

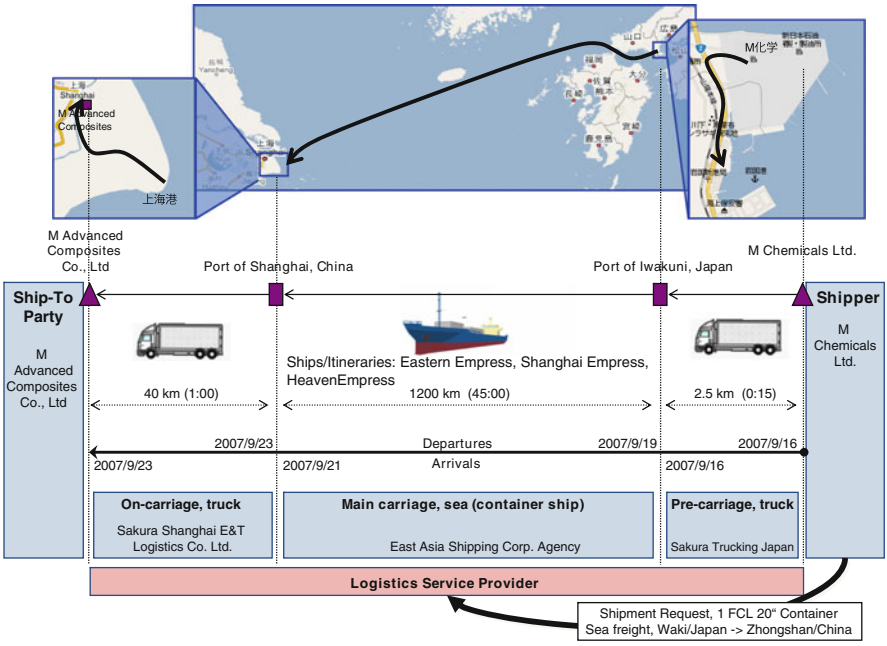


Fig. 2.39 Logistics view of the sample process

The main steps in transportation processing are listed below (see the total object model Fig. 2.36):

1. **Order management – Shipper**
   The shipper commissions transportation via telephone and would also like to receive a transportation proposal and pricing information.
2. **Order management – Transport booking agent**
   The transport booking agent enters the order in the system (business object *shipment request*). Then he activates the shipment request, creates three route recommendations using the transportation proposal function, clarifies the desired transportation process with the shipper, and calculates the freight prices for shipper and recipient. This activation triggers the system to automatically generate transport demands (freight units).
3. **Transportation planning – Main carriage**
   The planners are automatically informed of the new freight units via their Personal Object Worklists. First, the sea freight planner books a container on the ship requested by the customer, consuming a portion of the previously reserved capacity (business object *booking order*) in the process. At the appropriate time, the sea freight planner generates a subcontract for the sea vessel (business object *shipment request*), which serves as the *master B/L*. Here, of course, consolidation with other shipments may also take place, but this is not the case for our sample process.
4. **Transportation planning – Pre-carriage/on-carriage**
   After the sea freight booking, the import and export planners can independently plan the pre- and on-carriage shipments in their work list and generate subcontracts for them (these are also business objects of the type *shipment request*).
5. **Freight cost management and settlement**
   The transport booking agent can already create and send the invoice to the shipper (*FOB prepaid*, from the pick-up location to on board the ship). For this, he generates a pro-forma invoice (business object *customer freight invoice request*) and forwards it to SAP ERP FI/CO.
6. **Subcontracting and tendering – Pre-carriage**
   The pre-carriage planner can use the service provider selection and tendering functions to submit inquiries to several service providers regarding price quotations and pre-carriage processing.
7. **Quotation – Pre-carriage**
   The contacted service providers can submit quotations for the processing of the pre-carriage transport via the collaboration portal.
8. **Service provider selection – Pre-carriage**
   After the tendering period has expired, the pre-carriage planner can select a service provider and grant the transport job by forwarding the pre-carriage shipment request.
9. **Subcontracting and tendering – On-carriage**
   Like the pre-carriage procedure, the import planner can commission on-carriage with the aid of the on-carriage shipment request.

10. **Generation of a house bill of lading**
    Before the process is executed, the export planner creates the shipment, and can generate the house bill of lading from it as well as initiate shipment tracking.
11. **Freight cost management and invoicing the recipient**
    At any time after cost calculation in the shipment request, the invoice for the recipient can also be initiated. Here, too, a customer freight invoice request is generated and sent to SAP ERP FI/CO.
12. **Freight cost management and payment of service provider invoice**
    The supplier freight invoice request is generated from the shipment orders for pre-carriage, main carriage and on-carriage and also forwarded to SAP ERP Materials Management. This makes them available for verification of incoming carrier invoices.
13. **Profitability calculation**
    After receipt of the supplier invoices and, if applicable, adjustment of invoice amounts, the shipment request can be subjected to a profitability check. Thereafter, the shipment request is marked as *completed*.

2.6.4 Order Management

Order Management provides functions necessary for the acceptance of a shipment order. A variety of business objects are available for this. Table 2.3 provides an overview of the application areas of order business objects.

Table 2.3 Order business objects in SAP TM

Business object	Application
Shipment request (SE)	Agreement between a transportation service provider and an ordering party with relation to the shipment of goods or transportation equipment from a supplying location to a receiving partner or location in accordance with stipulated conditions
Freight request (FA)	Request from an ordering party to transport goods from one or more supplying partners or locations to one or more receiving partners or locations. A freight request is a combination of shipment requests
Quotation	Offer from a transportation service provider (supplier) to an ordering party (customer) for the transportation of goods at desired conditions
Template for shipment request	Partially filled-out shipment request that can be used as a master for regularly recurring, similar shipment requests
Shipment (SN)	Contractual document in logistics that the transportation service provider sends to an ordering party. It contains information on goods that are transported together in one or more means of transport throughout the entire transportation chain or during the main carriage
Freight unit (FE)	Combination of goods that are transported together throughout the entire transportation chain. A freight unit can include transportation restrictions for transportation planning

The shipment request is the central order business object with which all major verification and processing steps in order management are performed. A shipment request can be created as a shipment order in SAP TM either through electronic transmission (EDI) or manual entry.

Manual creation can occur in the system in several ways:

- A shipment request is newly created and generated in SAP TM with the order data provided by the ordering party.
- An order is created from which a shipment request is generated through copying and, if necessary, editing.
- For frequently recurring, similar order processes, a template can be created for a shipment request. It includes the recurring data (such as shipper, ship-to party, goods description and transportation conditions). Through copying and editing, a new shipment request is created from the template.
- An existing shipment request can be used as a master for a new shipment request.

Figure 2.40 diagrams the possible ways of generating a shipment request.

Role and type codes in SAP Transportation Management. In SAP TM, data fields with role codes and type codes are used in many business object nodes, in order to map categories and characteristics of data. This enables you to define as many characteristics of certain data fields as you like. In contrast to explicit data storage (in which, for example, data fields are defined in the business object

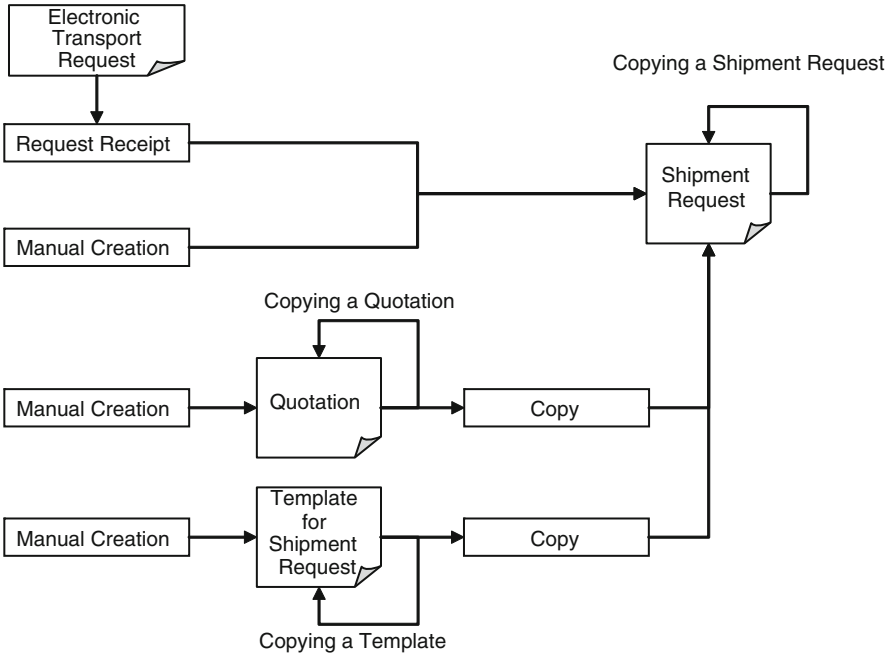


Fig. 2.40 Alternatives for the generation of shipment requests

for business partners like *Shipper* and *Ship-to Party*), in role code-based definition, there is a table with the columns *Role* and *Business Partner*. This lets you enter information for the roles Shipper and Ship-to Party and the respective business partners in addition to as many other user-defined business partners as you wish (such as *Packing Service Provider*, *Customs Agent*). You are not able to indicate these in the explicit definition, since the respective fields are missing.

In our sample process, the shipper grants the transportation order via telephone. The employee processing the transportation order accepts the order and adds a new shipment request using the *Create* function taken from his personal work list for shipment requests.

In the shipment request template, the shipper enters the shipment request type " Full container sea freight house-to-house". Inferable information, such as the sales organization, can be automatically set as a personal default value of the transportation order processor (user settings for the corresponding data fields).

Transportation order for an FCL sea freight shipment. Figure 2.41 shows the basic view of the shipment request screen in which you can enter the most important data on a single screen. The Details button switches to a more detailed display, which enables you to access all available data areas.

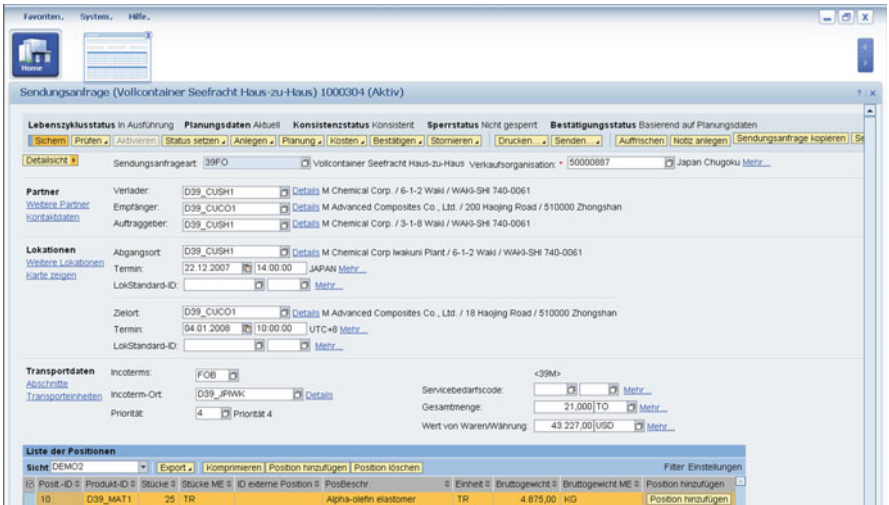


Fig. 2.41 Entry of a shipment request in SAP TM (basic view)

Now we will look at the individual data areas for shipment requests that are filled out by a transportation order processor. The most important data areas are:

- **Shipment request header data and transportation data**
  For categorization of a shipment request in various order types (such as sea freight, air freight and general truck cargo) and allocation to organizational units (like a sales organization or sales office). The header data also includes status information regarding the shipment request that applies to the entire order. The transportation data includes Incoterms, load composition, service definitions and total dimensions and values.
- **Business partners**
  Business partner data includes the obligatory information about the shipper, ship-to party and ordering party, as well as other parties involved in the shipping processes. They may include a predefined service provider (for instance, one a customer has requested), agent or bill-to party. Using the role concept, you can assign as many business partners as you wish.
- **Item data**
  Used to define details of the goods to be shipped. Here, you can indicate the type of goods, goods description, Material numbers, selection numbers, etc. In further subnodes, you can enter the departure and arrival location and dates for each item. You can also enter any necessary measurements (weights, volumes, count, dimension), values, and information regarding dangerous goods, customs and packaging. All fields, with the exception of the goods description and amount fields, are optional.
- **Packaging**
  In the packaging node, you can enter information on the individual packages necessary for the shipment order. A package is defined as shipping material (such as a pallet, cardboard box or pallet cage) with reference to the shipping items or parts thereof. A shipping item with 20 household appliances can, for instance, be packed on five pallets.
- **Resources**
  Resources are subdivided into transportation unit and vehicle resources. You can either use these business object nodes to define resources provided by the customer (such as an ordering party who picks up goods that have already been packed in a container), or you can indicate special resource requirements of the ordering party.
- **Shipment stages**
  In the shipment stages, the individual partial shipment segments are defined. The stages can be multimodal, and can be used for the calculation of distance and mode-dependent transportation costs.
- **Memos**
  Within a shipment request, any number of language-dependent memos can be entered. Notes are categorized free texts (such as of the category *Shipping Memo*) that can be used to forward information in the process chain as well as for printout and communication purposes.
- **Dossier**
  The dossier offers the opportunity to create document references and information on necessary documents and data attachments (such as scanned

documents related to the shipment request) and make them available to people to edit them.

- **Costs and payment methods**
  These subnodes enable the recording of costs and invoice information for shipment requests. Here, the calculated costs are saved for which the shipper or ship-to party will later be invoiced. In addition, information regarding the feasibility of the cost calculation is stored here, and can be accessed to analyze the calculated prices.
- **Official requirements**
  These can be stored under the nodes for official requirements that are relevant for performance of export and dangerous goods checks.

When the transportation order processor enters the shipper and ship-to parties, the ordering party data and the departure and destination location are automatically filled in. Afterward, the processing employee can enter the desired departure and delivery dates. He enters the Incoterms (FOB Iwakuni) into the transportation data, as well as the load characteristics (chemicals, flammable), priority, shipping type code and service requirement code. The total amounts and values are automatically calculated.

The materials loaded into the full container are entered in the shipment request items. There are 25 and 30 barrels with various elastomers. In addition to the gross weight and volume, the gross and net weights and volumes of each shipping unit are recorded. The total value of each item is also entered, as is the value per shipping unit. This data is used later to generate a packing list and pro-forma invoice for customs. Figure 2.42 shows an overview of the amounts and values of a shipment request item.

The container is entered in the shipment request as a transportation unit resource. The individual container numbers are entered in the Registration Number field. Depending on the category of transportation unit resource, a corresponding check of the registration number takes place. The previously entered items can then be allocated to containers to enable labeling of packages.

When a shipment request is created electronically (such as via EDI) or manually, it is initially inactive. This state is part of its *life cycle* and characterizes the initial shipment order of a customer – the customer's wish, so to speak. Through its activation, which can be done by an administrative employee or through program control, a working copy of the shipment order is generated that a planner can use for further processing. This ensures that the customer's wish is preserved in the system in its original form and can be referenced as needed. The various life cycle statuses of the shipment request include *In Planning*, *Planned*, *Confirmed*, *Ready for Execution*, *In Execution*, *Executed*, *Completed* and *Canceled*.

Following activation, the booking processor can have the system issue a transportation proposal (see Fig. 2.43).

Depending on the configuration, SAP TM generates one or more recommendations on how the ordered shipment can be transported, taking into account dates, shipment characteristics, available transportation capacities and routes, and transportation costs.

Transportation proposal for an FCL sea freight shipment. Figure 2.43 shows a transportation proposal for our sample shipment from Japan to China. Three possibilities with varying costs were determined. The most economical is displayed in detail with the individual stages. The desired recommendation can be selected from the presented transportation proposals and stored in the transportation stages of the shipment request.

When the transportation proposal function is accessed, SAP TM automatically generates *freight units* according to defined rules. A freight unit is a shipping volume set by a shipper that is moved collectively through the transportation chain and forms the basis for further transportation planning and optimization. The rules used to create the freight unit define amount restrictions and the granularity of the constructed freight units, such as:

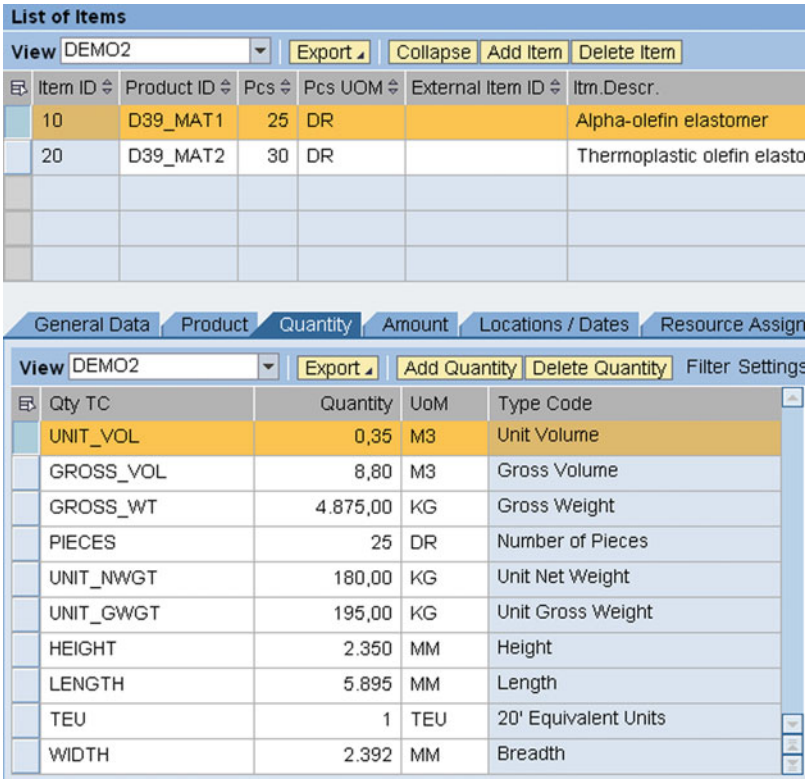


Fig. 2.42 Shipment request items with amounts and values

- Freight unit per container, pallet or other packaging
- Freight unit per shipment or shipment item
- Freight unit per 100 kg of an item
- Freight unit per 1 cubic meter of a shipment order

Figure 2.44 shows the principle of freight unit generation using a shipment request with two items.

Important attributes of the freight unit include the shipper, ship-to party, items and their amounts and material characteristics, and transportation restrictions that can be used to regulate the transit route of a freight unit. Transportation restrictions provide load transfer points and periods for a freight unit that will subsequently be taken into account by Transportation Planning. In addition to the shipment stages of the shipment request, the transportation proposal function also generates transportation restrictions for a particular freight unit.

In our example, the freight unit is constructed on the basis of containers, meaning that the shipment request leads to a freight unit corresponding to a 20-ft container with its contents. Based on the transportation proposal, the ports of

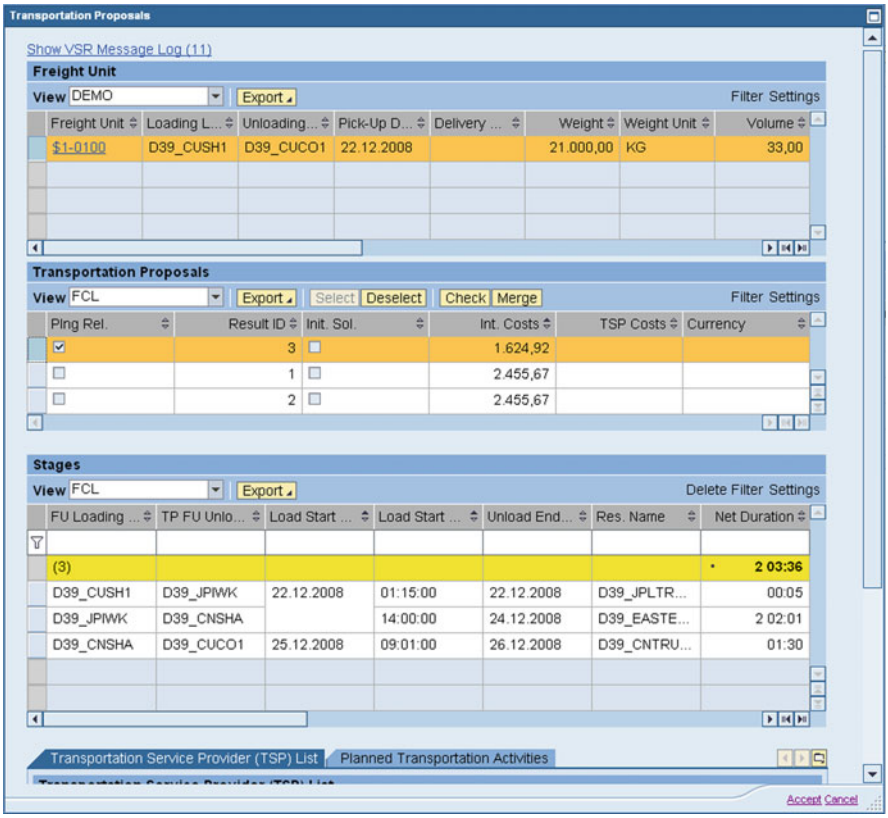


Fig. 2.43 Transportation proposal with route details

Iwakuni in Japan and Shanghai in China are set as load transfer points. This instructs Transportation Planning to avoid routing the freight through Hong Kong, for instance.

At a later time, the planner can, if necessary, create a shipment from the freight units of a shipper through allocation or consolidation that can serve as a basis for the generation of the bill of lading (see Fig. 2.44).

Based on the data in the shipment request (header, items, stages, resources), a booking employee can execute a freight sales price calculation in the shipment request, in order to confirm the freight price for the customer. Determination of freight costs is done using the SAP TM component *Transportation Charge Management*, which is accessed from the shipment request (see also the overview of the TM object model in Fig. 2.36). In Transportation Charge Management, the list of freight price components is generated with the aid of existing freight contracts, tariffs, price calculation schemes and installment structures, and the individual prices are calculated. The result is then stored in the freight cost details of the shipment request. In Fig. 2.45, you can see an overview of the price components that are billed to the ship-to party in our sample process.

To print documents (see the example in Fig. 2.46) in SAP TM, the *Post Processing Framework* (PPF) is used, which represents a further development of the SAP ERP printout control. In the PPF, you can define flexible printing times and requirements, print routes, used forms and their contents for SAP TM standard documents as well as your own documents. Document definition itself is based on Adobe Interactive Forms, with which you can create and edit documents in a graphical editor.

Print document generation using the example of a pro-forma customs invoice. Figure 2.46 shows a sample document (*Customs Invoice*) based on a shipment request with the allocated data segments from which the field values

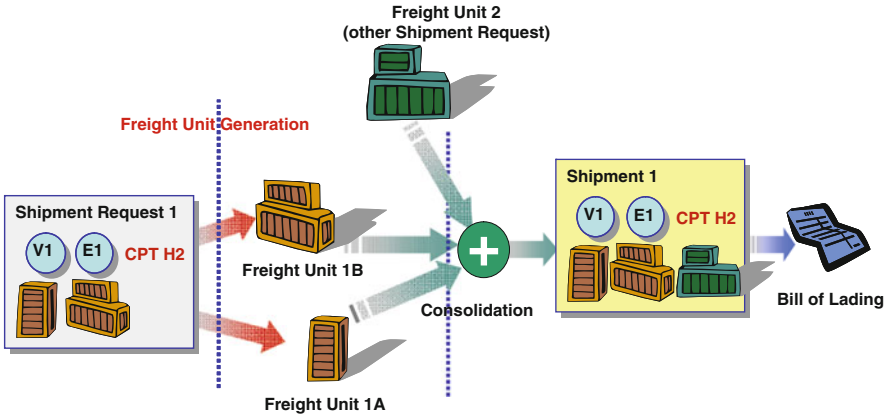


Fig. 2.44 Creation of freight units and shipments

are filled in. A variety of standard document types are available in SAP TM, such as bills of lading based on various norms, shipment request confirmations or transportation instructions.

2.6.5 *Transportation Planning and Optimization*

Transportation planning and optimization operate on several levels, with the initial transport demand being more concretely transformed into transport requests with each level. Figure 2.47 provides an overview of the planning levels.

1. Shipment requests represent the initial transport demand as defined in the request overview, which generally only indicates departure and destination locations (A, B, C, D).
2. After the transportation proposal, a detailed itinerary is determined as a binding requirement for the transportation restrictions of the generated freight units. For cost calculation purposes, respective shipment stages are generated in the shipment request. Additional load transfer points (N, R) are added, which will be taken into account in subsequent optimization.
3. Transportation planning and optimization considers the individual transport demands in the stages (A-N, B-N, N-R, R-D and R-C) and, under consideration of available capacity, schedules, freight costs, transshipment times, service providers and incompatibilities (such as refrigerated goods in a nonrefrigerated container), generates a cost-optimized solution. The planning run results in tours

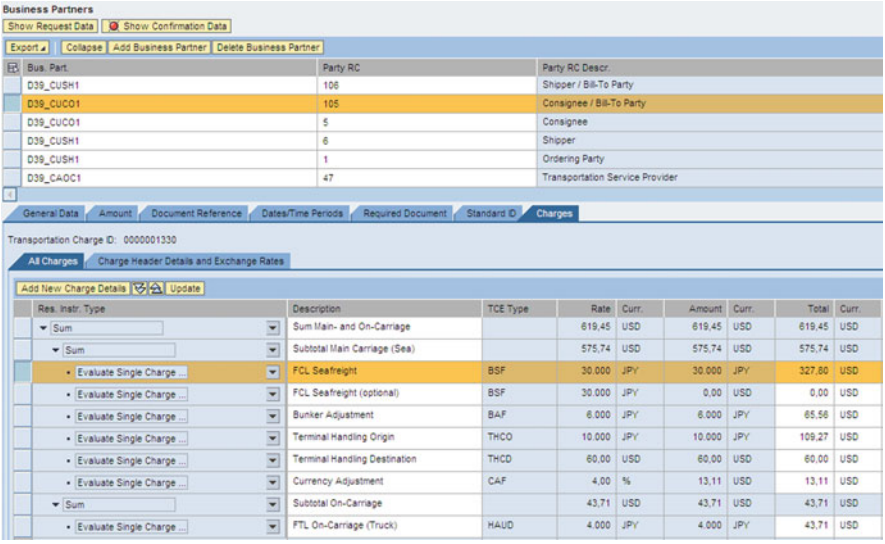


Fig. 2.45 Freight cost calculation (here for the ship-to party with the Incoterm FOB)

with allocated means of transport and service providers with whom the freight units are moved between the load transfer points.

4. Generation of the shipment order creates shipment orders for each tour and their freight units that can be forwarded to the service provider. In the example presented in Fig. 2.47, three shipment orders were generated:
   - Pickup of goods from A and B with a collective truck tour and delivery to Port N
   - Shipping of the goods in a collective sea transport from N to R (master B/L)
   - Collective truck transport from destination port R to goods recipients C and D

In the FCL business process example, the following planning steps are performed:

1. The shipment booking employee has already issued a transportation proposal upon entering the shipment request. This generates shipment stages in the shipment request as well as transportation restrictions in the freight unit. In our example, they are the segments A-N (Waki to Iwakuni port), B-N (Hiroshima to Iwakuni port), N-R (Iwakuni port to Shanghai port), R-D (Shanghai port to Zhongshan) and R-C (Shanghai port to Shanghai).
2. The individually generated freight unit transportation restrictions now automatically appear in the Personal Object Worklist of the import/export planner.

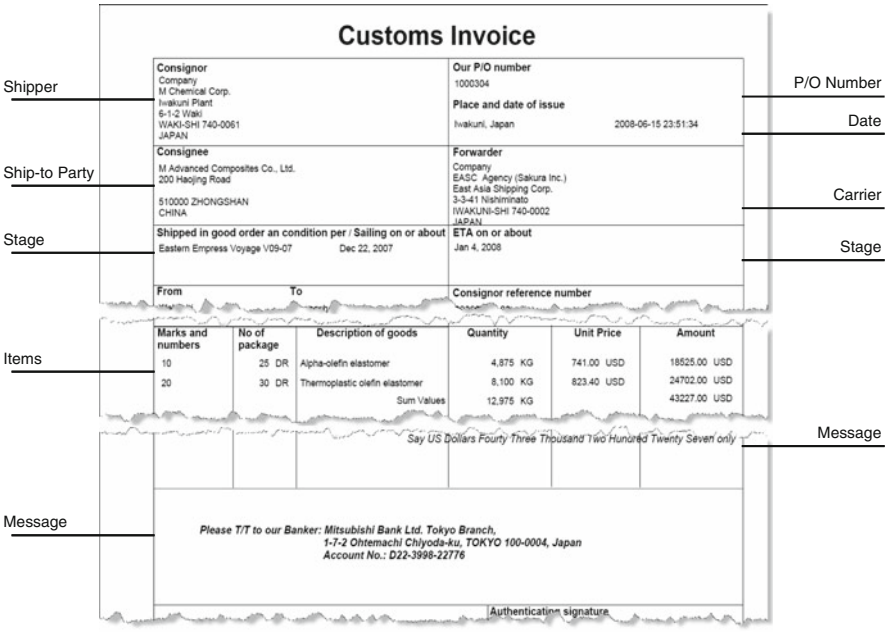


Fig. 2.46 Example of a print document having a data origin (Customs Invoice, not part of the SAP TM standard collection)

3. Initially, the sea freight export employee in Japan plans the two transportation restrictions of the freight units intended for sea transport based on booking orders or itinerary-based resources, thus determining the sea route of the freight.
4. Subsequently, the land freight export planner in Japan can plan the road transport from the shippers to the port in Iwakuni. Depending on the resource situation, costs and time restrictions, load consolidation may take place (as shown in Fig. 2.47, both freights are picked up sequentially by the same vehicle on a single tour and brought to the port), or separate tours are planned. Once the truck tour is complete, the planner can create the shipment order.
5. When the deadline for accepting sea shipments has arrived, the sea freight planner can create and release the shipment order for the sea freight service provider.
6. As soon as it is decided, based on the deadline, which freight units are to be transported on the ship and unloaded in Shanghai, the import planner in the Chinese organization of the logistics service provider can perform planning for transportation restrictions in China. As in the export portion, here, too, circumstances may require consolidated road transport. The planned tours are then used as the basis for generating shipment orders for the on-carriages.

User entry in the Transportation Planning realm is done by selecting two profiles that will largely control the course of planning:

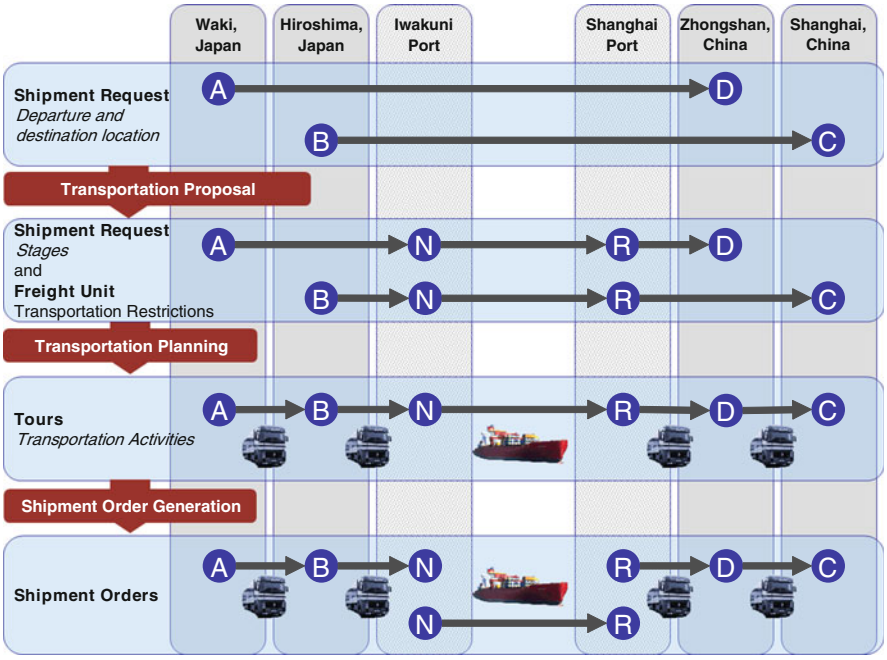


Fig. 2.47 Planning levels in SAP TM

- **Requirement profile**
  The requirement profile defines which freight units are to be selected for planning. For this, you can set geographic criteria (departure and destination locations or zones), temporal criteria (such as delivery within the next 3 days) and other conditions (such as only refrigerated goods). The selected freight units are then integrated in the planner's Personal Object Worklist.
- **Planning profile**
  The planning profile controls the functions of planning and optimization. In the planning profile, you can configure elements in several subareas such as cost evaluation, use of queue and loading time definitions, quality of the optimization results and individual planning steps (optimization, tour generation, shipment order generation or service provider determination).

By selecting those two profiles, a user can determine his work area when entering the planning realm. Examples for work areas pertaining to our sample process displayed in Fig. 2.38 include:

- **Sea freight planning**
  Planning of sea freight shipments from Japanese to Chinese ports for the coming 2 weeks, including tour generation but without creating a shipment order.
- **Land freight planning for Japan**
  Planning and pick-up of FCL freight in the area of western Japan with the destination of western Japanese sea ports within the coming 3 days, including the generation of tours and creation of shipment orders.
- **Completion of sea freight planning**
  Shipment order creation and release for the planned sea freight tours from Japan to China.
- **Land freight planning for China**
  Planning of a delivery of FCL freight from the Shanghai port with the destination of the Shanghai metropolitan area within the next 3 days, including the tour generation and shipment order creation.

After selecting the profiles, an interactive planning screen opens. On this screen, the user can select the freight units to be planned and the resources to be used. Then he can either start manual planning or an optimization run with the selected units. Of course, it is also possible to include all selected freight units and resources in a common planning run.

You can also make use of screens with a tour overview, graphic map display of the transport course or a resource overview. As a result of the planning, the individual transportation activities (loading, transport, unloading, trailer coupling and uncoupling) are stored in SAP TM. If tours have already been created, they are stored as a summary of several activities.

SAP TM Transportation Planning enables you to plan multimodal scenarios, that is, you can also plan the transport in our sample process in a planning run that determines and schedules land as well as sea freight stages together. Figure 2.48 shows a sample network.

Transportation planning and the optimizer used in SAP TM allow you to employ multifaceted planning parameters and optimization strategies and goals. Below, we cite the most important elements that can influence the optimization result:

- **Multidimensional load capacity and time-dependent capacity consumption for resources and booking orders**
  Resources (vehicles, trailers) and booking orders have a certain capacity that can be defined via several dimensions (such as a trailer with a 25-t payload, 100 m shipping volume, 24 pallet storage spaces and 16 loading meters). In the course of time, freight units are loaded and unloaded, such that a consumption profile results for every capacity dimension that serves as the basis for any further loading. If the trailer mentioned above has already been loaded with 25 t but only 50 cubic meters in volume, no further loading can take place.
- **Fixed costs per vehicle**
  Fixed costs can be allocated to every vehicle for optimization purposes.
- **Use of freight cost-relevant elements**
  Cost-relevant elements, such as the distance of a transportation route, number of loading devices, loading weight and volume, transportation duration-dependent costs or costs incurred through intermediate stops can be taken into consideration during optimization. For that process, either optimization results with real freight costs can be calculated and compared, or imaginary optimization costs can be used.
- **Restrictions for transportation duration, number of intermediate stops or total distance**
  You can configure certain settings to limit such things as the maximum transportation duration. This is advisable if a pick-up vehicle can only travel for a maximum of 8 h. Optimization can prevent a 10-h tour from being scheduled.
- **Load compartments**
  For vehicles and trailers, you can define fixed or variable load compartments that can then be planned independently of one another (for instance, a tractor-trailer

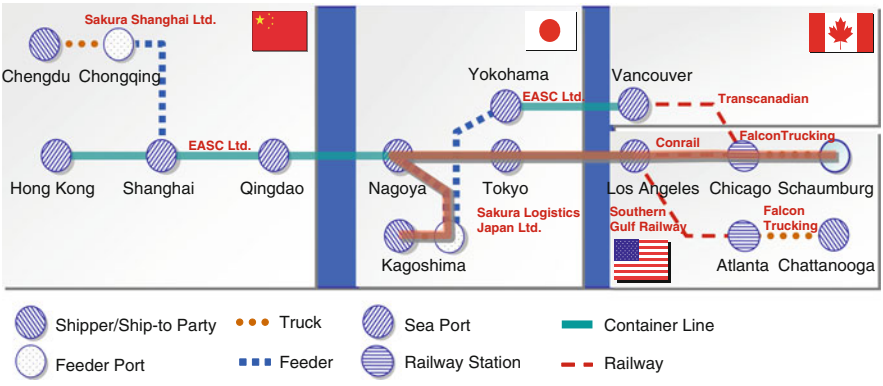


Fig. 2.48 Planning in complex, multimodal networks

with dry and refrigerated compartments). Through an incompatibility definition, the system can be forced to only plan compatible loads for the respective compartments (milk in the refrigerated compartment, rolled oats in the dry compartment).

- **Decreasing capacities in variable load compartments**
  If load compartments are used for individual separation of the freight of individual shippers or recipients, an increasing number of compartments can lead to a decrease in the total capacity of a vehicle in the case of incomplete capacity utilization. This factor is taken into account through modeling of decreasing capacities.
- **Availability and capacity utilization of handling resources in load transfer points**
  If shipments are carried out via load transfer points, the number of available handling resources at these points are decisive for loading lead time at the load transfer point. For example, if a distribution center only has one forklift, wait times will inevitably occur if three trucks need to be unloaded at once. This is considered in optimization planning.
- **Opening hours**
  Different opening hours can be defined for each location and are considered during planning. Freight can only be picked up or dropped off during the opening hours.
- **Duration of loading and unloading**
  Depending on products and locations, variable loading and unloading durations can be modeled. Palleted goods can be unloaded much faster than goods only in cardboard boxes, meaning a product-dependent variance occurs for the durations. This is taken into account during planning.
- **Incompatibilities**
  Incompatibilities represent a means of preventing optimization solutions from having a certain combination of planning element attributes or characteristics. Planning elements that are taken into account include locations, resources, products, business partners, means of transport, service providers or load compartments. Examples of using incompatibilities include:
  - Customer A does not want to be supplied by Carrier X.
  - Shipper B has a ramp that can only be accessed by trucks with a maximum of 12 t.
  - Milk is not to be transported in unrefrigerated compartments.
  - Certain chemicals may not be transported together.
  - Concrete is not to be filled into tanker trucks.
  - Alcohol is not to be transported through Saudi Arabia.
- **Minimum and maximum stopover durations at load transfer points**
  The attributes defined at the locations regarding the minimum and maximum waiting times are used by the optimizer to generate a realistic time lapse when scheduling transports.

- **Depot locations**
  You can define depot locations for vehicles, that is, a location to which a vehicle can return after successful delivery or pick-up. The trip to the depot location is automatically included in the tour by Planning. Vehicles without a depot location can begin a new tour directly from their last loading/unloading point.
- **Waiting and stopover durations (location- and product-specific)**
  In addition to the waiting times defined at the locations, special waiting and stopover durations can be set, and these can be added for a specific product. For example, you can schedule a regular loading time of one hour, but add an additional hour for products that are especially difficult to load.
- **Itineraries**
  Itinerary-based resources (such as liner ships, airplanes, trains, transit system networks) can be supplied with itineraries having regular or irregular departures. The departure times are taken into account during planning.
- **Tractors and trailers, possible combinations**
  Vehicles can be defined as active resources (with loading capacity, such as a truck, or without loading capacity, such as a tractor) or as passive resources (trailers). You can establish predefined combinations of active and passive resources that you can use to model tractor-trailer or railway car combinations. These vehicle combinations are taken into account for the optimization process. It is also possible to unhitch trailers during a tour (leaving them at a depot) and take new trailers.
- **Penalties for early or late delivery or non-delivery**
  Optimization not only takes into account costs related to freight, legs, vehicle and time, but also anticipated penalties that occur due to early or late pick-up or delivery, or because of a failure to deliver.

When several optimization runs are preformed sequentially, a particular evaluation of transportation costs and penalties may lead to planned freight units being removed from the transportation plans. Penalty costs can depend on the significance of a customer and the priority of his transportation contract. Non-delivery may occur if, for instance, individual freight units are removed from planning based on insufficient vehicle capacity or other, more highly prioritized, freight units. An example for such a decision can be seen in Fig. 2.49, which assumes loading a ship with 10 container loading spots.

The loading process depicted in Fig. 2.49 results in the freight unit types with various priorities listed in Table 2.4:

On the *first booking day*, the capacity situation is not yet serious; all of the freight units resulting from orders can be transported as requested.

On the *second booking day*, overbooking occurs, which is accommodated for by removing two of the freight units having a lower priority from the plan (the firm's own containers that are to be repositioned).

On the *third booking day*, extreme overbooking takes place, which leads to customer freight units not being able to be transported. Units with a lower priority

are taken out of the plan and shipped with subsequent transports. The decision of which freight units not to transport is made on the basis of which ones would produce the lowest penalties.

2.6.6 Booking Freight Space

A *freight space booking* is a reservation of freight space on a ship, airplane, train or truck for which it may not yet be clear what is to be transported at the time of the booking. For instance, in sea transit, connections from Asia to Europe or to the United States are often used to capacity, because many goods are produced in Asia but consumed in the rest of the world. That is why there is a very unbalanced flow of goods from West to East compared with that moving East to West, a phenomenon which also affects freight prices.

In order to secure transportation of the goods with regard to available capacity, you can use a booking order to book freight space in advance and receive a booking confirmation. As is the case with a shipment request, you can enter the following data in a booking order:

- Departure und destination location: generally a departure and destination harbor, airport or railway station

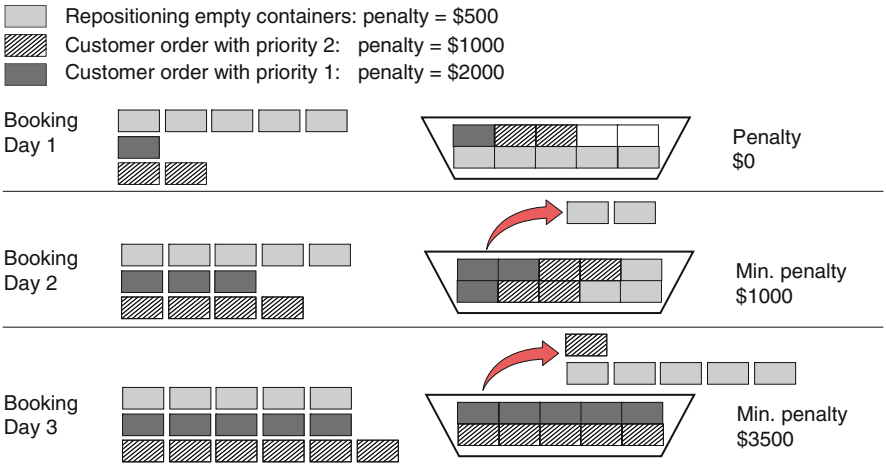


Fig. 2.49 Optimization situation with a minimization of penalties

Table 2.4 Penalties for non-fulfillment of shipments (sample values)

Freight unit type	Priority	Planned penalties for non-fulfillment
Repositioning empty containers	3	$500
Freight units of standard customers	2	$1,000
Freight units of preferred customers	1	$2,000

- Departure and arrival dates
- Reserved freight space capacity with capacity type (such as ten 40-ft containers, 8 loading meters, 3 t)
- Reserved transportation units
- Service provider that executes transport
- Identification of the flight, ship, cruise or train

Booking order for a container ship in the FCL process. Figure 2.50 shows a booking order for sea freight transport in our sample process. Here, freight space for five 20-ft containers is reserved. Thus, the booking order also has a consolidating function.

Confirmation of a booking order can either be done by the service provider electronically or by one of your employees. After the booking order has been confirmed, the confirmed capacity is available for transportation planning, as is the case for the itinerary resource. You can then assign freight units as transport demand to the booking order as transportation capacity. All of the transportation activities allocated to a booking order are used to create a tour. A shipment order can then be created from that tour. In accounting terms, the shipment order represents the master bill of lading (Master B/L, MAWB).

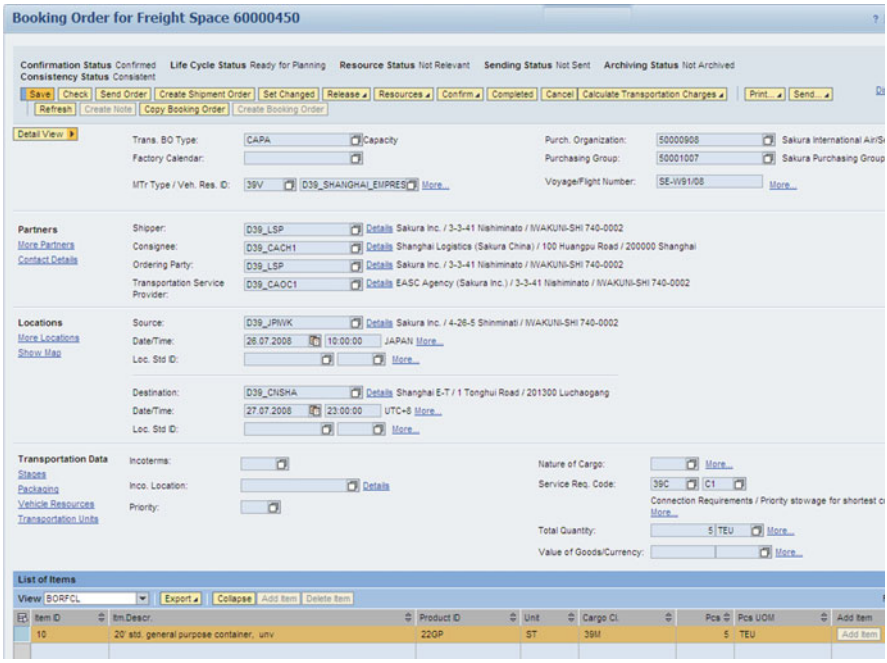


Fig. 2.50 Booking order for sea transport with five standard containers (20-ft)

2.6.7 Subcontracting

The subprocess *Subcontracting and Tendering* enables you to create, manage and settle transport requests to third parties, such as carriers, other logistics service providers or one's own fleet. The central business object in this area is the *shipment order* (see Fig. 2.36). You can also use a freight order to consolidate several shipment orders for a single service provider.

Shipment orders are generally the result of manual or optimized transportation planning after the created tours have been processed by shipment order generation. The same is true for *freight orders*, either generated as a result of consolidation or from a connected transportation planning effort (*Continuous Move*), for which a series of tours is allocated to a service provider to achieve higher cost efficiency.

You can also manually create shipment orders to request a shipment that has either nothing or only little to do with actual transportation planning. Such orders can include the following cases:

- Provisioning or pick-up for empty containers
- Work orders to service companies, such as for packing, aeration, measuring, declaring or loading freight

Shipment orders are connected to the original shipment request via the transportation activities and freight units referenced therein. This enables SAP TM to relate the sales side (shipment requests) with the purchasing side (shipment orders) and perform a profitability calculation for transportation orders (see Fig. 2.36).

In terms of their content, *shipment orders* and *shipment requests* are very similar, since they represent an outgoing transportation order (that is, an order to a transportation service provider) and an incoming transportation order (meaning a transportation order from a shipper). Thus, you can naturally enter the same data in a shipment order as in a shipment request. The structure of the messages used for electronic communication is also the same. It corresponds to the EDIFACT format IFTMIN. Figure 2.51 illustrates order development in SAP TM and the subsequent communication with service provider systems (here, including SAP TM).

Based on the original shipment requests (on the left of the illustration), freight units are formed that, with the aid of Transportation Planning, are allocated to tours and shipment orders. Several shipment orders can be assigned to a freight unit (for example, a pre-carriage, main carriage and on-carriage) that are then communicated electronically to various service providers. If these service providers also use SAP TM, the incoming messages are converted to shipment requests that each service provider can individually plan.

The shipment order user interface is designed in the same way as that of the shipment request, with the exception that there is no basic view (see Fig. 2.41), since manual entry is only done in exceptional cases. Figure 2.52 shows the detail view of a pre-carriage shipment order.

Unlike the shipment request, in which the shipper and recipient of goods are entered as locations, the shipment order cites the freight station of the logistics

service provider at the port of dispatch as a destination location. The cost view in the shipment order shows the billing items that are invoiced by the transportation service provider. Because the shipment order can be a consolidation of several freight units – including from different shippers – it is also the business object that represents the master bill of lading in SAP TM.

The *transportation service provider selection* is a function that is executed based on shipment orders. You can manually allocate a shipment order to one or more possible transportation service providers, or this can be done with the support of the

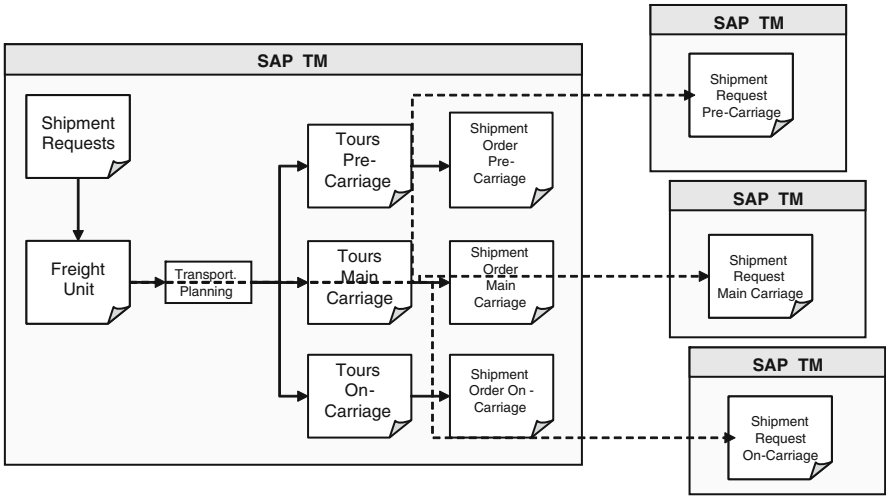


Fig. 2.51 Communication of shipment orders to service provider systems (as a transportation order or shipment request)

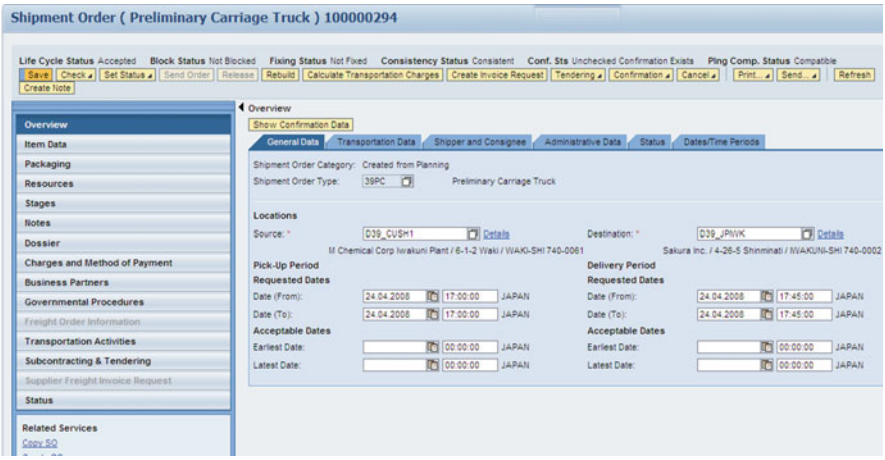


Fig. 2.52 Detail view of a pre-carriage shipment order

system. Automatic transportation provider selection is a good idea in the following instances:

- When several transportation service providers are possible for certain shipments, and the one that is most inexpensive, reliable or has the highest priority is to be selected.
- When certain service providers serve particular regions or only execute certain types of transports (for instance, some will not transport dangerous goods or only ship within New England), and the allocation of a suitable service provider is to be done automatically.
- Outline agreements are stipulated with various service providers regarding percentage-based or absolute quotas in a transport job that must be fulfilled to receive special shipping conditions and prices (such as a minimum of 500 TEUs on the Hamburg-to-Singapore container line or 20% of all truck transports in New England).

As described above, you can allocate a shipment order to one or more service providers. The shipment order is always only given to one service provider. However, the indication of several service providers is required for the transportation *tendering* function. Tendering serves to select service providers from the list who:

- Ensure/confirm available transportation capacity and performance
- Offer the lowest price (spot quote)

SAP TM offers three procedures for the execution of the transportation tendering. The tendering procedures are each controlled by a process triggered in SAP Event Management. It ends the current process step when a service provider has responded or the tendering period has expired, and begins the next tendering step or presents the tendering result:

- **Peer-to-peer tendering**
  Tendering is performed sequentially and for each individual service provider, in order of priority. This means that the service provider with the highest priority is contacted. If he answers with an acceptance of the tender and the price, tendering is complete. If he does not respond, rejects the bid or offers insufficient conditions, tendering goes to the next service provider.
- **Broadcast tendering**
  Tendering is sent simultaneously to all service providers. Upon expiration of the tendering period, the offers are compared and the best one selected.
- **Open tendering**
  Open tendering works in much the same way as broadcast tendering; however, not only preselected transportation service providers are contacted that have already been allocated to a shipment order, but all service providers maintained in the system that correspond to certain selection criteria (such as truck transportation in New England).

Tendering can either be performed via electronic data communication, meaning the service provider receives a request to submit a quote via EDI, or you can give service providers access to a *collaboration portal*, where they can view tenders directed at them and respond to them.

After the tendering process has been completed, the selected service provider is commissioned via electronic data communication, fax or email.

After the service provider has been selected, you can calculate the freight purchase price in the shipment order just as was done in the shipment request. After the calculation, in the corresponding views of the shipment request, you will find a detailed list of the individual cost items (see Fig. 2.45). They can be manually adjusted and subsequently used in the invoice verification process for the service provider and in the credit memo procedure to settle open invoices.

2.6.8 Transportation Charge Management

Transportation Charge Management is a powerful tool in SAP TM with which you can calculate all costs occurring in transportation processes:

- Earnings from the sale of transportation services
- Costs for the purchase of transportation services
- Internal costs for use of a company's fleet
- Internal settlement between organizational units of a logistics service provider

The realm of Transportation Charge Management is primarily composed of the following elements:

1. Contract, tariff and freight rate data (master data)
2. Operative cost structures in the order documents
3. Settlement-related cost structures in the settlement documents
4. Incoming and outgoing invoices and internal clearing
5. Booking in Cost Accounting and Financial Accounting

As depicted in Fig. 2.36, you will find elements 1, 2 and 3 in SAP TM, and elements 4 and 5 in SAP ERP.

The *master data* of Transportation Charge Management is constructed in a multilevel way, with the elements of the central and lower levels being reusable (see Fig. 2.53).

The top level of the definition is represented by *freight agreements*, which stipulate a contractual relationship between parties with the goal of determining transportation prices for freight purchasing or sales. In addition to the contractual partners and application (purchasing or sales), other details such as validity periods, currency definitions and cost limits can also be defined.

Every freight agreement contains one or more tariffs that can be used within the context of the freight agreement. A tariff defines the way in which transportation charges are to be calculated for certain transportation processes. The tariff is also

defined by determining conditions for its application; in the example shown in Fig. 2.54, these include the shipment type *sea freight* and the departure and destination ports of *Hong Kong* and *Los Angeles*. Further conditions can include stipulations for types of goods, transportation zones or service conditions.

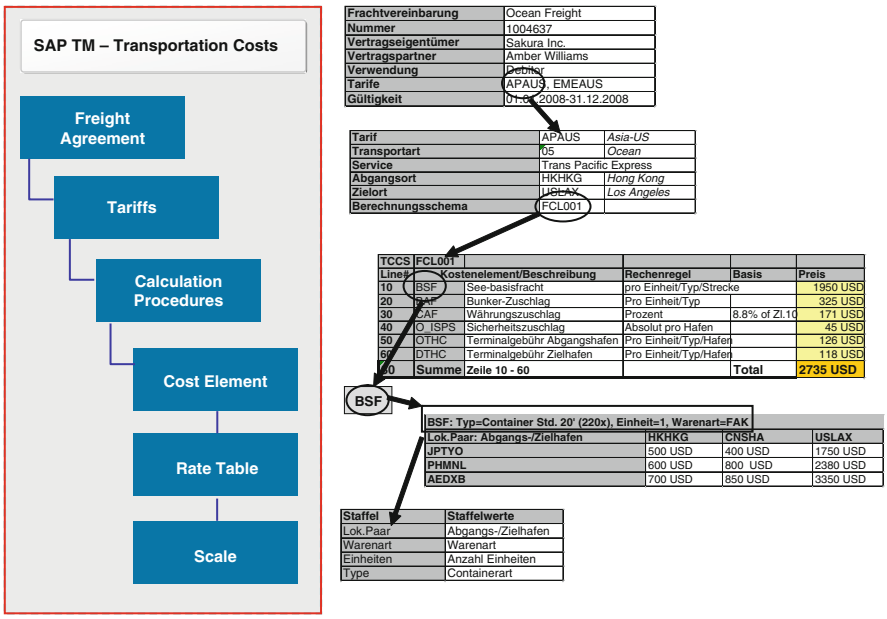


Fig. 2.53 Structure of the charge management master data

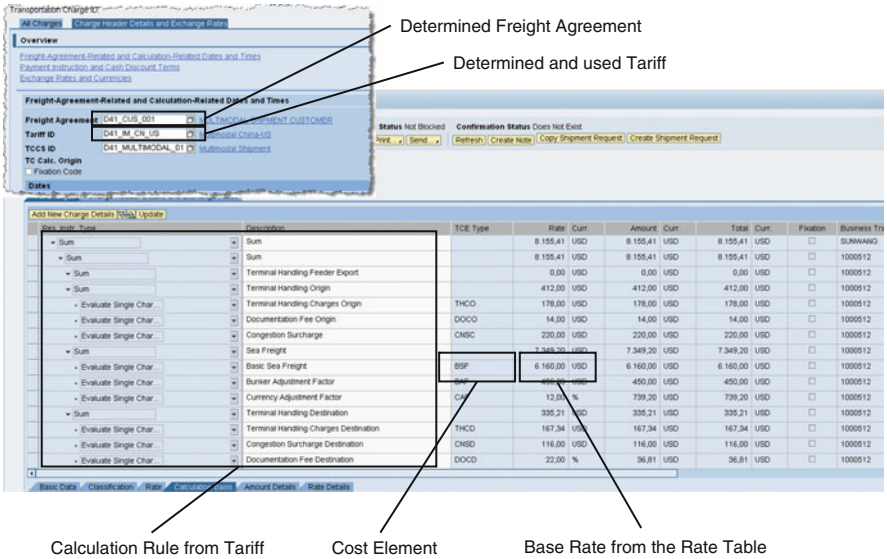


Fig. 2.54 Structure and allocation of transportation costs in the agreement documents (shipment request, shipment order)

A *transportation charge calculation* is maintained in every tariff, which defines individual cost elements and their relationships. A transportation charge calculation can be a list of individual cost elements (such as the ocean base freight, bunker surcharge, or terminal fees), defined either with absolute values, as percentages with reference to other cost elements or with reference to a *calculation rule* (such as a rate table). Every cost element can, in turn, have conditions for its application. For instance, you can define cost elements that can only be applied to certain Incoterms.

To calculate cost elements, *rate tables* are frequently consulted, which are based on scales representing various dimensions. A rate table can have up to nine dimensions, for which the scales are either defined as direct values or as minimum and maximum values. A typical rate table in sea freight might have the following dimensions:

- Departure port (Hamburg, Rotterdam, Antwerp)
- Destination port (Singapore, Hong Kong, Shanghai)
- Container type (20-ft standard, 40-ft standard, 40-ft refrigerated container)
- Type of goods (general freight/FAK, electronics, dangerous goods)
- Service degree of the transport (standard, priority)

The price per container is then defined depending on these five dimensions. That price is multiplied by the number of corresponding units in the charge calculation.

Operative calculation of transportation charges is always either triggered by the shipment request (calculation of the sales price) or the shipment order (calculation of the purchase price) (see Fig. 2.36). The data of the respective order is transferred to freight cost determination in a standardized format. Once there, the applicable freight agreement and tariff are determined. This in effect determines the charge calculation. After each cost element is calculated (under consideration of the condition of applicability) the finished list is returned to the shipment request or order, where it is displayed with the business object in the Costs and Payment Method (see Fig. 2.54). Here, you can also overwrite amounts and other data to adjust the subsequent invoice. The data is stored along with the order.

Costs view of a shipment request. Figure 2.54 shows the Cost view of a shipment request with the various attributes and areas (freight agreement, tariff, cost elements, etc.) high-lighted. The value in the column Total is converted to the currency stipulated with the respective business partner in the freight agreement.

When it comes time to generate or verify the invoice, *requests for freight settlement* are generated and represent a pro-forma invoice in SAP TM. Because the actual invoice generation or verification is performed in SAP ERP, only pro-forma documents are generated in SAP TM, which are transferred to the ERP system after their check and release.

In the case of a shipment request, a customer freight invoice request is generated and directly transferred to SAP ERP, where it leads to an invoice document. This

document can be directly used for customer freight settlement and is automatically integrated into Financial Accounting.

In the case of a shipment order, a service provider freight invoice request is generated for settlement. This is initially transferred to SAP ERP to accrue reserves for the expected service provider invoice. If a pro-forma invoice is then transferred, a purchasing document for services is generated with a service entry sheet. Based on this, the data is integrated into Financial Accounting and incoming invoice verification is subsequently conducted.

2.6.9 Integration with SAP Event Management

For purposes of process control and tracking the status of transportation procedures, SAP TM is integrated with SAP Event Management. Relevant processes that must be monitored by Event Management are automatically initiated:

- Tracking of the processing status of a shipment request
- Shipment tracking
- Tour tracking (itinerary monitoring)
- Tracking of a resource as an asset (containers and railway car tracking)
- Status and life cycle management for tendered shipment requests

Status values are reported to Event Management either from the current process in SAP TM or, more frequently, from outside via electronic data communication (EDI) or interactive feedback (such as a vehicle computer or onboard unit, OBU). You can then display the status history in SAP TM, in the context of the respective business object. Figure 2.55 shows the view of the status history of a shipment from our sample process.

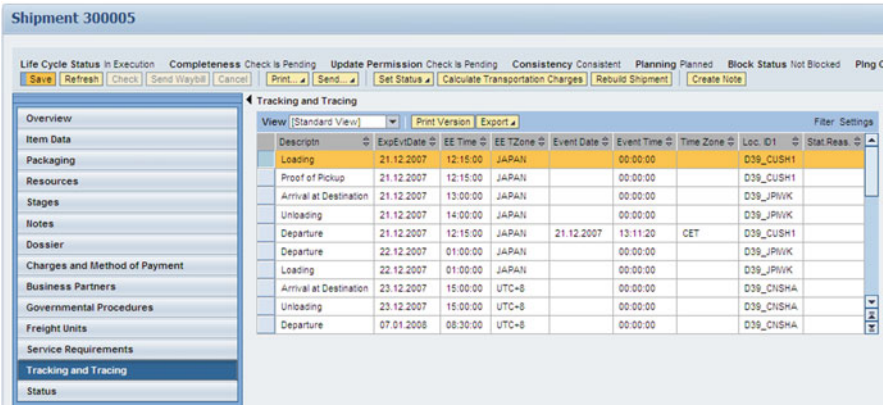


Fig. 2.55 Status tracking/history of a shipment

2.7 Summary

In the world of SAP solutions, each transportation management component has a special significance. As the most modern of the components, *SAP Transportation Management* (SAP TM) offers the widest range of functions and the greatest degree of flexibility.

For simple scenarios, however, and considering TCO (*Total Cost of Ownership*) aspects, the use of SAP ERP Transportation Management can also be beneficial; with it, you do not need any additional system for transportation management.

If you have demands in the realm of transportation optimization, you can either integrate an external transportation planning system into ERP Transportation Management, or select APO Transportation Optimization, which also gives you the integration of an availability check.

In the next chapter, we will examine warehouse logistics and inventory management with SAP.