S4TM2

Planning and Execution in SAP S/4HANA TM

PARTICIPANT HANDBOOK
INSTRUCTOR-LED TRAINING

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Typographic Conventions

American English is the standard used in this handbook.

The following typographic conventions are also used.

This information is displayed in the instructor's presentation	
Demonstration	
Procedure	
Warning or Caution	
Hint	
Related or Additional Information	
Facilitated Discussion	
User interface control	*Example text*
Window title	*Example text*

Contents

Course Overview

TARGET AUDIENCE

This course is intended for the following audiences:

- Systems Architect
- Application Consultant
- Industry / Business Analyst Consultant
- Super / Key / Power User
- Business Analyst
- Solution Architect
- User

UNIT 1 Transportation Management Overview

UNIT OBJECTIVES

- Understand the SAP TM evolution and timeline
- Describe the differences between basic shipping and advanced Transportation Management
- Understand SAP TM deployment options and migration paths
- Describe the end-to-end transportation processes

Unit 1
Lesson 1

SAP TM Overview and Evolution

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Understand the SAP TM evolution and timeline
- Describe the differences between basic shipping and advanced Transportation Management

SAP TM Overview and Evolution

SAP Transportation Management

Companies have been shipping products across countries and continents for centuries. The concept of managing the transportation of products is not new. However, using new methodologies and technology can make a difference in an industry. Today, most economies are wholly reliant on efficient transportation logistics.

With the shift in recent years towards a global economy, crossing borders has become commonplace. Reaching customers in more remote locations and sourcing the procurement of product from multiple vendors or locations has increased the cost of transporting products. As the world becomes smaller, the team tasked with maintaining logistics needs to respond faster and more cost-effectively.

Global natural disasters and other dangers show the vulnerability of the global supply chain. Despite these challenges, the transportation part of the supply chain, in particular, has to solve the problems that arise in order to keep factories running and customers supplied.

The following figure provides a high-level overview of TM:

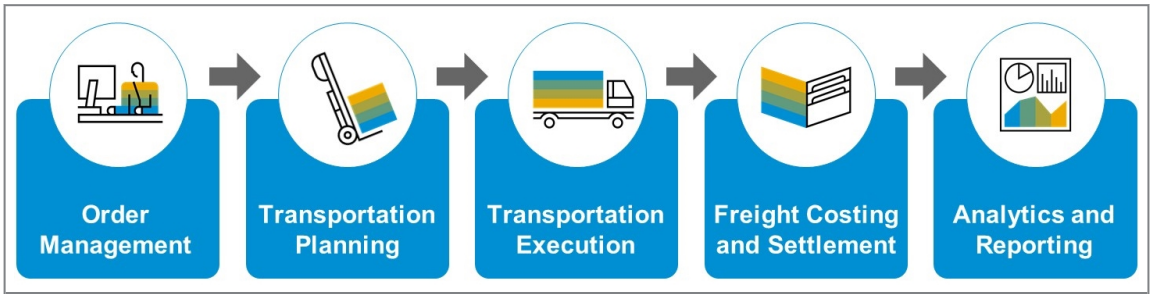

Figure 1: Comprehensive Transportation Management Coverage

A typical transportation process starts with order management. Order management is the process of creating a transportation requirement. Transportation requirements can be sales orders, purchase orders, deliveries, and so on. In a second step, these transportation requirements are planned. SAP TM offers manual planning functions, optimizer planning, and semi-automated processes (transportation proposal creation). Different aspects of planning supported by SAP TM are means-of-transport selection (for example, rail versus road),

carrier selection based on real carrier rates, load optimization (3D-planning of container/ truck utilization). Once the planning process is finished, SAP TM also supports the execution of transports. Execution includes delivery creation, document creation (print or electronic, like waybills), event management integration (track and trace), as well as warehouse integration (EWM integration). If you do not operate your own fleet, you need to make sure that the external carrier is paid for their services. SAP TM allows you to maintain freight agreements, calculation sheets, and rate tables to accurately define real carrier costs, which can be used for charge calculation (already in the planning phase, carrier selection), but also for settlement processes after the transport has been executed. Analytic and reporting functionalities complete the available functions of SAP TM.

Evolution of SAP Transportation Management

The transportation solution that was released as part of SAP R/2 was in the first logistics solution release by SAP. In 1993, SAP R/3 logistics execution (LE-TRA) was released. Transportation Planning/Vehicle Scheduling TPVS was released in 2000 and it enabled transportation network optimization. SAP TM 6.0 and 7.0 evolved from the SAP Transportation Planning/Vehicle Scheduling (TPVS) solution. With SAP TM 8.0/8.1, the architecture was redesigned and simplified. It focused on Shippers and LSP processes. SAP TM9.0 was focused on Air Freight forwarding. As time went on, customer feedback and lessons learned from the early implementations were used as a basis for improving the solution and further versions of SAP TM were developed. As society and business make the move to mobile, SAP TM is evolving accordingly and now includes several mobile-friendly elements. For example, drivers can input updates using mobile devices and this information can be used to update customers of possible delays. While previous iterations included integration with Global Trade Services (GTS) and facilitated compliance, the focus more recently has been on improving the shipper and freight forwarder elements of SAP TM.

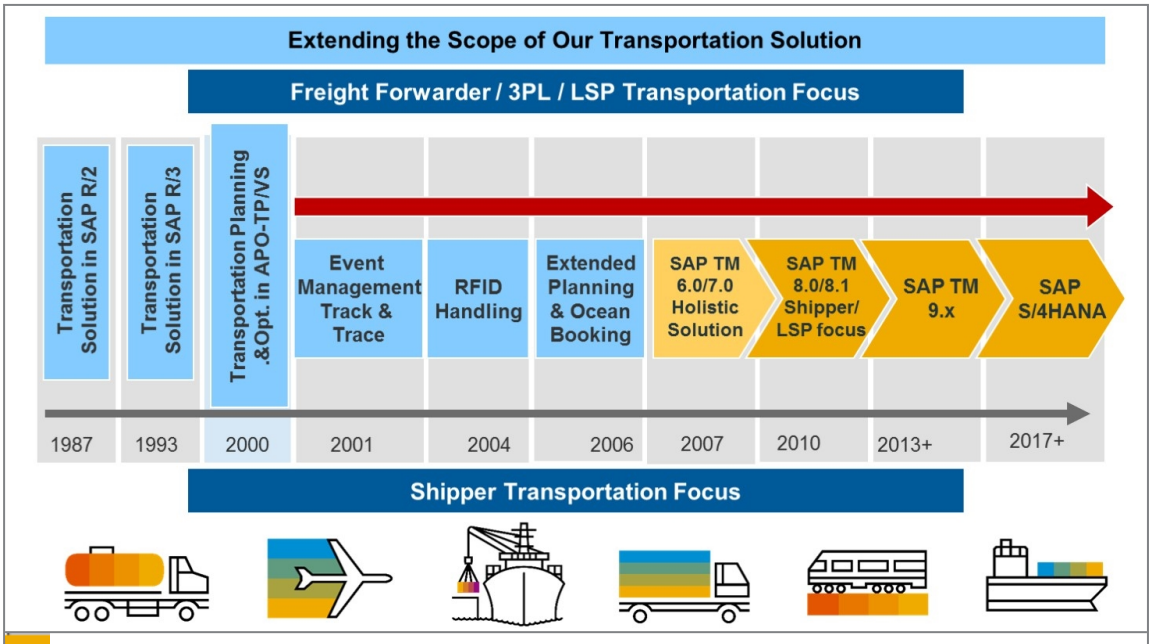

Figure 2: SAP TM Evolution

From SAP S/4HANA 1709, Transportation Management becomes part of S/4HANA Enterprise Management. It offers a much more comprehensive and sophisticated functionality in the domain of transportation. Use of its advanced functions requires an additional license. However, it can also be used with limited scope, that is, offering the same capabilities that have been offered by LE-TRA. Use within this limited scope does not require a specific license.

The software component LE-TRA that provided transportation-related content in SAP ECC is part of the compatibility scope (SAP Note 2269324 – Compatibility Scope Matrix for SAP S/4HANA on-premise). That means that its code line is kept within SAP S/4HANA Enterprise Management until the end of 2025. The functionality offered from this component is called basic shipping.

Both technical applications are independent of each other and can then be used next to each other on the same SAP S/4HANA database instance. They have no data exchange/integration within the shipping process. Long term, the collection of basic shipping processes will only be realized by using selected functions of SAP S/4 HANA TM. The shipment from LE-TRA will be replaced by the freight order from SAP TM.

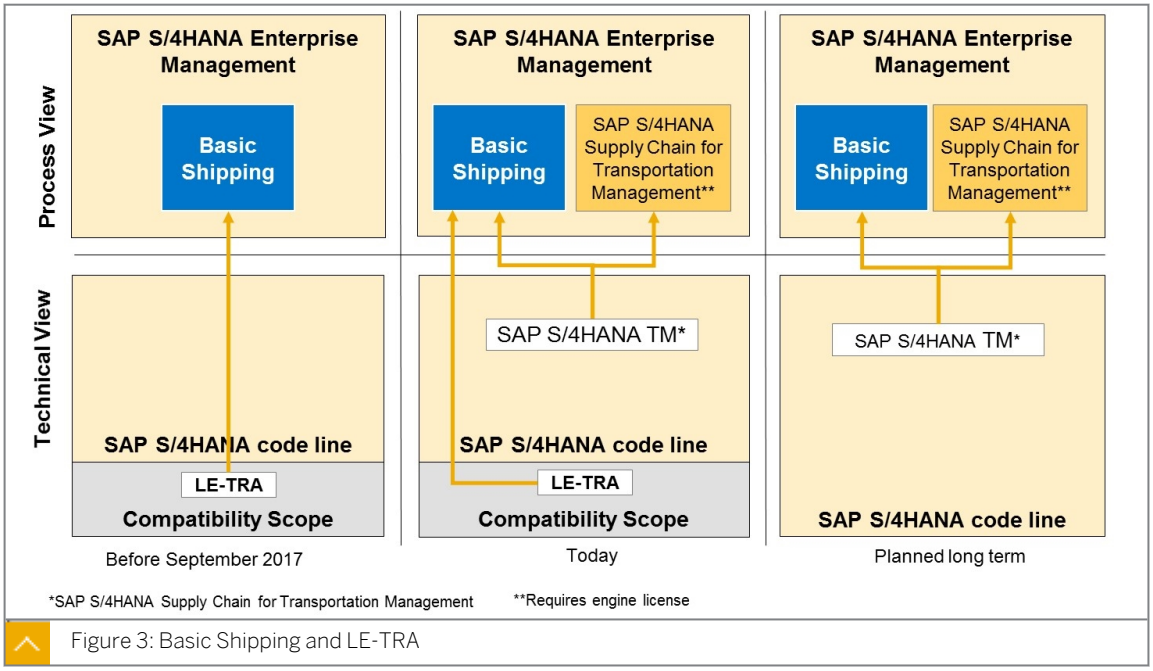

Figure 3: Basic Shipping and LE-TRA

Differences Between Basic Shipping and Advanced Transportation

Comparison of Basic Shipping and Advanced Transportation

Figure 4: Comparison of Basic Shipping and Advanced Transportation

Advanced TM addresses not only the shipping industries, but also freight forwarders. It allows early planning based on orders (sales orders, purchase orders, MM scheduling agreements) in addition to planning based on deliveries (outbound and inbound), which is the only option in basic shipping. Combined planning of inbound and outbound deliveries within one freight order is allowed in the advanced transportation option. Sophisticated planning and optimization options in the domain of vehicle scheduling and routing, carrier selection, load consolidation and load planning are key differentiators between advanced transportation and basic shipping.

Detailed Description of Functional Difference

Sources of information, whether specific functionality relates to basic shipping or advanced transportation scope, is defined in the SAP S/4HANA 1909 Feature Scope Description document.

Basic shipping is defined as follows:

Transportation Management in SAP S/4HANA supports the entire transportation chain. You can manage the transportation demands by planning, tendering, and settlement of freight processes. Also, you can book carriers in accordance with the requirements of hazardous goods. Transportation Management supports the following end-to-end processes:

- Domestic and international transportation for the shipper industry
- Inbound and outbound freight management

Advanced Transportation Management is defined as follows:

Advanced Transportation Management (TM) in SAP S/4HANA supports the entire transportation chain. You can manage the transportation demands by planning, optimizing, tendering, subcontracting, and settlement of freight processes. Also, you can book carriers in

accordance with the requirements of international trade and hazardous goods. TM supports the following end-to-end processes:

- Domestic and international transportation
- Inbound and outbound freight management based on sales orders, purchase orders, deliveries, stock transport orders, and returns
- Embedded analytics and key performance indicators for real-time performance visibility

Furthermore, SAP note 2868497 provides a detailed overview and comparison between LE-TRA, basic shipping TM and advanced transportation management scope.

Best Practice Scenarios

Best practices have been defined for the implementation of basic shipping scenarios. The following notes describe the details:

- 2563537 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Outbound Transportation (Basic Shipping Scenario) 1709
- 2563425 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Stock Transport Orders (Basic Shipping Scenario) 1709
- 2606349 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Inbound Transportation (Basic Shipping Scenario) 1709
- 2632695 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Combination of Inbound and Outbound Transportation (Integrated Transportation Management) 1709
- 2849562 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Outbound Transportation (Basic Shipping Scenario) 1809
- 2849539 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Inbound Transportation (Basic Shipping Scenario) 1809
- 2849584 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Combination of Inbound and Outbound Transportation (Integrated Transportation Management) 1809
- 2970146 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Inbound Transportation (Basic Scenario) 1909
- 2969153 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Outbound Transportation Scenario 1909
- 2970191 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Combination of Inbound and Outbound Transportation (Advanced Transportation Management) 1909
- 2970165 - SAP Best Practices for S/4HANA Supply Chain for Transportation Management – Stock Transport Orders (Basic Scenario) 1909

LESSON SUMMARY

You should now be able to:

- Understand the SAP TM evolution and timeline

- Describe the differences between basic shipping and advanced Transportation Management

Unit 1
Lesson 2

Deployment Options and Migration Paths

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Understand SAP TM deployment options and migration paths

Deployment Options

The initial release of SAP TM was on SAP NetWeaver or SCM server and used as a separate application interfacing with SAP ECC. Since SAP S/4HANA 1709, SAP Transportation Management is part of SAP S/4HANA (embedded TM), which also supports side-by-side scenarios, meaning that demand can be received from other SAP ERP or SAP S/4HANA instances. Depending on which system is currently implemented, the following scenarios can used by used to migrate to SAP S/4HANA:

- SAP ERP with SAP TM 9.x: Classic business suite integration of SAP TM and SAP ERP
- SAP S/4HANA with SAP TM 9.x: SAP S/4HANA ERP using SAP TM side car solution. Side-by-side integration of SAP S/4HANA and the business suite
- SAP S/4HANA ERP with SAP S/4HANA TM: SAP S/4HANA ERP system with decentralised SAP S/4HANA TM system
- SAP ERP with SAP S/4HANA TM: SAP ERP with side-by-side SAP S/4HANA TM – for customers not yet converted to SAP S/4HANA ERP

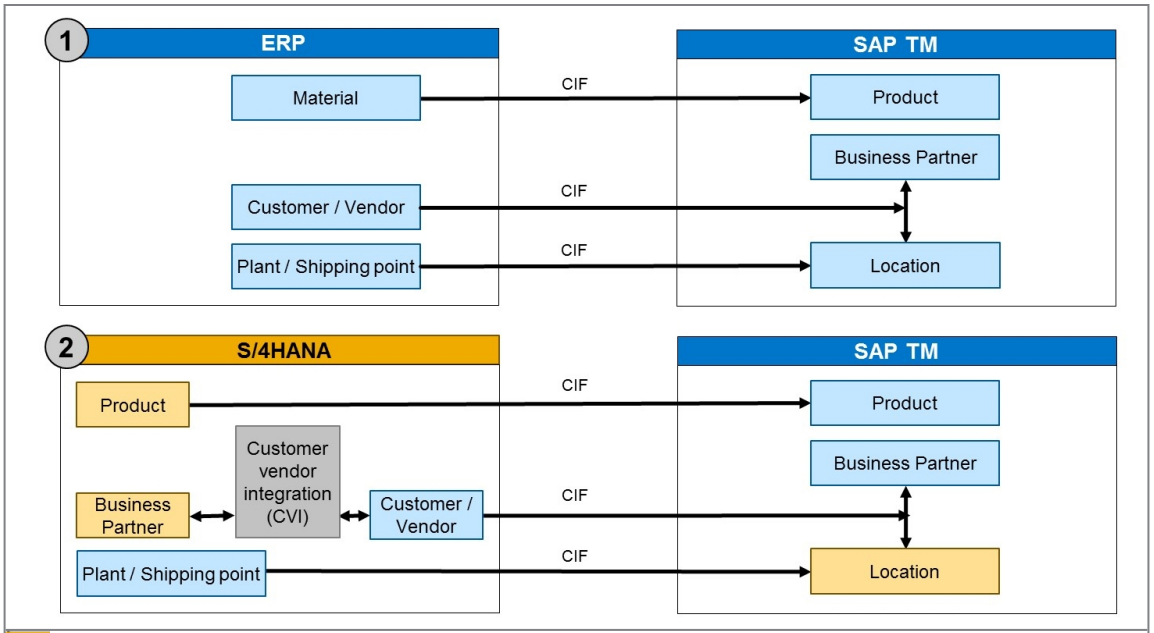

Figure 5: Deployment Scenarios 1 & 2

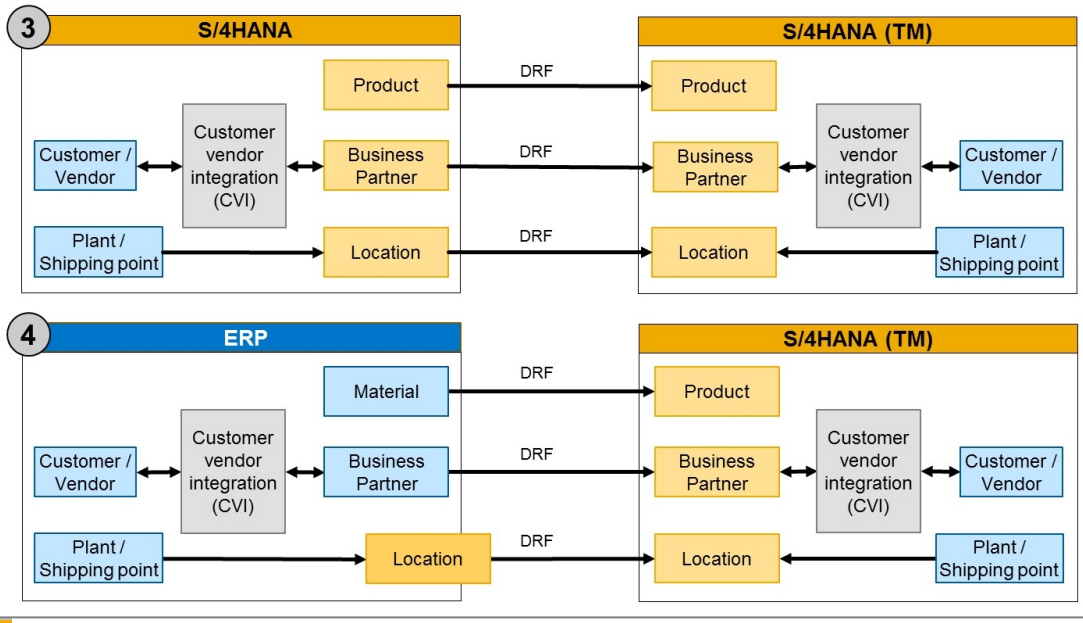

Figure 6: Deployment Scenario 3 & 4

No interface is obviously required if SAP TM is used "embedded", because in this case, all relevant master data objects are available in SAP S/4HANA, and following the "principle of one", no replication is required. If SAP TM is used in a "side-by-side" deployment, the interface used to transfer master data from an SAP ERP or SAP S/4HANA system to SAP TM or SAP S/4HANA TM depends on the destination system. If the receiving system is an SAP TM 9.x (Business Stack), then CIF (core interface) is used. If the receiving system is an SAP S/4HANA system, then DRF (data replication framework) is used.

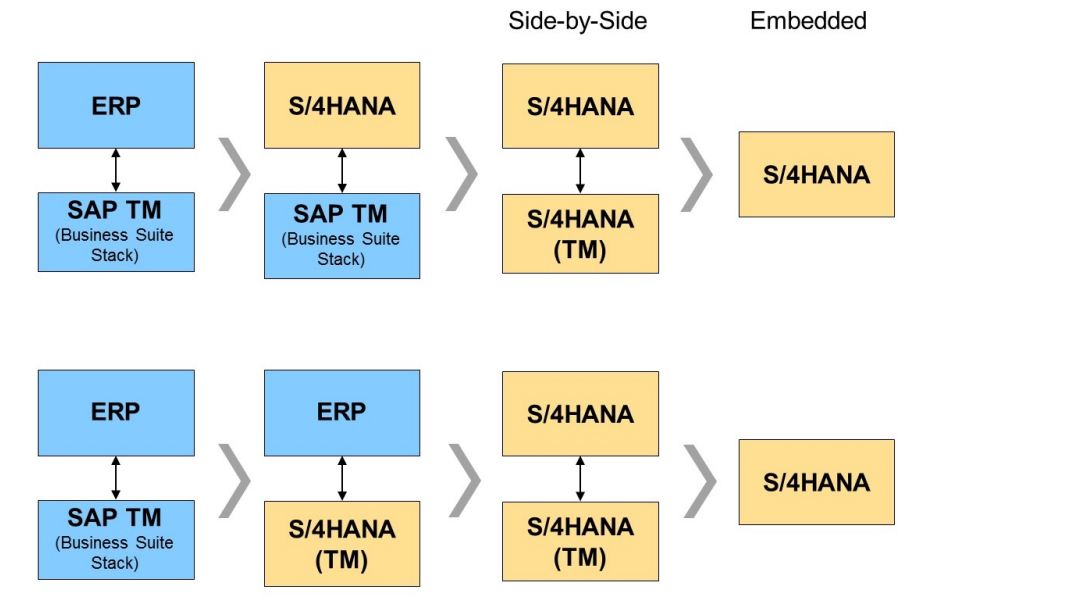

Figure 7: Migration Path and Deployment Options

LESSON SUMMARY

You should now be able to:

- Understand SAP TM deployment options and migration paths

End-to-End Transportation Process

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Describe the end-to-end transportation processes

End-to-End Transportation Processes

Transportation Management - Object Overview

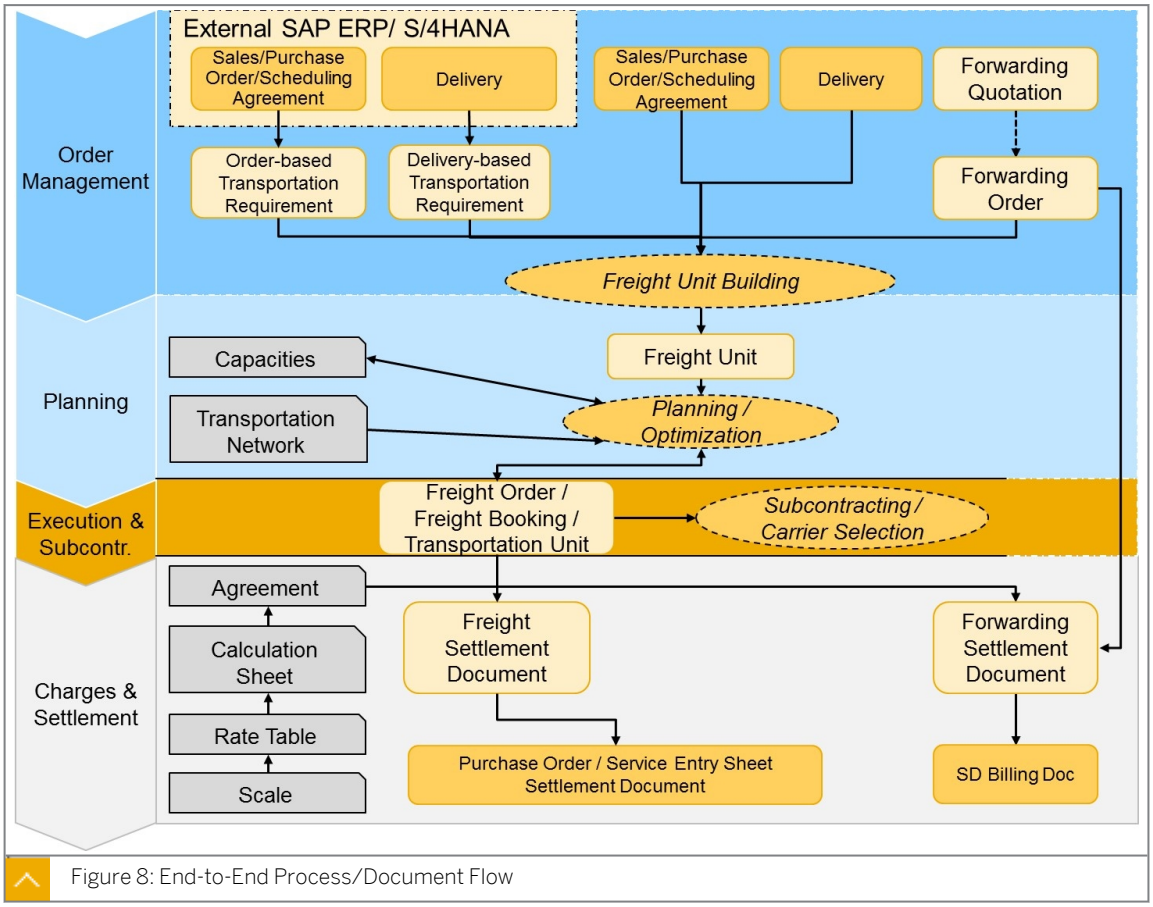

Figure 8: End-to-End Process/Document Flow

The figure, End-to-End Process/Document Flow, gives an overview of the SAP TM document model. Depending upon the extent of your integration and business requirements, different objects, documents and statuses are available. Different types of transportation requests can be created in SAP TM by the execution or order management system. The documents that are the basis for freight unit creation depend on your business scenario and deployment of SAP TM, as follows:

- If you are a shipper and you have deployed SAP TM in a side-by-side scenario, (sales/purchase) orders from your SAP ERP or SAP S/4HANA system are the basis for order-based transportation requirement creation in SAP TM.
- If you are a shipper and you have deployed SAP TM in a side-by-side scenario, (outbound/inbound) deliveries from your SAP ERP or SAP S/4HANA system are the basis for delivery-based transportation requirement creation in SAP TM.
- If you are a shipper and you have deployed SAP TM in an embedded scenario, (sales/purchase) orders from your SAP S/4HANA system are directly the basis for freight unit creation in SAP TM (no replication of data required).
- If you are a shipper and you have deployed SAP TM in an embedded scenario, (outbound/inbound) deliveries from your SAP S/4HANA system are directly the basis for freight unit creation in SAP TM (no replication of data required).
- If you are a logistics service provider/forwarder, you create forwarding orders in SAP TM directly (or based on forwarding quotations).

Upon receiving transportation requirements, freight units are created and become the basic element for planning the movement of goods through the network. The freight unit is a transport unit used in planning. It could be a pallet or container, but it could also be two pallets that need to be transported together, for example, for customs reasons.

Freight orders will record the manual or system-generated transportation planning (intermodal) activities. These freight orders are the result of planning, consolidation of freight units on a vehicle, booked capacity, or scheduled means of transport. Once freight orders are created, carriers are assigned. Once this has been completed, transport order execution can be triggered and follow-on settlement processing can begin.

Order Management

The business purpose of order management is providing the ability to handle transportation requests, which are designated as requirements or demands from an ordering system.

One of the major benefits of SAP TM is the ability to use the system integrated to SAP ERP or SAP S/4HANA as the source demand system ("side-by-side") or as a component within SAP S/4HANA ("embedded"). So you can see the flexibility with SAP TM from an order management standpoint. If you choose to integrate with an SAP ERP or SAP S/4HANA system, SAP TM would be integrated by means of Process Integration (PI) interfaces. Orders and deliveries from SAP ERP or SAP S/4HANA can be converted into SAP TM transportation requirements automatically. LSP forwarding order creation is either done by manual entry in the SAP TM UI, or integrated from a customer's system via EDI.

You can use the Forwarding Order Management component in SAP TM to create, edit, and confirm the forwarding orders from your ordering parties. In addition to creating the forwarding order, you can also enter the data as a forwarding quotation and send it to the ordering party. You can then create a forwarding order based on the forwarding quotation.

Transportation Planning

You can use the Freight Order Management component in SAP Transportation Management to create and edit freight orders and freight bookings. You use freight orders for land transportation and you use freight bookings for sea and air transportation.

Freight orders and bookings are the result of transportation planning.

One of the major benefits of SAP TM is the ability to perform advanced planning activities. SAP TM has been developed as a planning and execution system desired to support

transportation-related activities for several different industries. Some of the planning processes delivered with SAP TM are as follows:

- Vehicle Scheduling and Route Optimization
- Load Consolidation
- Load Planning
- Carrier Selection
- Freight Tendering

Transportation Execution

In addition to advanced planning capabilities in SAP TM, your organization can also gain the added benefit of integration execution activities in SAP TM.

These integration tasks include the following:

- Integration with SAP Event Management (EM) for alerts and transportation tracking
- Trigger generation of delivery documents
- Integration with dangerous goods management
- Document printing
- Integration with SAP Extended Warehouse Management (EWM)
- Realtime analytics

Charges and Settlement

When working with customers or subcontractors, it may be necessary to collect or pay fees in relation to the movement of products. With SAP TM, it is possible to introduce a settlement process in addition to planning and execution activities. The settlement process supports the following tasks:

- Ability to define transportation charges
- Definition of freight or forwarding agreements
- Generation of settlement documents
- Posting of settlement documents and purchase order / service-entry-sheet generation
- Cost distribution
- Customer billing

LESSON SUMMARY
You should now be able to:

- Describe the end-to-end transportation processes

Learning Assessment

1. Which functions are part of the basic shipping scope?

   Choose the correct answers.

   - [ ] A Delivery-based planning
   - [ ] B Order-based planning
   - [ ] C Manual carrier selection
   - [ ] D Automatic carrier selection using the optimizer

2. Which documents are relevant for the basic shipping scope using SAP S/4HANA Supply Chain for Transportation Management?

   Choose the correct answers.

   - [ ] A Shipment
   - [ ] B Sales Order
   - [ ] C Outbound Delivery
   - [ ] D Freight Order

3. If SAP TM is used in a "side-by-side" deployment, the interface used to transfer master data from an SAP ERP or SAP S/4HANA system to SAP TM or SAP S/4HANA TM depends on which of the following?

   Choose the correct answers.

   - [ ] A Source system
   - [ ] B Destination system
   - [ ] C Both source and destination system

4. Which of the following are the main functional areas of SAP Transportation Management?
   Choose the correct answers.

   - ☐ A Order Management
   - ☐ B Transportation Planning
   - ☐ C Transportation Execution
   - ☐ D Charges and Settlement

5. Which of the following are valid deployment options for SAP TM?
   Choose the correct answers.

   - ☐ A SAP ERP to SAP TM ("side-by-side")
   - ☐ B SAP ERP to SAP S/4HANA TM ("side-by-side")
   - ☐ C SAP S/4HANA to SAP S/4HANA TM ("side-by-side")
   - ☐ D SAP S/4HANA to SAP TM ("side-by-side")
   - ☐ E SAP S/4HANA ("embedded")

Learning Assessment - Answers

1. Which functions are part of the basic shipping scope?

   Choose the correct answers.

   - [X] A Delivery-based planning
   - [ ] B Order-based planning
   - [X] C Manual carrier selection
   - [ ] D Automatic carrier selection using the optimizer

   Correct. Delivery-based planning and manual carrier selection are part of the basic shipping scope. Order-based planning and automatic carrier selection using the optimizer are part of advanced transportation management.

2. Which documents are relevant for the basic shipping scope using SAP S/4HANA Supply Chain for Transportation Management?

   Choose the correct answers.

   - [ ] A Shipment
   - [ ] B Sales Order
   - [X] C Outbound Delivery
   - [X] D Freight Order

   Correct. Outbound deliveries and freight orders are documents required for the basic shipping process in SAP S/4HANA Supply Chain for Transportation Management. Sales orders are not relevant, because the basic shipping process covers only delivery-based planning and the shipment is an object used within LE-TRA, but not within SAP S/4HANA Supply Chain for Transportation Management.

3. If SAP TM is used in a "side-by-side" deployment, the interface used to transfer master data from an SAP ERP or SAP S/4HANA system to SAP TM or SAP S/4HANA TM depends on which of the following?

   Choose the correct answers.

   - [ ] A Source system
   - [X] B Destination system
   - [ ] C Both source and destination system

   Correct. If SAP TM is used in a "side-by-side" deployment, the interface used to transfer master data from an SAP ERP or SAP S/4HANA system to SAP TM or SAP S/4HANA TM depends on the destination system. If the receiving system is an SAP TM 9.x (Business Stack), then CIF (core interface) is used. If the receiving system is an SAP S/4HANA system, then DRF (data replication framework) is used.

4. Which of the following are the main functional areas of SAP Transportation Management?

   Choose the correct answers.

   - [X] A Order Management
   - [X] B Transportation Planning
   - [X] C Transportation Execution
   - [X] D Charges and Settlement

   Correct. The four main functional areas of SAP Transportation Management are: Order Management, Transportation Planning, Transportation Execution, and Charges and Settlement.

5. Which of the following are valid deployment options for SAP TM?

   Choose the correct answers.

   - [X] A SAP ERP to SAP TM ("side-by-side")
   - [X] B SAP ERP to SAP S/4HANA TM ("side-by-side")
   - [X] C SAP S/4HANA to SAP S/4HANA TM ("side-by-side")
   - [X] D SAP S/4HANA to SAP TM ("side-by-side")
   - [X] E SAP S/4HANA ("embedded")

   Correct. You can deploy SAP TM either embedded or side-by-side. For side-by-side deployments all combinations of SAP ERP / SAP S/4 HANA to SAP TM / SAP S/4HANA TM are allowed.

UNIT 2 Transportation Management Master Data

UNIT OBJECTIVES

- Understand the business partner concept and categories
- Explain the transportation network
- Understand resource and resource types
- Understand carrier schedules and routes

Business Partners

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Understand the business partner concept and categories

Business Partners

The master data of customers and vendors is managed in SAP S/4HANA by using business partner master data. By using this approach, it is possible to centrally maintain the master data for customers and vendors (in SAP ERP they have been handled separately).

Figure 9: Business Partner Category

Business partner master data can be maintained with the transaction BP or by using a corresponding app from the SAP Fiori launchpad. Business partners can be assigned multiple company codes. Business partners can be categorized as a person, group, or organization. An organization represents units such as a company, a department of a company, or an association. Organization is an umbrella term to map every kind of situation in the day-to-day business activities. A group represents a shared living arrangement, a married couple, or an executive board.

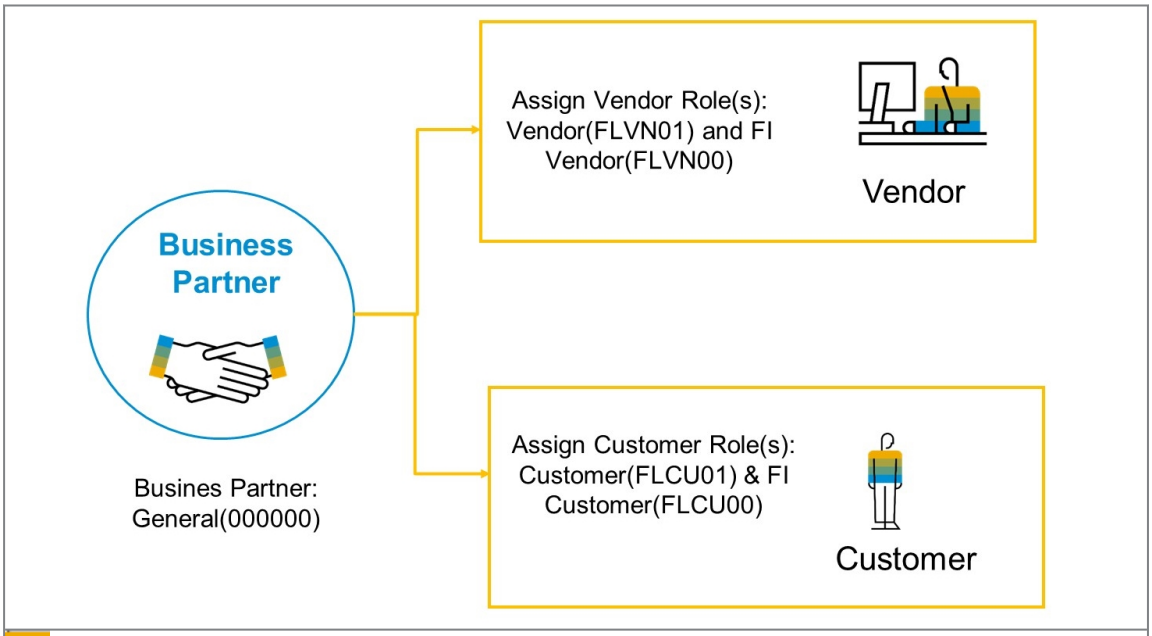

Figure 10: Business Partner Roles

The link between a business partner and other components is achieved by a role concept. A business partner role corresponds to a business context in which a business partner can appear. Relevant business partner roles related to shipping process are:

- Business Partner general (000000)
- Customer (FLCU01)
- FI customer (FLCU00)
- Vendor (FLVN01)
- FI vendor (FLVN00)
- Invoicing Party (BBP006)
- Carrier (CRM010)

This ensures that the relevant master data for the various processes can be recorded correspondingly and that the business partner can be used for the relevant functions (such as sold-to party).

You define the general business partner data once and assign business partner roles (BP roles) to the business partner. Specific data is stored for each business partner role. In this way, you do not store redundant data, since the general data is independent of a business partner's function or application-specific extensions. When you first create a business partner in the system, the BP role General Business Partner is automatically assigned to the business partner.

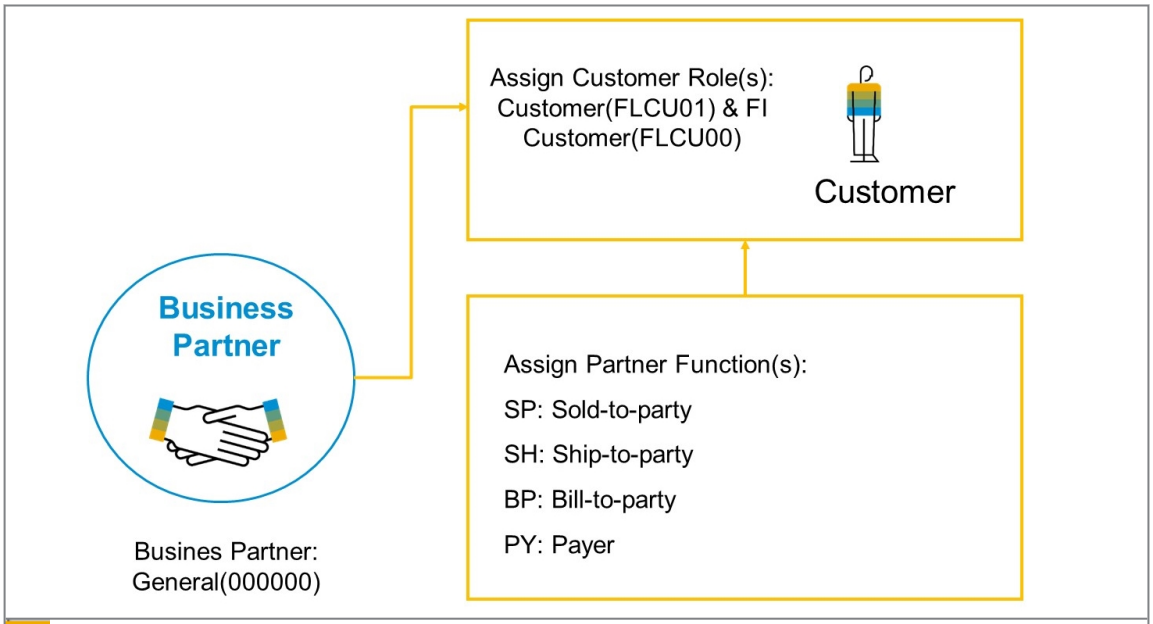

Figure 11: Partner Functions

Assigning partner functions in the SAP system determines the functions of particular partners in the process. A partner function is a particular role that a business partner can take during the process. For example, one customer orders some products (partner function: sold-to-party and another customer receives the material (partner function: Ship-to-party). One partner may have several functions. For example, when all the partner functions within the customer partner type are assigned to one business partner, the same customer is the sold-to-party, ship-to-party, payer, and bill-to-party.

The following is a list of partner functions commonly used in the shipping process:

- Consignee
- Bill-to-party
- Carrier
- Shipper
- Ordering party
- Driver
- Payer
- Freight forwarder

Additional text can be defined for the business partner master data and you can use them as the printing address. The same business partner number can be maintained across multiple company codes.

Drivers: Drivers operate vehicles. They are defined as business partner with the role driver. Attributes like driver qualifications, shift sequence, validity period, home location, and absences can be maintained.

Business Partner Determination

The system can be enabled to determine business partners for various document types. This allows users to easily and efficiently enter business partners in a business document. It cuts

down on the chance of manual errors, and reduces the need to enter a business partner for each partner function.

In Customizing for Transportation Management under *Master Data → Business Partners → Define Partner Determination Profiles*, you can create a partner determination profile that the system uses to automatically determine the following features:

- Users can specify the list of partner functions that the system makes available in a business document.
- The level of control the user has in entering the partner function can be defined. Depending on the settings defined in Customizing, users can change or delete a partner function, or add a partner function from a list of available partner functions. Settings can be specified so that users cannot change or delete specific partner functions.
- Users can enable the system to automatically determine business partners based on specific Incoterms.
- Users can enter a specific static business partner in the profile directly.

You can assign the business partner determination profile to document type customizing (for example, freight order type customizing) to facilitate automatic business partner determination.

LESSON SUMMARY

You should now be able to:

- Understand the business partner concept and categories

Unit 2
Lesson 2

Transportation Network

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Explain the transportation network

Location Master

A location is a logical or physical place in which resources are managed on a quantity basis. This business object is used as the basis for the transportation processes in which you name a source location, a destination location, and any transshipment locations necessary to complete it.

Different customizing entries and master data elements from SAP S/4HANA are displayed in SAP TM as locations with different location types. SAP S/4HANA plants, customers, vendors, and shipping points are integrated with SAP TM and become the following types of location: Plants-1001 (production plant) or 1002 (distribution center), Business Partners- 1021 (business partners), and Shipping Points-1003 (shipping point). The following location types exist:

ID	Location Type
1001	Production Plant
1002	Distribution Center
1003	Shipping Point
1021	Business Partner
1030	Terminal
1040	Store
1100	Port
1110	Airport
1120	Railway Station
1130	Container Freight Station
1140	Hub
1150	Gateway
1160	Container yard
1170	Warehouse
1180	Carrier Warehouse

ID	Location Type
1190	Rail Junction
1191	Border Crossing Point

If you are using SAP TM in SAP S/4HANA, no integration is required – material master and business partners are already available. Location master data is created on the fly or via a report when needed. In traditional SAP TM 9.6 deployment, the location type is automatically determined based on the object being transferred from SAP S/4HANA. In the SAP S/4HANA system, each inventory-relevant location can be assigned one or more shipping points. A shipping point is an independent organizational unit at a fixed location that processes and monitors inbound and outbound deliveries. The physical address of a shipping point is represented as a location in master data.

Transshipment locations are used for unloading goods from one freight order and loading them onto another freight order during the transportation process. This function is necessary when different means of transport or different transportation service providers (carriers) have to be used to execute a transportation process, for example, truck-ocean-truck; truck-rail-truck. Transshipment locations may also be used when consolidating or de-consolidating goods to be transported.

Geocoding Locations

Locations are critical elements of your transportation network, because they identify source and destination points. Based on where these two points are located, SAP TM can use distance and duration to calculate the best means of transporting a product.

Geographical information plays an important role in TM. Almost all business processes relate to it. High-quality geodata improves these processes. The SAP TM Transportation Network is the foundation of a transportation planning process.

To see geographic information related to location master data, log into SAP Fiori, then choose *Master Data folder → Define Location*.

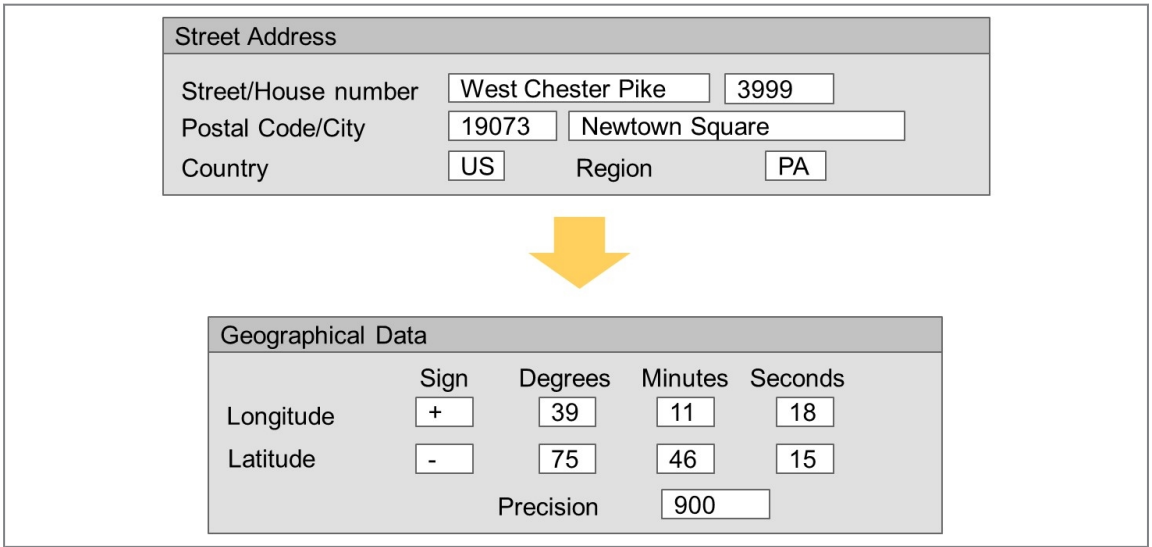

Figure 12: Location Geocoding

A location is a specific point on the earth's surface that is defined by the geographical coordinates of longitude, latitude, and altitude. These coordinates are determined from the address data of a location. An address can contain a country, region, postal code, city,

district, street, and house number, as well as additional fields. Determining geographical coordinates from address data is called geo-coding. A geographical information system can be used to get precise geographical coordinates.

In SAP TM, the location master data object describes the geographical setup of the transportation network underlying business processes. Location can store an address and the geographical coordinates that define its position. The accuracy of the geo-coordinates depends on the address data provided and which service is used to determine them.

Standard SAP applications automatically determine a geo-coordinate at region level when creating or changing the location address data. This is sufficient for processes not working with static information or depending on distances, times, or map display. Because geo-coordinates are the basis for distance and duration determination and map display, they must be high quality in case those functions are required.

Geo-coordinates are displayed in degrees, minutes, and seconds in the *Geographical Data* area of the Location user interface and can be overwritten manually by the user. The *Precision* field indicates the granularity of the geo-coding result.

A geocoder determines the geographical coordinates (longitude and latitude) from a given address. The following two levels of geocoding are possible in SAP TM:

1. Standard (included in the SAP TM software license)
2. Full addresses (depending on capabilities of geocoding software)

The geocoding program supplied by SAP determines the longitude and latitude based on the country and region code. There are several companies who provide geocoding products, including the following: Google, Here, Rand-McNally, PC-Miler, and PTV (Karlsruhe, Germany).

Transportation Zone

Transportation zones are used to group individual locations. All the properties of zones are transferred to its locations. Transportation zones are typically used as the origin and destination points for transportation lanes. Transportation zones reduce the effort needed to model the geographic network in planning. Grouping locations into transportation zones reduces the volume of master data in the TM system. Transportation zones can group locations and can include one-time locations. Transportation zones can include zones within their locations and sub-zones. For example, all locations that are supplied by the same warehouse (individual locations and transportation zones) are grouped into a transportation zone.

If SAP S/4HANA integration through the DRF is used, transportation zones are automatically created from the address of the location. The location is automatically assigned to the transportation zone.

Transportation zones are not physical locations and therefore do not have an address. Transportation zones can also be assigned geographical coordinates. SAP TM offers two options for calculating these coordinates. After defining the locations, regions, or postal codes, the system can calculate the coordinates. This estimates the center point of the zone based on the coordinates of all locations included in the zone. Alternatively, identify the geographical coordinates and manually enter them in SAP TM.

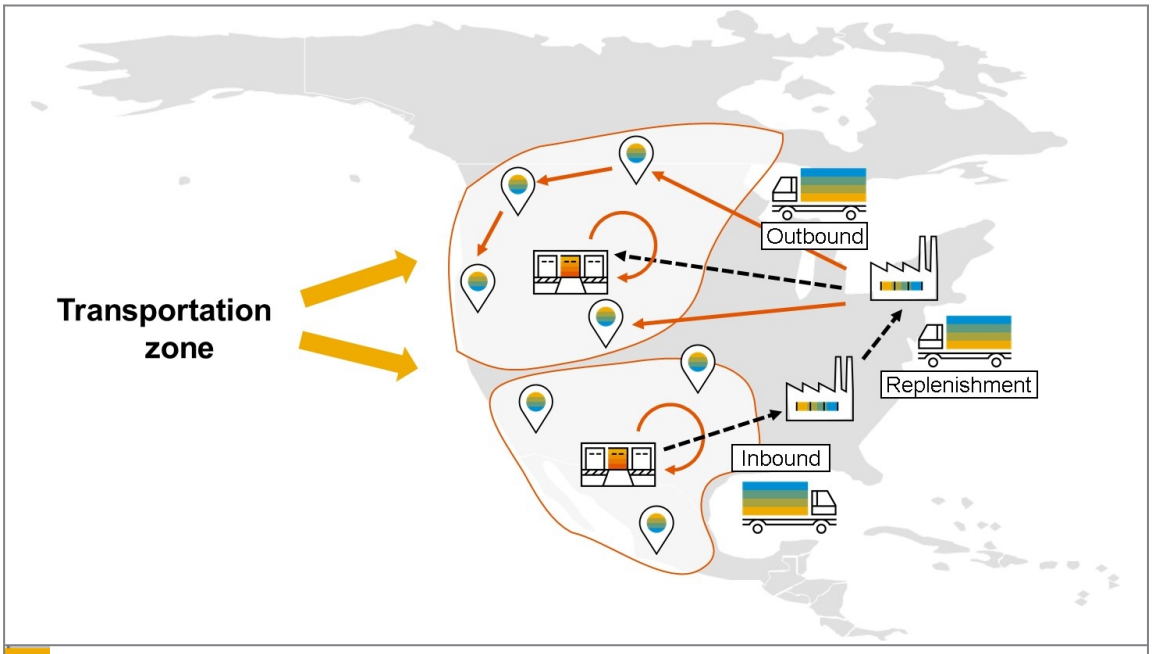

Figure 13: Planning with Transportation Zones

Transportation Zone Types

- Region: In a regional zone, locations are specified by a country or region. For example, the state of Illinois can be defined as its own zone. In the figure, the zone US-Illinois is created and only Illinois is assigned to it.
- Postal Codes: Transportation zones can be defined by the use of postal codes. Companies can use zip/postal codes or zip/postal code ranges to define these geographical areas. Most major U.S. truck-load and less-than-truck-load carriers publish their rate structures and transit time tables based on origin and destination three-digit zip code lanes rather than city or state level lanes. In these documents, carriers use ranges of three-digit zip codes, such as 170-173.
- Direct: In a direct assignment, locations are assigned directly to a zone. For example, a particular customer might be in a zone that has low volumes. By including them in a zone with a larger geography, you might improve the optimization results.
- Mixed: You can use any combination of these types of transportation zones when defining a zone. This is a called a mixed zone.

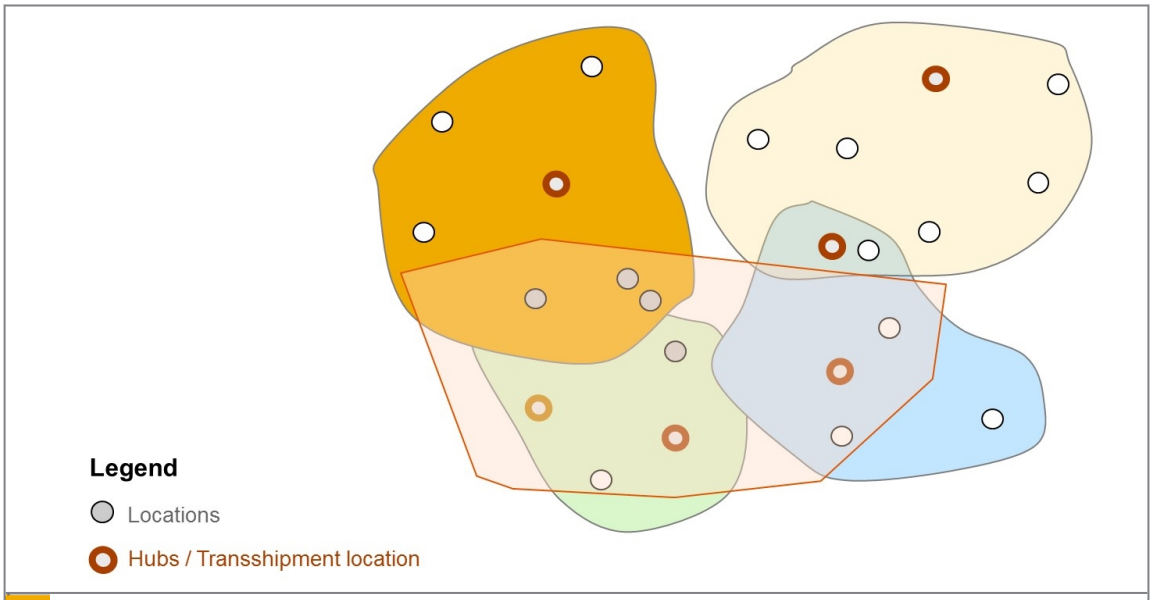

Figure 14: Transportation Zones

Transportation Zone Hierarchy

Organizing transportation zones into transportation zone hierarchies allows you to transfer the properties of the higher level transportation zone to the locations on lower levels of the hierarchy. You cannot assign a transportation zone to itself or to a zone already assigned to the same zone.

Transportation zone hierarchies reduce the amount of master data to be maintained in SAP TM:

- A zone can be assigned to any number of higher-level zones
- Locations can be assigned to any number of zones
- A zone cannot be assigned to a location

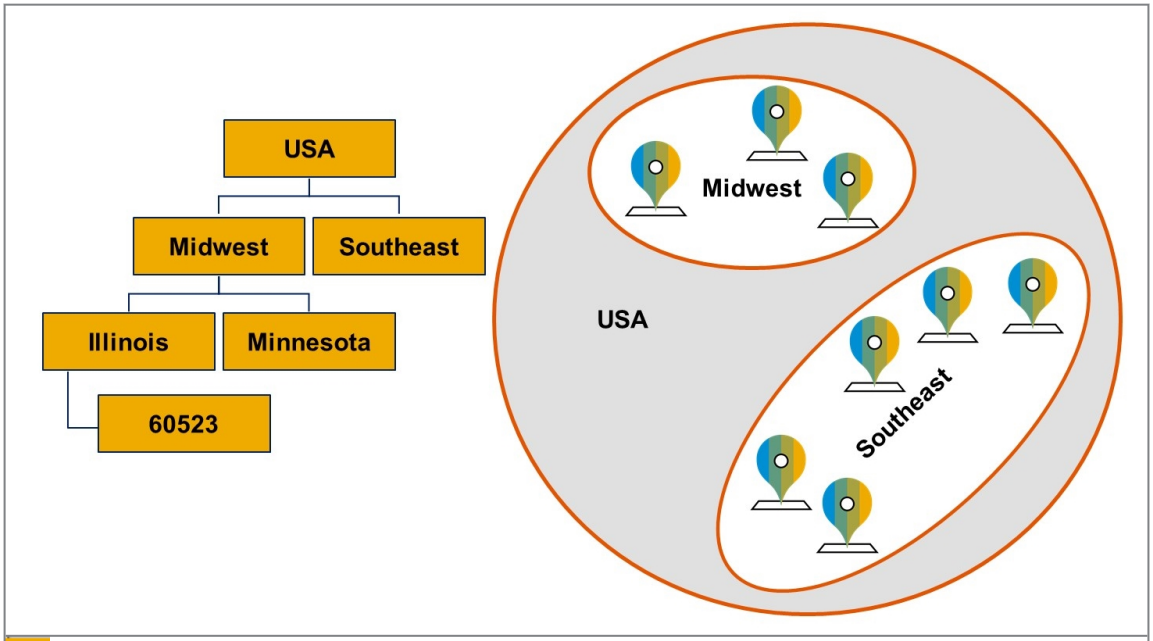

Figure 15: Transportation Zone Hierarchy

Transportation Zone Hierarchy Definition

Transportation zone hierarchies can include locations and transportation zones. To see zone hierarchy, log into SAP Fiori, then choose *Master Data folder → Define Zone Hierarchy*.

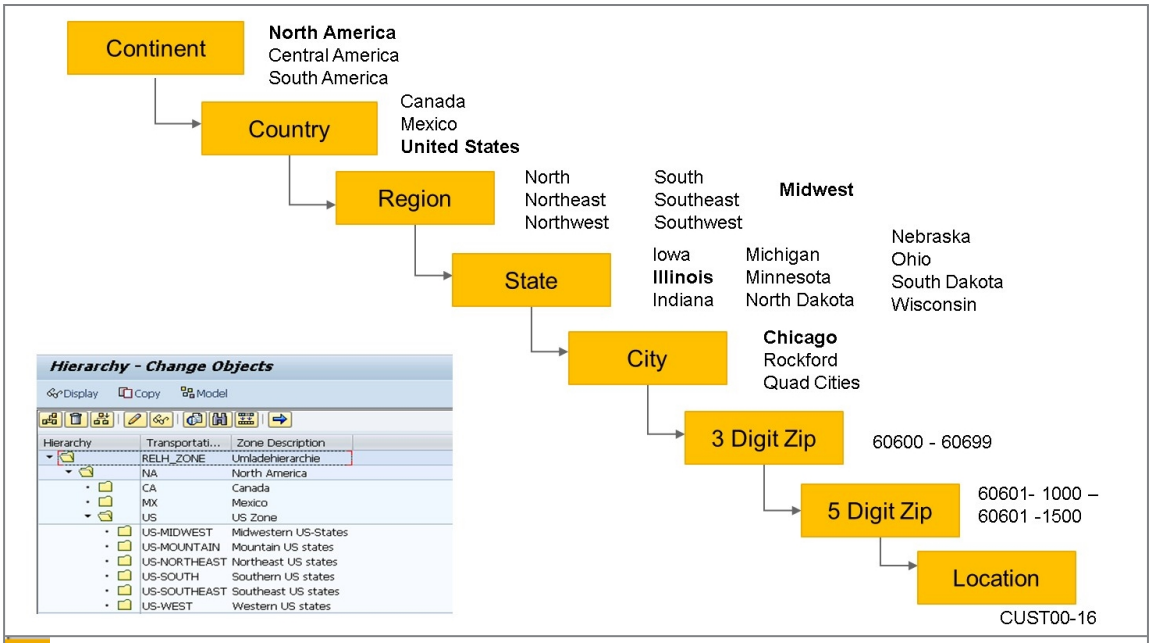

Figure 16: Transportation Zone Hierarchy (2)

Transportation and Trade Lane

Transportation lanes represent the relationship between two locations, two transportation zones, or a combination of locations and transportation zones that expresses the direct approachability of the locations, or of all locations, within the transportation zones for a specific means of transport (MTr).

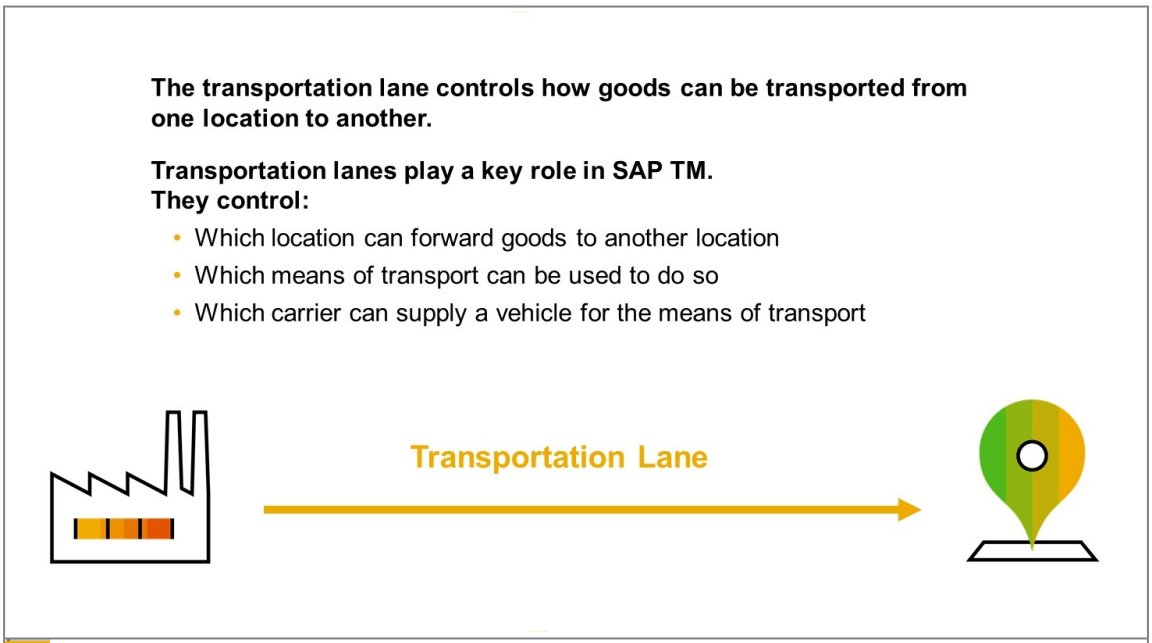

Figure 17: Transportation Lane

Using transportation zones as the source, destination, or both, considerably reduces the amount of transportation lanes to maintain.

A transportation lane points only in one direction. To model the reverse direction, you need to create another transportation lane.

Trade Lane

A trade lane can have a mode of transport and means of transport. The trade lane defines a direction for transportation, which is characterized by the orientation, source, and destination. Possible orientations are: Inbound, Outbound, From, To, Within and Along.

A trade lane is an abstract representation of transport classification. A trade lane instance does not represent a connection between any transportation network nodes (zone/location, and so on), it is a context independent classification of any transportation-related activities.

Trade lanes may build up a hierarchy, that is, more generic trade lanes imply more specific trade lanes (for example: "Within Germany using means of transport Truck" implies "Along from Frankfurt to Hamburg using means of transport Chilled Truck" and "Within Bavaria using means of transport Truck for liquids").

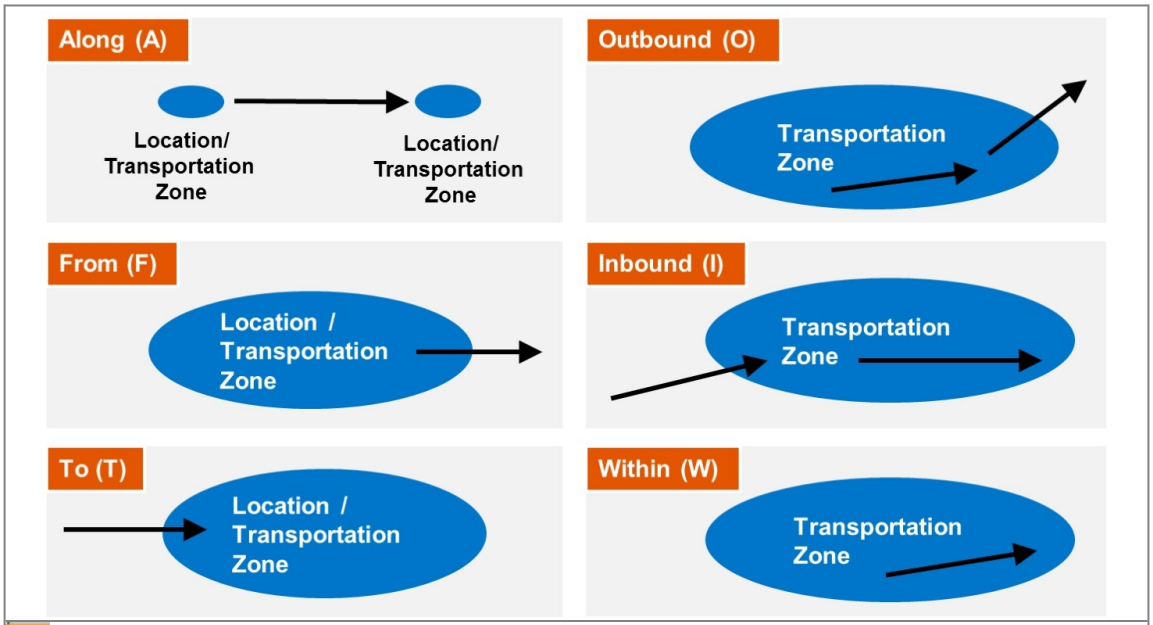

Figure 18: Trade Lane

Trade lanes may overlap each other (for example, "From Germany using Airplane" and "Within Europe using Airplane"). Trade lane hierarchies include transportation zone hierarchy (for example: "From Germany" implies "From Bavaria", which implies "From Plant_Munich"), means of transport hierarchy (for example: "Within Germany with Mtr Truck" implies "Within Germany with Mtr Chilled_Truck") and means of transport – mode of transport relations (for example: "Within Germany with Mode of Transport Road" implies "Within Germany with Mtr Chilled_truck").

There is no direct link between trade lane and transportation lane.

Methods of Transportation

Transportation Mode

When all shipping and receiving locations are defined, frame how you intend to ship products between these locations. The complexity of your shipping scenarios influences how much detail you need to maintain.

For example, consider whether products are shipped over road, rail, or waterways.

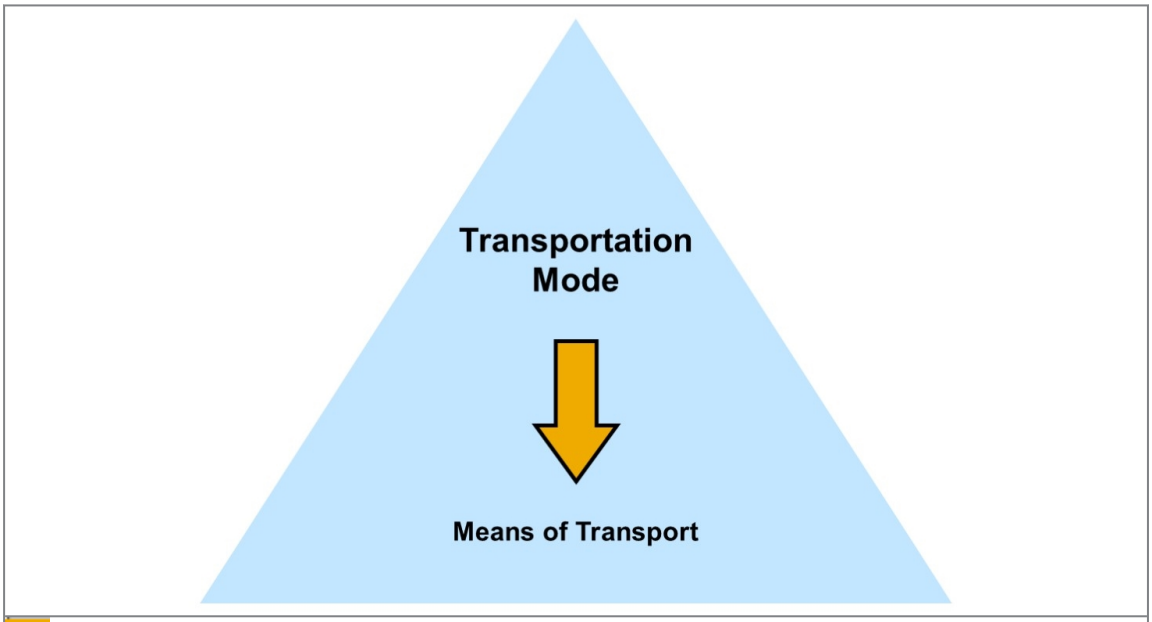

Figure 19: Transportation Mode

The first configuration step in the transportation process is to identify the transportation modes that can be used to move products. The transportation mode describes the highest-level transport grouping, for example, road, rail, inland waterway, sea, or air. Each method of transport is assigned a single transportation mode.

Transportation Mode Categories

SAP transportation mode categories are road, rail, sea, air, postal service, and inland waterways.

In addition to the transportation mode category, companies can assign a dangerous goods transport category. This signals that you may have to ship certain chemicals under pressure and only certain ways of transporting the product are suitable. These categories define the type of transport to be used. Category 99 (all modes) is used in the U.S. according to dangerous goods regulation 49 CFR. Customers can use categories 30 - 89 for their own definition.

The Main Carriage

The transportation mode can be set as the *Main Carriage*. The reference to the main carriage indicates that this segment of transportation is the primary segment. When dealing with export scenarios, you may have the pre-carriage, main carriage, and on-carriage. In a multi-modal or multi-stage shipment, the main carriage stage contains all of the shipment documents. It also allows pre- and on-carriage stages to be linked to it.

These transportation modes can be used at a high level to determine incompatibilities.

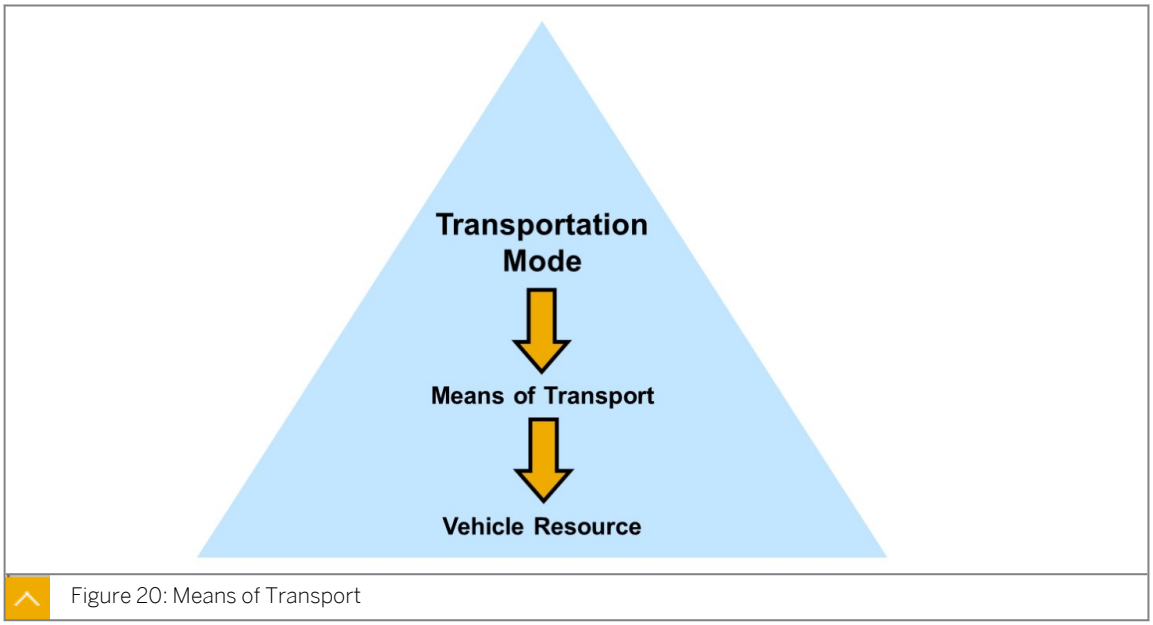

Figure 20: Means of Transport

When you define the various transportation modes, your company can further define the transportation process by creating and assigning different means of transport. The means of transport describes the characteristics of specific vehicle types or classifications that transport goods, such as a non-refrigerated truck, a refrigerated truck, a 60-foot rail boxcar, or a bulk container.

Assigning Vehicle Resources to a Means of Transport

The network can be expanded by defining vehicle resources and assigning them to a means of transport. Vehicle resources in a means of transport have a common set of physical characteristics that are taken into account during the planning process. These physical characteristics include the mode of transportation (air, rail, surface, or sea), vehicle capacity, speed, cost structure, geographic availability, and temperature control. Whether a company-owned fleet can be used to group vehicles in a means of transport is also a consideration.

Means of transport also allow a company to describe the cost structure and geographical availability of a class of vehicle.

Means of Transport Settings

There are a number of means of transport settings:

- Transportation mode
- Multi-resource
- Scheduled means of transport
- Own means of transport
- GIS quality

Means of Transport Definition

You can define the means of transport in Customizing for SAP TM.

Choose *Transportation Management* → *Master data* → *Resources* → *Define Means of Transport and Compartment* → *Define Means of Transport*.

Transportation Mode Assignment

Within the means of transport, you can assign a transportation mode. This specifies how a product is transported, for example, by road, rail, sea, or air. You use the means of transport to select the vehicle resources that are to execute the transportation.

The standard code assigned to means of transport represents the official representation of type of transport. The UN/EDIFACT standard uses the following codes:

- 006 - Aircraft
- 011 - Ship
- 031 - Truck
- 038 - Car

The relevant settings are:

- Scheduled means of transport: This defines if a resource is traveling based on a fixed schedule such as a sailing or rail schedule.
- Own means of transport: This determines if a resource is part of your own fleet or that of an external provider.

Multi-Resource

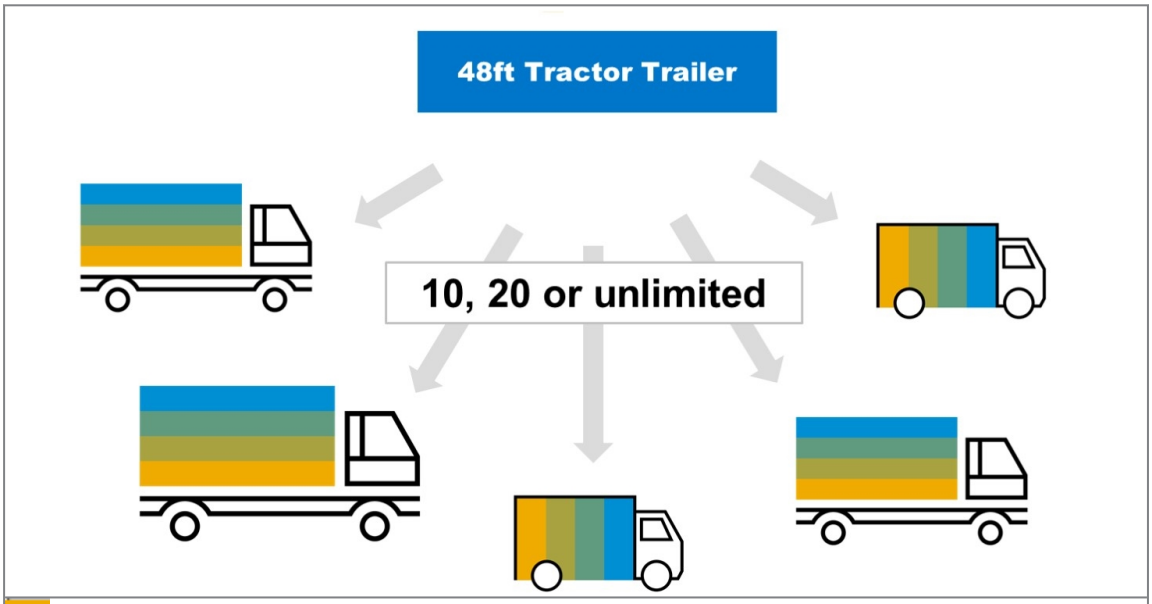

Figure 21: Multi Resource

Instead of creating individual resources for a means of transport, you can select the *Multi-Resource* checkbox for the means of transport. During planning, the system assumes the availability of the number of resources you define. If you do not specify a number in this field, the system assumes that an unlimited number of resources are available. During vehicle scheduling and pre-processing, the number of resources that you define in this field indicates the maximum number of parallel freight orders that the system is allowed to create for each resource.

Duration

Figure 22: Speeds

Duration is one of the key elements to consider when dealing with different means of transport. This can be influenced by the type of transport as well as the quality or type of transportation infrastructure used. Selecting the *GIS Quality* checkbox means your organization is integrating with a third party geographical information system. This integration is specific about which routes (interstate highways or county road) are used. Anticipated speeds for the different types of highways or roads that may be used can be defined.

Distance and Speed

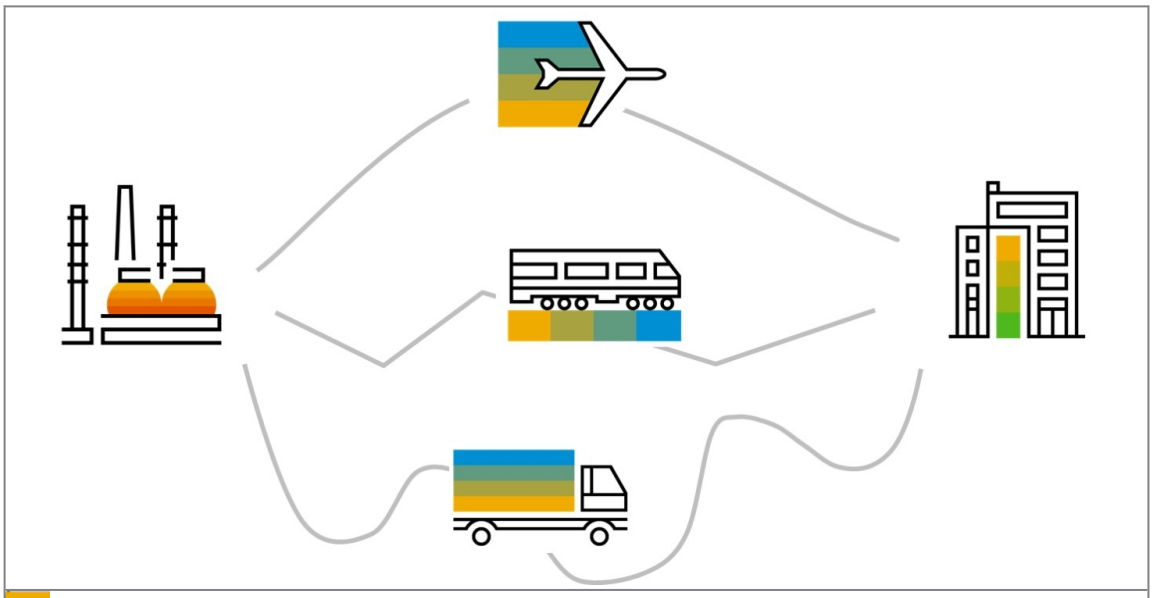

Figure 23: Distance Factor and Average Speed

If you choose not to integrate with a GIS, you still differentiate durations for different means of transport. Within each means of transport, you can specify an average speed. The speed is then used, along with the distance from the transportation lane, to calculate transit duration.

The distance factor establishes the difference between the linear distance between two locations and the actual distance covered by the vehicle. Based on the linear distance, you can use this factor to estimate the actual travel distance for a vehicle between two locations. Together with the average speed, you can estimate the transportation time.

How to Use the Path Finder

Scenario building can be time consuming. Scenario validation, especially for transportation optimization, is even more time consuming. The planner needs to establish if all elements of the transportation network are maintained correctly to enable the optimizer to find a valid solution.

You can use the path finder function to search for legs in your transportation network and take the following considerations into account during the process:

- Locations
- Transshipment locations
- Transportation lanes
- Schedules
- Transportation zones

The path finder enables you to easily determine whether a connection exists between two locations and, therefore, whether you have correctly configured your master data. However, the path finder does not take incompatibilities into consideration.

Path Finder Execution

You can execute the path finder and check the result in either the transportation network cockpit or on the transportation proposals user interface.

- Transportation Network Cockpit:

  When you open the context menu for a location in the transportation network cockpit, you can choose *Find Path To Location* and enter a destination in the displayed dialog box. The system then calculates all of the available connections in the transportation network and displays them on the map. The color of the connections indicates whether a valid transportation lane or schedule exists.

- Transportation Proposals:

  When you call the user interface for transportation proposals, you can choose the appropriate button to show or hide the available connections on the map. As in the transportation network cockpit, the color of the connections indicates whether a valid transportation lane or schedule exists.

- Explanation Tool:

  When you select one or more freight units, you can choose *Show Network Path* to analyze the underlying transportation network that is taken into account when planning the selected freight units.

- Requests

- Source location
- Destination location

- **Options**
  - Determine path
  - Determine connections
- **Restrictions**
  - Outbound, inbound, or implicit hub
  - Transportation mode
  - Means of transport

Path Finder Report: /SCMTMS/FIND_TN_PATH

The required input for the tool is a start and a destination location. Using assigned transshipment locations and existing connections (transportation lanes, schedules, and booking), the path finder tries to find all paths. The result indicates if there is a valid connection or not (all existing are listed) for each stage of a path. It is thus easy to find out if you have assigned a transshipment location, but if it cannot be reached from your start location.

The report has some limitations. For example, it is not possible to search within a certain timeframe and respect the validity of the connections. Also, transportation mode and means-of-transport filters are not available and incompatibilities are not considered.

LESSON SUMMARY

You should now be able to:

- Explain the transportation network

Unit 2
Lesson 3

Transportation Resources

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Understand resource and resource types

Resources Overview

Resources play a central role in planning and execution within SAP Transportation Management. Resource data is relevant to the planning of order dates, taking into account working times and the available capacities of the resources. Resources, in conjunction with booking, offer the capacity needed to perform transportation activities on freight units, such as transportation, loading, and unloading activities.

The following resource types exist:

- Vehicle Resource
- Handling Resource
- Calendar Resource
- Transportation Unit Resource

Goods are loaded onto and unloaded from vehicles and transportation unit resource and transported around the transportation network. Calendar resources specify operating hours for a location, during which goods maybe dropped off or picked up from this location. Handling resources offers handling capacity that allows the goods to be loaded or unloaded from vehicle resources.

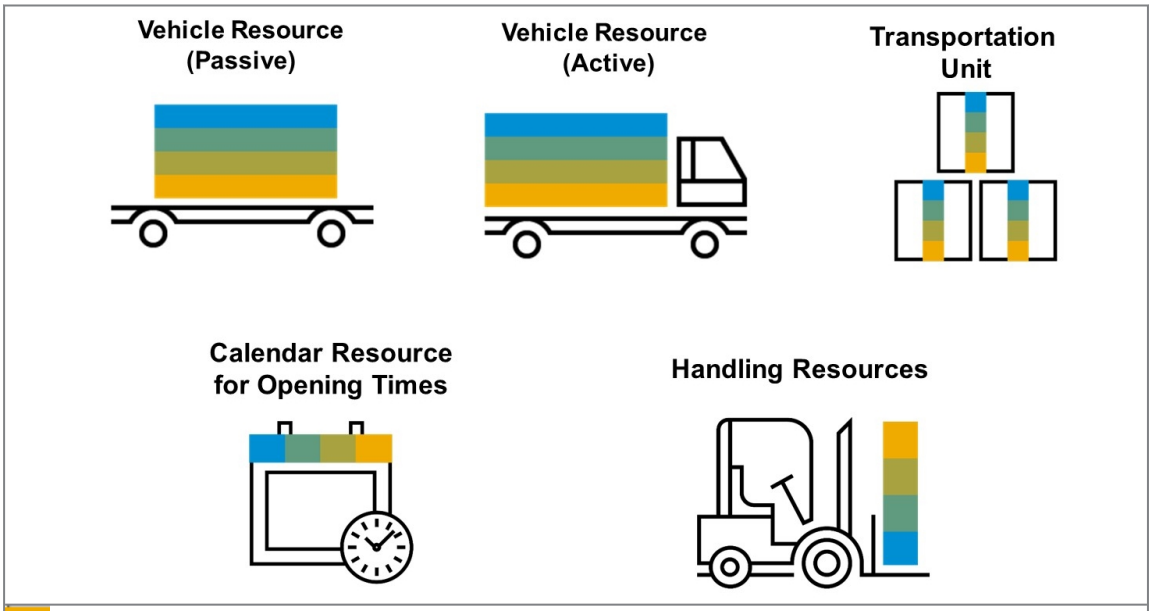

Figure 24: Transportation Resources

Vehicle Resource

Vehicles are moving resources that transport goods between locations, for example, trucks, rail-cars, planes, and ships. Each vehicle resource represents a unit load, for example, one trailer of a certain capacity, one container of a certain capacity, or one rail car of a certain capacity. Eight dimensions and unit of measurements can be used to define vehicle capacity, for example, mass, volume – that is, the capacity of a trailer can be specified as 40,000 lb, or 2200 cu ft/s, or 24 pallets. Planning can only take the vehicle capacity into account if these dimensions and unit of measurement correspond to the dimensions and unit of measurements that are defined in a freight unit building rule.

Vehicle group and vehicle types specify attributes such as physical properties of a certain kind of vehicle.

All vehicles are assigned to a means of transport (transportation method). Means of transport are groups of vehicle resources. The transportation mode is assigned to means of transport. The transportation mode specifies how the goods are transported, for example, as a sea shipment.

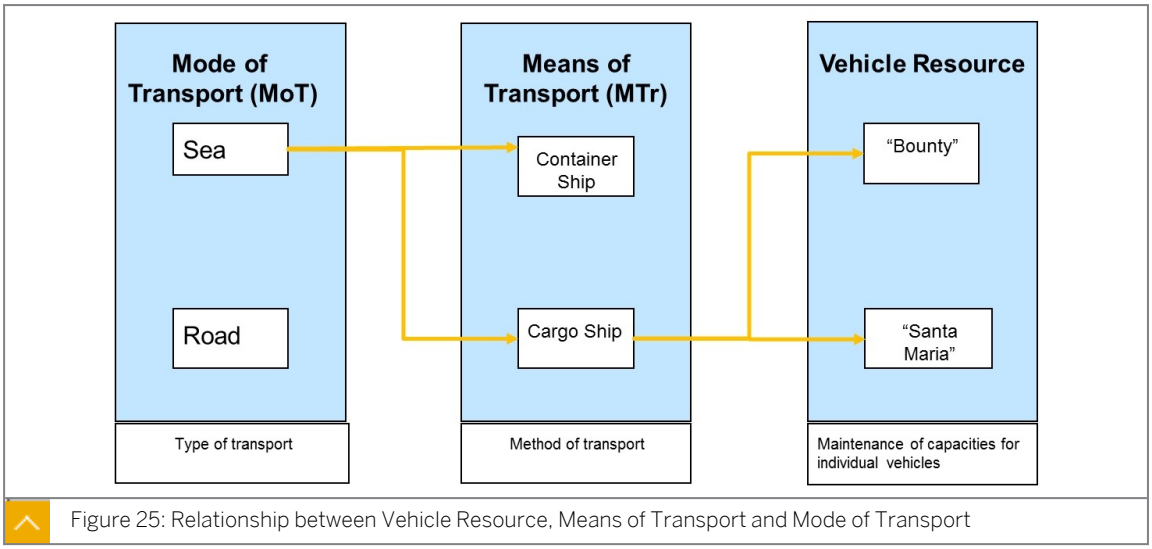

Figure 25: Relationship between Vehicle Resource, Means of Transport and Mode of Transport

There are two types of vehicle resources: passive and active. Active vehicle resources can travel by themselves. Passive vehicle resources cannot travel by themselves. A truck that has a motor and can travel by itself is an active resource. An empty trailer with no tractor is a passive resource.

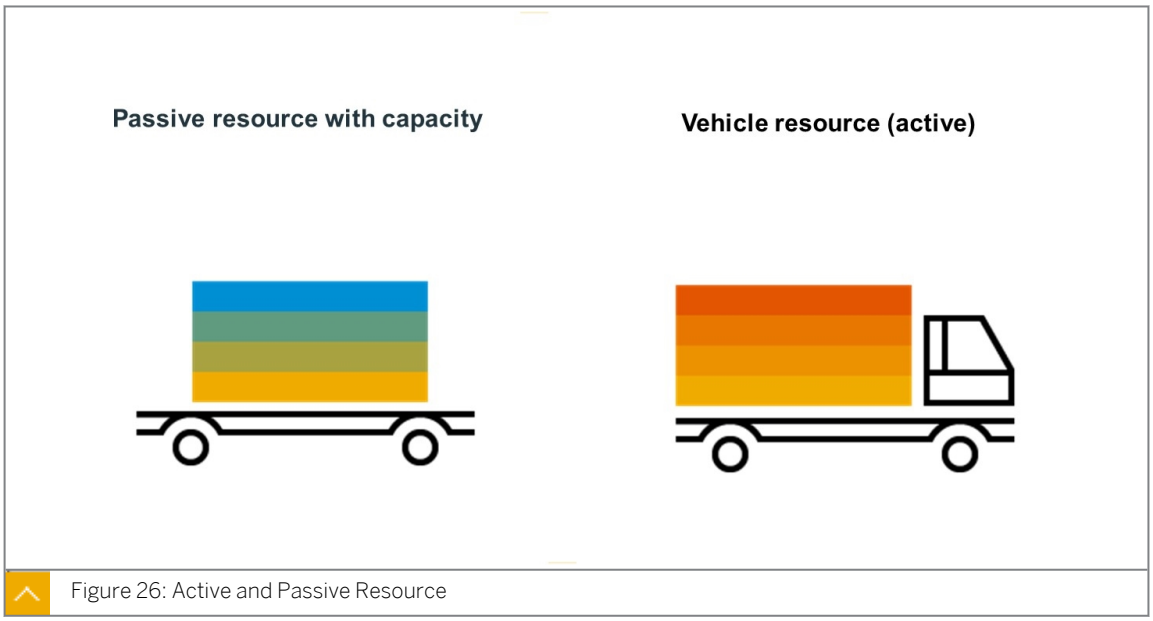

Figure 26: Active and Passive Resource

The means of transport and factory calendar should be defined before creating a vehicle resource. When creating a vehicle resource, it is recommended that the following information is input:

- A resource name
- A calendar and time zone
- A capacity

The following fields combined together define capacity and volume and are mandatory for creating a resource:

- Factory Calendar
- Continuous Dimension
- Capacity
- Unit of Measure

MTr combinations can be used to model truck and trailer combinations. Multiresources can be used to model an external fleet in one step.

Compartments

Compartments can be used to indicate a division of the vehicle resource (truck) and also the trailer into smaller units. Capacity constraints can be specified for compartments. Furthermore, they offer the following benefits:

- Flexible and fixed compartments
- Incompatibilities can be used to restrict certain freight units from being transported in certain compartments, for example, because of temperature restrictions

The use of compartments allows you to assign dangerous goods to certain areas of the truck. In addition, the use of compartments improves transportation planning for oil and gas, chemical, retail, and consumer products.

Means of Transport Combinations

A means of transport combination is an instance of a particular means of transport, or a group of identical instances of means of transport, that can provide transportation services. You use this business object to map the capacity and availability of vehicles that you want to use for transportation.

MTr combinations have the following attributes:

- They can be used to model a truck and trailer combination.
- You specify the number of the objects of each MTr within the combination, for example, 1 truck and 2 trailers.
- You specify capacities (several UoM): Maximum capacities of the combination.
- Additional (freely definable) attributes can be used for compatibilities and incompatibilities; based on a customizable attribute definition (code + text).
- Coupling/un-coupling durations are defined per passive MTr.

Handling Resource

Handling resources are used for handling transportation orders at a location. The handling resource offers handling capacity that allows the goods to be loaded onto and unloaded from vehicle resource, for example, door, loading ramp, or forklift. Handling resources maintain downtimes, restrictions on simultaneous activities, resource availability, qualification, and equipment requirements.

Availability times can be maintained by defining capacity variants and shift sequences.

Consumed capacity per loading and unloading operation is maintained in the location master data with the assignment of the (means of transport-specific) handling resource. The available capacity is maintained in the resource master data record.

Calendar Resource

Calendar resources determine the operating hours of locations. Loading and unloading activities can only take place during operating hours. Calendar resources are defined as resources and can be assigned to multiple locations as:

- Inbound operating hours
- Outbound operating hours
- Means-of-transport specific operating hours (inbound)
- Means-of-transport specific operating hours (outbound)

Availability times can be maintained by defining capacity variants and shift sequences.

Transportation Unit Resource

For an instance of a particular transportation unit, such as a container, you can use the transportation unit resource to map the capacity and availability that you want to use for transportation.

You can choose up to eight dimensions and units of measurement to describe the capacity. Note that the mass and volume are predefined by default. Planning can only take the

transportation unit resource capacity into account if these correspond to the dimensions and units of measurement that you define in a freight unit building rule.

The equipment, and equipment group types, specify attributes such as the physical properties of a certain kind of transportation unit resource. By creating a transportation unit resource, you can do the following:

- Use the type as a template to create transportation unit resources, copying the attributes of the type to a new resource.
- Request a special type of transportation unit resource in a forwarding order or in a booking order.

Transportation Unit Resource

- Master data object to represent individual containers
- Can be created with reference to equipment group type
- Parameters for transportation unit resource resources include the following:
  - Capacity
  - Minimum number of seals
  - Physical properties
  - Downtimes
  - Grouping attributes
  - Alternative names

LESSON SUMMARY

You should now be able to:

- Understand resource and resource types

Schedules and Default Routes

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Understand carrier schedules and routes

Route

Default Routes

A default route defines the sequence of stops for a given source/destination location combination. Default routes can be used in place of transshipment chains with sales orders and deliveries, forwarding orders, and forwarding quotations. Default routes can be modified manually where the desired route is different to that proposed by the system.

To see information related to routes, log into SAP Fiori, then choose *Master Data folder → Define default Routes*.

Carrier Schedules

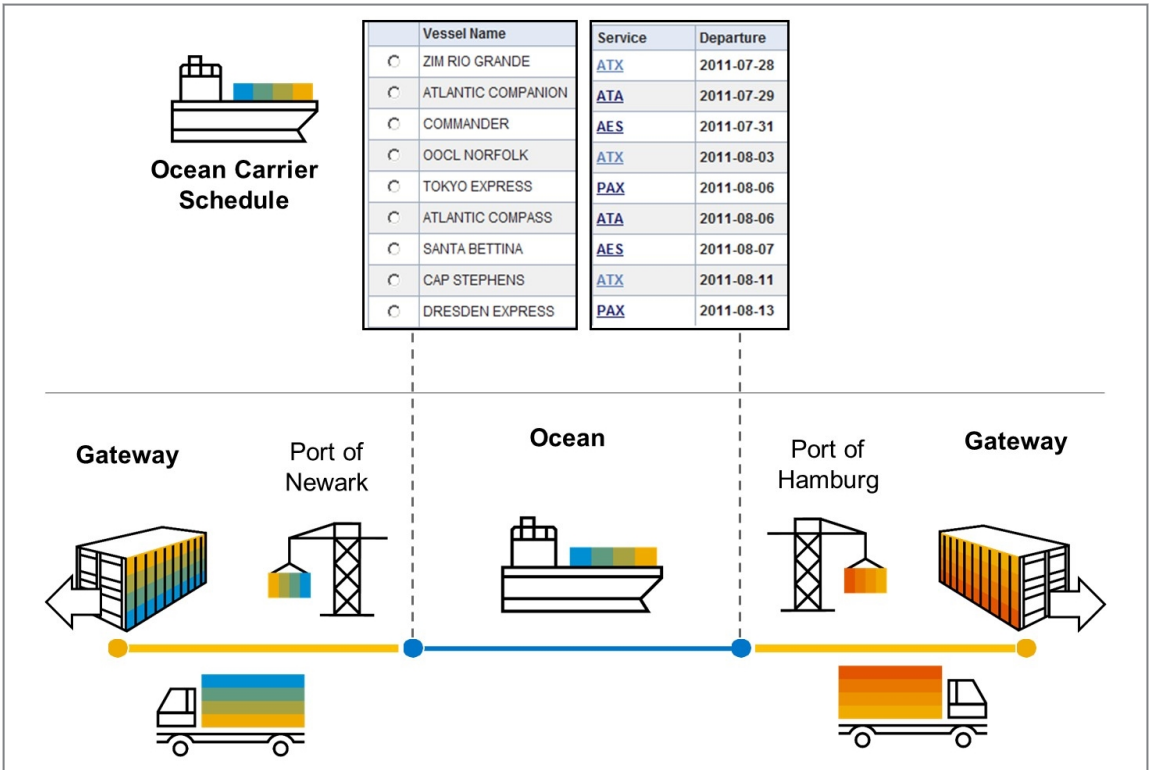

Figure 27: Sailing Schedule with Gateway (CFS)

When shipping products via air or ocean, consider that your partners are typically renting space at a port facility. This facility is used by many parties, and so options for moving product may be limited.

While the road-based scenario can make use of a variety of transportation lanes due to the flexibility of the carriers, ocean and air carriers often face more competition and more regulation. This limits the flexibility for departures and arrivals. From a transportation planning perspective, the implication is that you may need a more structured and predictable plan for scheduling purposes. With SAP Transportation Management (SAP TM), your organization can take advantage of different types of schedules to model specific departure and arrival rules suited to air and ocean shipping.

Carrier Schedules for Actual Transportation

Carrier schedules represent the actual transportation executed by the schedule vehicle, be it by plane, vessel, train, or truck. Usually, these schedules involve stopping at locations such as ports and airports that are used commonly and shared by many different carriers. Flights for air transportation and vessel voyages for ocean are examples of carrier schedules. Carrier schedules can also be truck schedules.

Location and time information are relevant to a schedule. For example, the planner asks the following questions:

- When and from where does the plane depart?
- When do you have to be there to board it?
- When will it arrive?
- Which carrier is responsible for the transportation?
- What can be transported?

Carrier schedules do not just have a start and end destination; they can have multiple stops, which is common for air transportation. Carrier schedules can be executed by different carriers on different stages using a connection schedule. It is possible to use a multi-stop carrier schedule in any sequential location combination, so it is not required to start at the first and leave at the last location.

Schedules can be created manually in SAP TM and uploaded from an external source. You can also upload schedules from an external data source to SAP TM by calling function module /SCMTMS/BAPI_SCHEDULE_SAVEMULT. This function is available for the sea, air, and road transportation modes. Alternatively, you can upload schedules for the air transportation mode in a spreadsheet or CSV format to SAP TM by executing report / SCMTMS/SCH_UPLOAD. For more information, see the system documentation.

You can delete schedules created manually and uploaded by calling function module / SCMTMS/BAPI_SCHEDULE_DELMULTI or by executing report /SCMTMS/SCH_DELETION.

Schedule Types

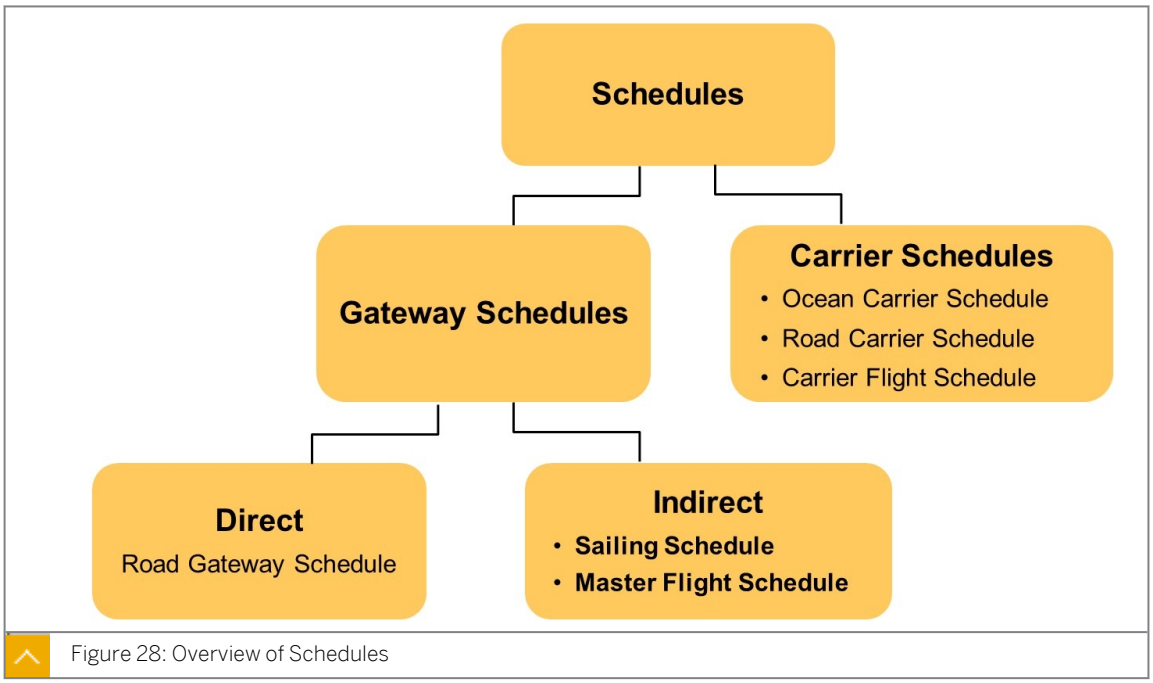

Figure 28: Overview of Schedules

SAP TM allows businesses to create different schedule types to handle the multiple shipping scenarios they may encounter. Schedules can be maintained for each business partner or carrier, and can identify different loading and unloading points, such as ports and airports.

If you have reappearing transportation traffic in your transportation network scenario, you can use the schedules functionality. A combination of transportation mode, gateway customer fact sheets (CFS), direct, and reference fields define the type of schedule.

A gateway schedule includes two gateway locations. In ocean scenarios, the locations could be the CFS-locations. In air scenarios, they can be the gateway locations.

Gateway Schedules: Subcategories

The following are the subcategories in gateway schedules:

- Direct

  The schedule goes from A to B without changing the mode of transport. For example, GW Nurnberg to GW Hamburg via truck.

- Indirect

  The schedule goes from A to B but the mode of transport changes. For example, GW Hamburg to GW Cape Town via truck and ocean.

Air and Ocean Scenarios: Subcategories

The following are the subcategories in ocean and air scenarios:

- Sailing schedules with vessel information
- Master flight schedules with aircraft information

Carrier schedules describe a sequence of transportation stops where the start location and the target stop are not gateways. A gateway is a transportation hub where freight is consolidated and deconsolidated.

Carrier Schedules

- **Ocean Carrier Schedule**

  Use the ocean carrier schedule to define a standard sequence of transportation stops that are served by a ship. By specifying departure rules, you can generate voyages automatically.

- **Carrier Flight Schedule**

  Use the carrier flight schedule to define a standard sequence of transportation stops that are served by a plane. By specifying departure rules, you can generate flights automatically.

- **Road Schedule**

  Use the road schedule to define a standard sequence of transportation stops that are served by a truck.

Schedule Capacities

In the schedule type, you can define if the schedule should have the following items assigned to it:

- Limited capacities
- Transportation costs

LESSON SUMMARY

You should now be able to:

- Understand carrier schedules and routes

Learning Assessment

1. Assigning partner functions in the SAP system determines the functions of particular partners in the sales process. Each partner can have only one function.

   Determine whether this statement is true or false.

   - ☐ True
   - ☐ False

2. When you create transportation zones, it reduces the amount of master data in the system by grouping locations together. Which of the following are examples of transportation zones?

   Choose the correct answers.

   - ☐ **A** Regional Zones
   - ☐ **B** Postal Code Zones
   - ☐ **C** Country Zones
   - ☐ **D** City Zones
   - ☐ **E** Island Zones

3. You cannot assign a transportation zone to itself or to a zone already assigned to the same zone.

   Determine whether this statement is true or false.

   - ☐ True
   - ☐ False

4. Which of the following vehicle resource attributes are considered for planning?

   Choose the correct answers.

   - [ ] **A** Capacity
   - [ ] **B** Means of transport
   - [ ] **C** Time zone
   - [ ] **D** Fuel economy
   - [ ] **E** Fuel type

5. When can loading and unloading activities take place?

   Choose the correct answer.

   - [ ] **A** Loading and unloading activities can take place outside operating hour when planned in advance.
   - [ ] **B** Loading and unloading activities can only take place during operating hours.
   - [ ] **C** Loading and unloading activities can take place only before 08.00 hours.
   - [ ] **D** Loading and unloading activities can take place regardless of the operating hours defined by calendar resources.

6. What is the minimum number of locations required to define a carrier schedule?

   Choose the correct answer.

   - [ ] **A** 1
   - [ ] **B** 2
   - [ ] **C** 3
   - [ ] **D** 4

Learning Assessment - Answers

1. Assigning partner functions in the SAP system determines the functions of particular partners in the sales process. Each partner can have only one function.

   Determine whether this statement is true or false.

   ☐ True

   ☒ False

   Correct. One partner may have several functions.

2. When you create transportation zones, it reduces the amount of master data in the system by grouping locations together. Which of the following are examples of transportation zones?

   Choose the correct answers.

   ☒ **A** Regional Zones

   ☒ **B** Postal Code Zones

   ☒ **C** Country Zones

   ☐ **D** City Zones

   ☐ **E** Island Zones

   Correct. Regional, postal code, and country zones are all types of transportation zones used in TM.

3. You cannot assign a transportation zone to itself or to a zone already assigned to the same zone.

   Determine whether this statement is true or false.

   ☒ True

   ☐ False

   Correct. No recursive assignments are allowed.

4. Which of the following vehicle resource attributes are considered for planning?

   Choose the correct answers.

   - [X] A Capacity
   - [X] B Means of transport
   - [X] C Time zone
   - [ ] D Fuel economy
   - [ ] E Fuel type

   Correct. Capacity, location, means of transport, time zone, and continuous dimension are attributes that are considered for planning.

5. When can loading and unloading activities take place?

   Choose the correct answer.

   - [ ] A Loading and unloading activities can take place outside operating hour when planned in advance.
   - [X] B Loading and unloading activities can only take place during operating hours.
   - [ ] C Loading and unloading activities can take place only before 08.00 hours.
   - [ ] D Loading and unloading activities can take place regardless of the operating hours defined by calendar resources.

   Correct. Calendar resources define the operating hours of locations, and as a result, loading and unloading activities can only take place during operating hours.

6. What is the minimum number of locations required to define a carrier schedule?

   Choose the correct answer.

   - [ ] A 1
   - [X] B 2
   - [ ] C 3
   - [ ] D 4

   Correct. Two locations are required.

UNIT 3 Creation of Transportation Requirements

UNIT OBJECTIVES

- Define transportation relevance
- Explain freight units and freight unit building rule
- Understand the concept of conditions and incompatibilities
- Understand how to process deliveries
- Build packages
- Explain change controller

Defining Transportation Relevance for Orders and Deliveries

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Define transportation relevance

Transportation Requirements

The initial event that triggers the transportation management process is a transportation requirement. Based on the deployment option used for SAP TM, the following are the transportation requirement starting points:

- Logistics Service Providers (LSPs or 3PLs)
- The side-by-side deployment / external TM system integration
- The embedded deployment / internal TM component integration

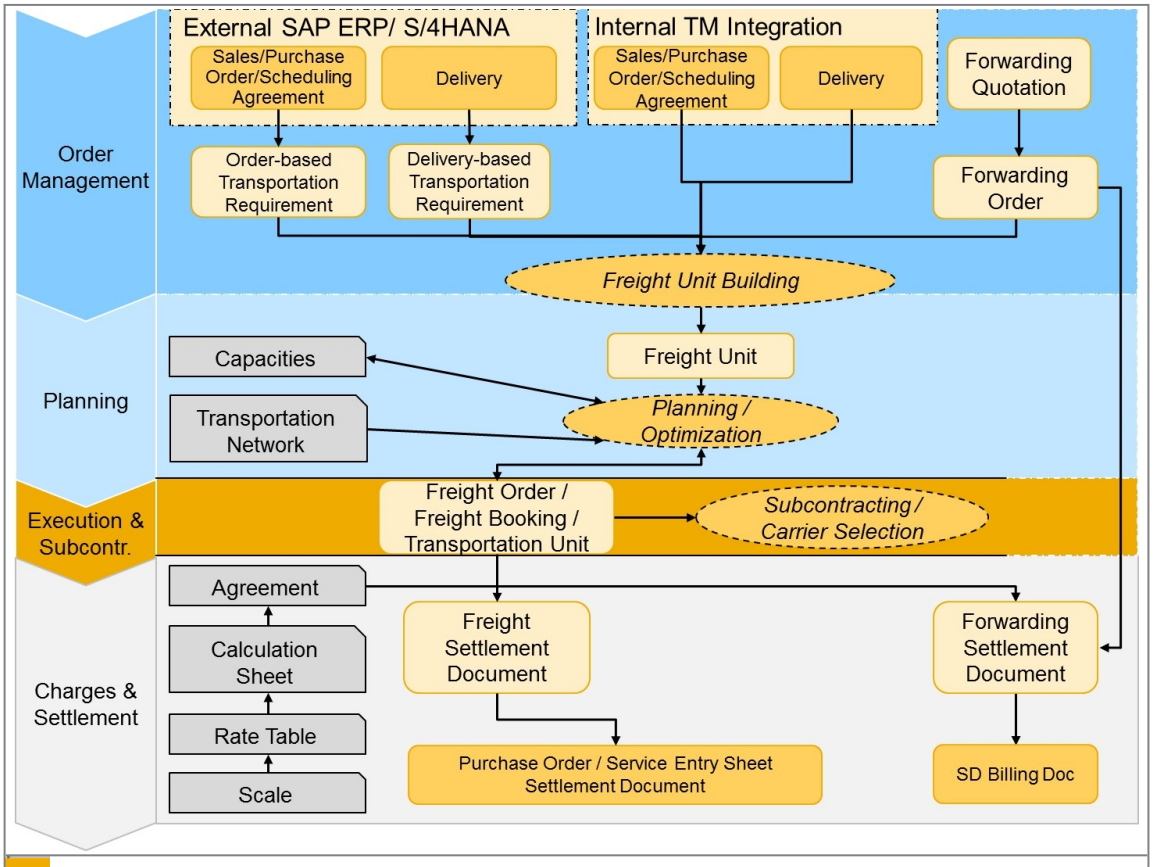

Figure 29: Transportation Requirements

Logistics Service Providers (LSPs or 3PLs)

Logistics service providers (LSPs or 3PLs) can also receive transportation requirements. For LSPs, the forwarding orders are created in one of two ways – manually, using the SAP TM UI, or through integration with an external system via electronic data interchange (EDI).

In an LSP process, the following documents act as transportation requirements:

- Forwarding orders
- Forwarding quotation

The Side-by-Side Deployment / External TM System Integration

In side-by-side deployment scenarios, SAP TM is installed as a separate system and the original document causing the transportation demand is not present in SAP TM. Therefore, a replication of this information to the SAP TM system must take place. This replication can either create order-based transportation requirements or delivery-based transportation requirements. Order-based transportation requirements may be created from a sales order, a purchase order, a stock transport order (STO), or a scheduling agreement. Delivery-based transportation requirements may be created from an outbound or inbound delivery. Integration between SAP TM and the source system (SAP ERP or SAP S/4HANA) is accomplished using XML messages via SAP Process Integration, or a point-to-point communication.

The Embedded Deployment/ Internal TM Component

In the embedded deployment scenario, a separate document representing a transportation requirement is not required, since the original object causing the transportation demand is already present in the SAP S/4HANA system itself. This can be order documents like sales orders, purchase orders, stock transport orders, scheduling agreements, or delivery documents like inbound or outbound deliveries. In this deployment scenario, the freight unit is the starting object for SAP TM and the freight unit is created directly from the original object causing the transportation demand. The embedded scenario is the primary focus of this overview training.

Business Functions

The following business functions have to be activated for integrating the SAP TM functionality within the SAP S/4HANA system:

- LOG_TM_ORD_INT
- LOG_TM_ORD_INT_II
- LOG_TM_ORD_INT_III
- LOG_TM_ORD_INT_IV
- LOG_TM_IV_INT
- SD_01
- OPS_ADVRETURNS_1

Logistics Integration

The following documents can trigger an SAP TM process, either through internal SAP TM component integration or via external SAP TM system integration:

- Sales orders

- Customer returns
- Purchase orders
- Stock transport order
- Returns stock transport order
- Sales scheduling agreement
- MM Scheduling agreement
- Outbound deliveries
- Inbound deliveries

The following configuration steps enable freight order creation from SD/ MM documents:

- Activate Integration of documents via control key
- Create logistics integration profile
- Assign logistics integration profile to document type

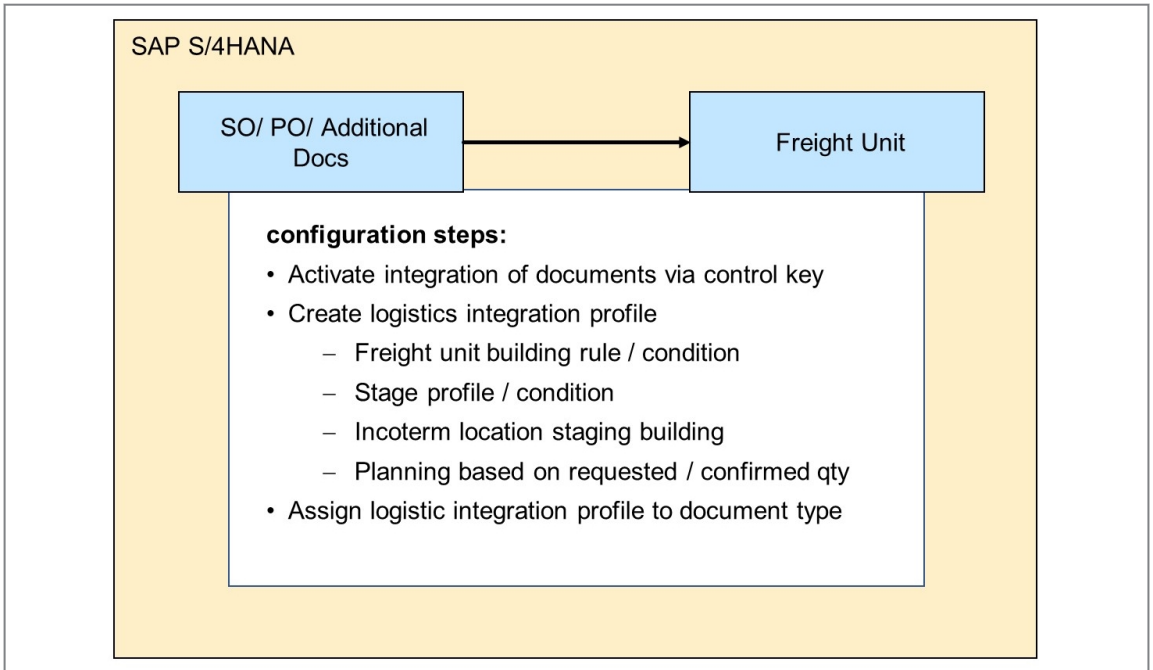

Figure 30: Logistics Integration Configuration Steps

LESSON SUMMARY

You should now be able to:

- Define transportation relevance

Creating Freight Units

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Explain freight units and freight unit building rule

Freight Unit

The freight unit is the smallest unit that can be transported. The predecessor document data and the freight unit building rules form the basis for building freight units. You define the most important settings for the freight unit in the freight unit type.

Predecessor documents can be forwarding orders, sales order, delivery, order-based transportation requirements, or delivery-based transportation requirements. For embedded TM deployment, the sales order or forwarding order will be the predecessor document. For side-by-side deployment, OTR/DTR and forwarding orders will be the predecessor documents.

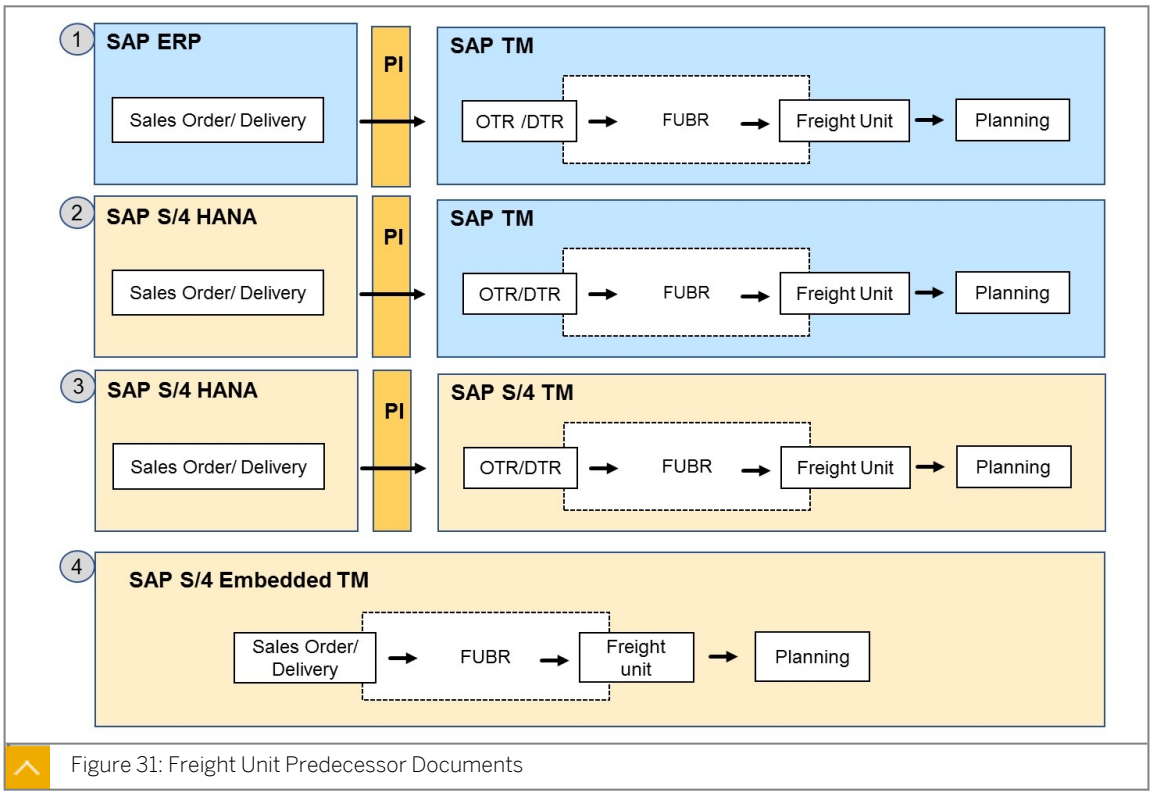

Figure 31: Freight Unit Predecessor Documents

An N:N relationship is possible between the freight unit and its predecessor documents. The figure below is applicable for the embedded environment. The same applies for the side-by-side scenario. Freight units can be further deleted, split, merged based on settings defined in the freight unit type customization.

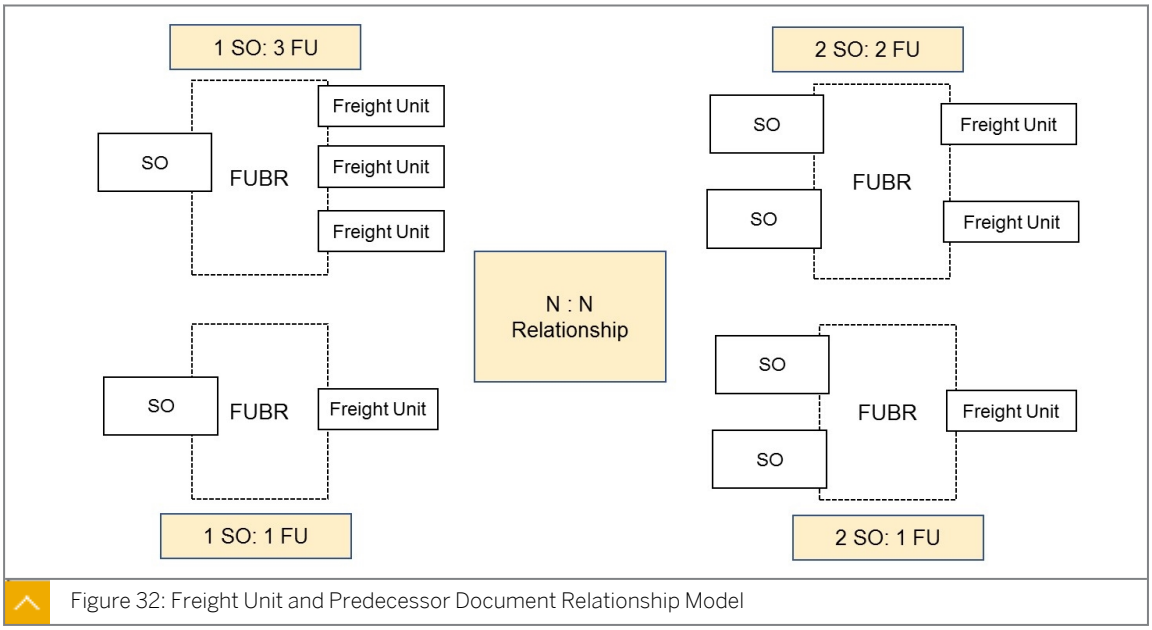

Figure 32: Freight Unit and Predecessor Document Relationship Model

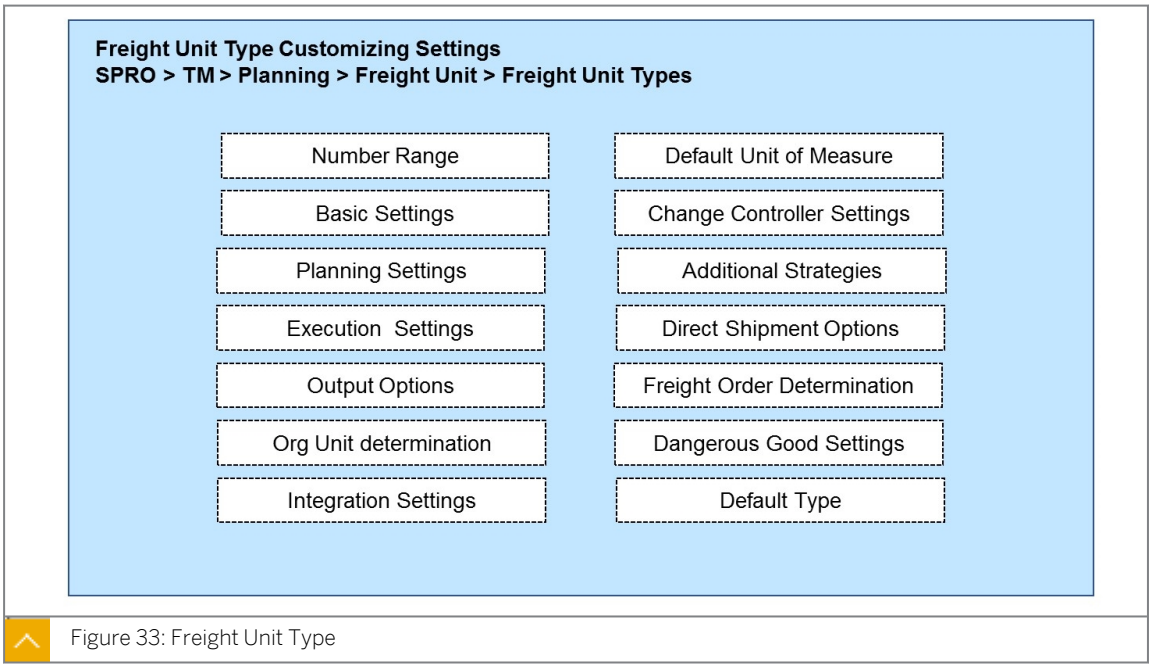

Figure 33: Freight Unit Type

The following are the configuration settings for freight unit type:

Change Controller Settings: You can assign several different settings related to the change controller. These settings impact how TM responds to changes made to the freight unit and freight order.

Additional Strategies: There are a number of additional strategies:

- Creation Strategy: Specifies tasks that the change controller is to perform when creating a freight order, freight booking, and freight unit.
- Save Strategy: Specifies tasks the change controller is to perform when saving a freight order, freight booking, and freight unit.
- Delete Strategy: Specifies tasks that the change controller is to perform when a freight order, freight booking, or freight unit is deleted or canceled.

Execution Settings: There are a number of execution settings:

- Execution Track Relevance: Indicator for controlling the tracking of documents. To track certain types of documents, choose 2 (Execution Tracking) or 3 (Execution Tracking with External Event Management). The system sets the initial document execution status to Not Started. If you do not want to track certain types of documents, choose 1 (No Execution Tracking). The system then sets the initial document execution status to Not Relevant.
- Immediate Processing checkbox.

Planning Settings:

- Planning profile: Planning profile can be assigned to freight unit type for freight order planning.
- Rule for pick up/ delivery windows: Time windows can be specified for pick up and delivery of goods. If condition is not defined then rule is considered.
- Condition for pickup and window determination window: Condition /SCMTMS/ TOR_TIMEWIND can be assigned to the freight unit type based on this condition. The following four dates and times for pickup and delivery are calculated for source and destination based on information derived from the sales order, forwarding quotation, OTR, DTR:
  - Acceptable start date and time
  - Requested start date and time
  - Requested end date and time
  - Acceptable end date and time

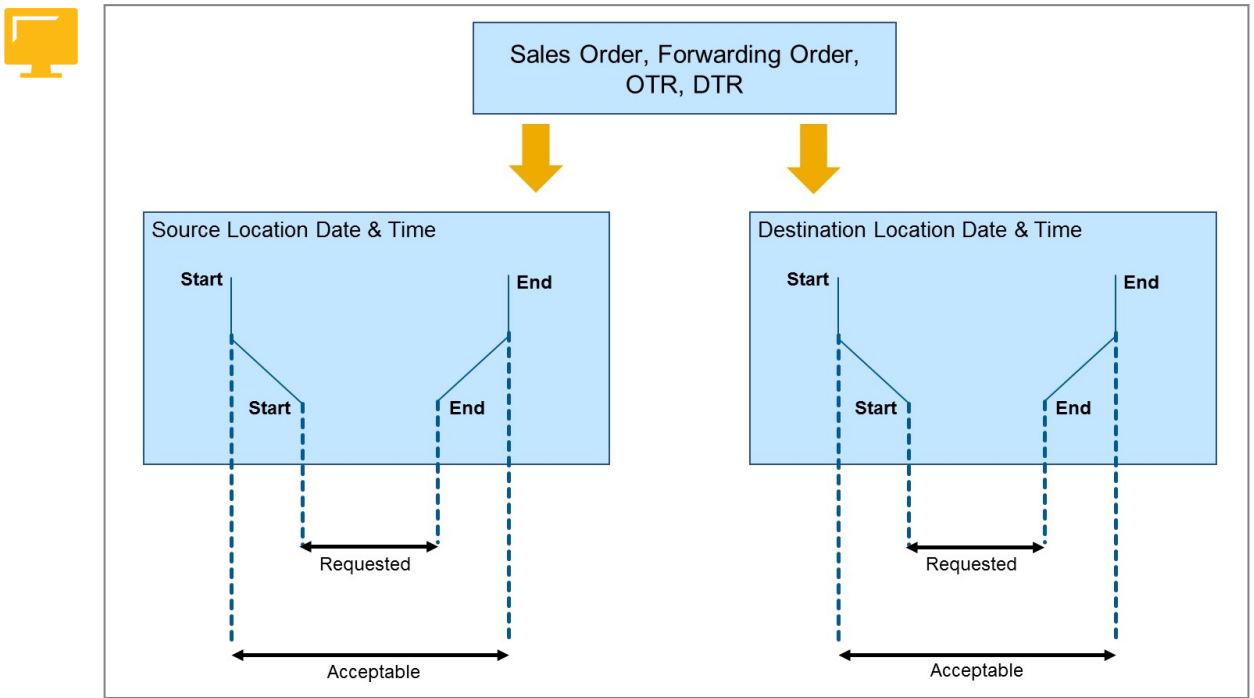

Figure 34: Pickup and Delivery Window

Event Management Settings:

- Application Object Type: Type of application object to be tracked on the application system necessary for determining event management relevance for an application object. The event manager only processes event messages for these objects.
- Last Expected Event for Execution of a Document: Last expected event for a document, for example, the unexpected event Unload End.

Default MTr Definition Settings:

- Default MTr for Type: Indicate the default means of transport type
- Condition for Default MTr

Default Units of Measure:

- Weight
- Volume

Direct Shipment Options:

- Direct Shipment Option Type: There are three standard options which include no determination of direct shipment options, automatic determination of direct shipment options, and manual determination of direct shipment options.
- Carrier Selection Settings: Indicates carrier selection settings that are used for the determination of direct shipment options.
- Carrier Selection Conditions: Specifies the condition that the system uses to determine carrier selection settings for direct shipment processes at run-time.
- Direct Shipment Strategy: Specifies the process controller strategy that can be used to determine the direct shipment options for a freight unit.

Freight Order Determination:

- Freight Order Type: Default freight order type for direct shipment.
- Freight Order Type Condition: Condition can be created to decide which freight order type is used for direct shipment.

Organizational Unit Determination:

- Default Org Unit: Execution Organization, Purchasing Organization, Execution Group, Purchase Group. These are the organization numbers that are created in Organizational Structures.
- Consider Organization Unit of User checkbox: Considers the organizational unit assigned to the user that creates the freight unit in the determination of the organizational unit responsible for the freight unit.
- Condition of Determination Rules: Conditions can be created to effect the organizational unit determination.

Additional Settings:

- Track Changes checkbox: Select this box if changes are to be tracked.

Freight Unit Building Rule

Freight unit building rules define how freight units are built. The system determines which freight unit building rule will be taken into account for the business document during planning. The following are the three freight unit building rule determination options:

1. The system checks the condition defined in the logistics integration profile. If there is no condition or the condition cannot determine a result, the system moves to the second option.
2. The system checks if a freight unit building rule has been maintained in the logistics integration profile. If no freight unit building rule is maintained, the system moves to the third option.
3. The system applies standard settings.

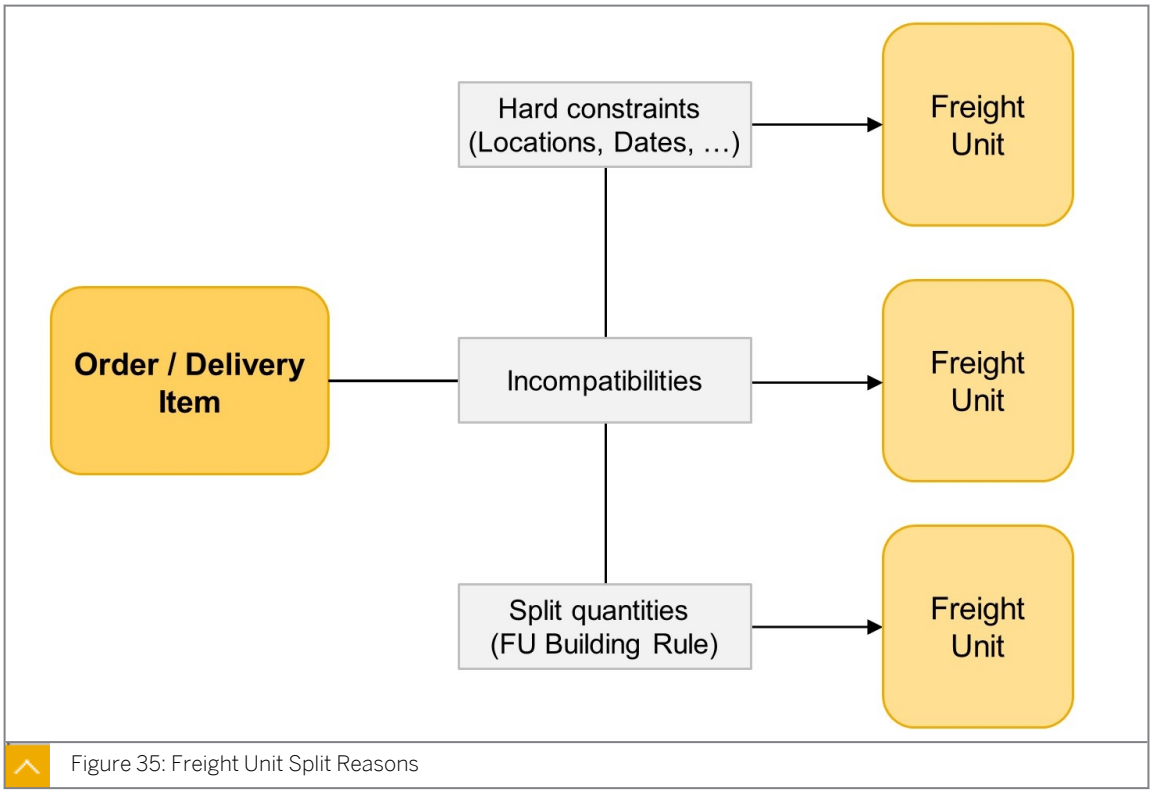

Figure 35: Freight Unit Split Reasons

When creating freight units, the system first groups all delivery items within the following parameters:

- Hard constraints for source / destination location and pick-up / delivery dates
- Business document attributes and packaging information
- Incompatibilities

Freight units are created automatically if transportation-relevance is determined for the transportation demand (sales order, purchase order, delivery, forwarding order, OTR, DTR).

The system considers freight units that already exist for the transportation demand. It creates freight units depending on the split quantity and the checkbox for the item split allowed. The system considers these entries when creating multiple freight units. You can use strategies to create freight units in accordance with your own requirements. SAP delivers the standard strategy FUB_AUTO for freight unit building.

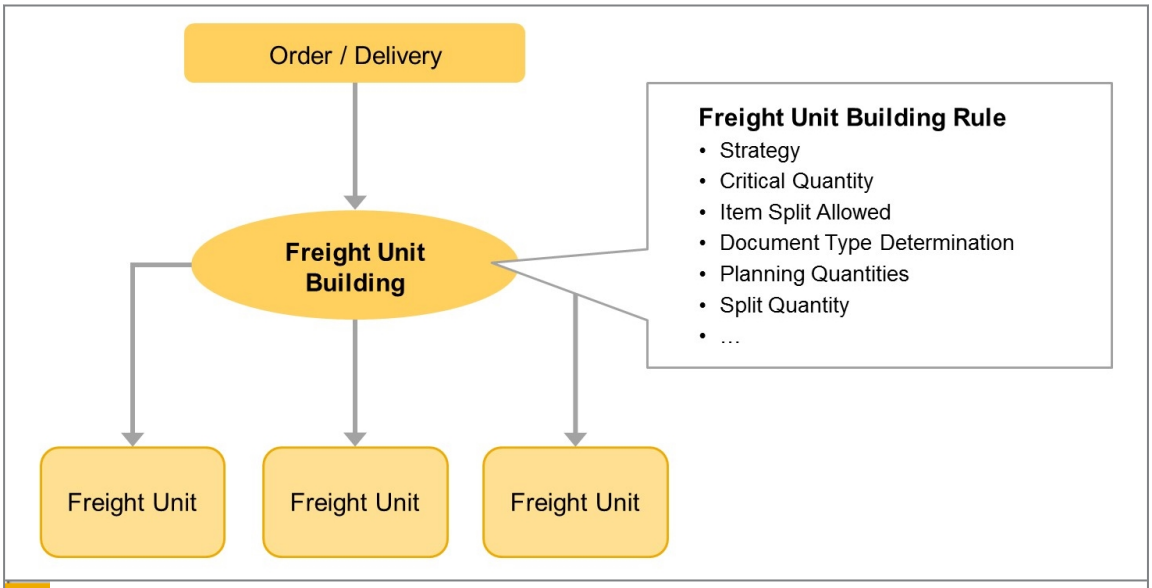

Figure 36: Freight Unit Building Rule

Within the freight unit building rule, you must specify the critical quantity. This parameter defines the primary unit of measure that allows a line item on a transport requirement to be split into multiple freight units. Besides that, several planning quantities can be defined, for example, weight and volume. Every planning quantity is considered for capacity checks of resources during transportation planning, and every planning quantity is copied to the freight unit.

The split quantities define the maximum capacity of a freight unit. The system calculates the freight unit as a multiple of the rounding quantity. If Item Split Allowed is selected, the freight unit splits the item while it is being built, if it is over the split quantity. The process controller strategy allows you to use strategies to define the way in which freight units are created, in accordance with your requirements. If you maintain an equipment type in the freight unit building rule, the capacity of the equipment is considered during freight unit building and the items consolidated into one freight unit are loaded into the equipment.

If necessary, companies can define that the freight units are split if certain constraints are present. For example, you define the maximum capacity of a freight unit using the split quantity. Let's say you have to transport 5 tons of cement, but you can only transport it in batches of 500 kg. In this case, you define a split quantity of 500 kg and the system generates 10 freight units.

Based on the definition of freight units, all items included in a freight order are transported together from their source to their final destination. However, in multi-modal scenarios, different planners may be involved in scheduling the different stages of the transport. For this reason, stage information can be added to the freight unit. This allows a degree of independence when scheduling the stages.

Using the process controller, freight unit building can be adjusted to customer-specific requirements using ABAP coding.

Freight Unit Building Rule

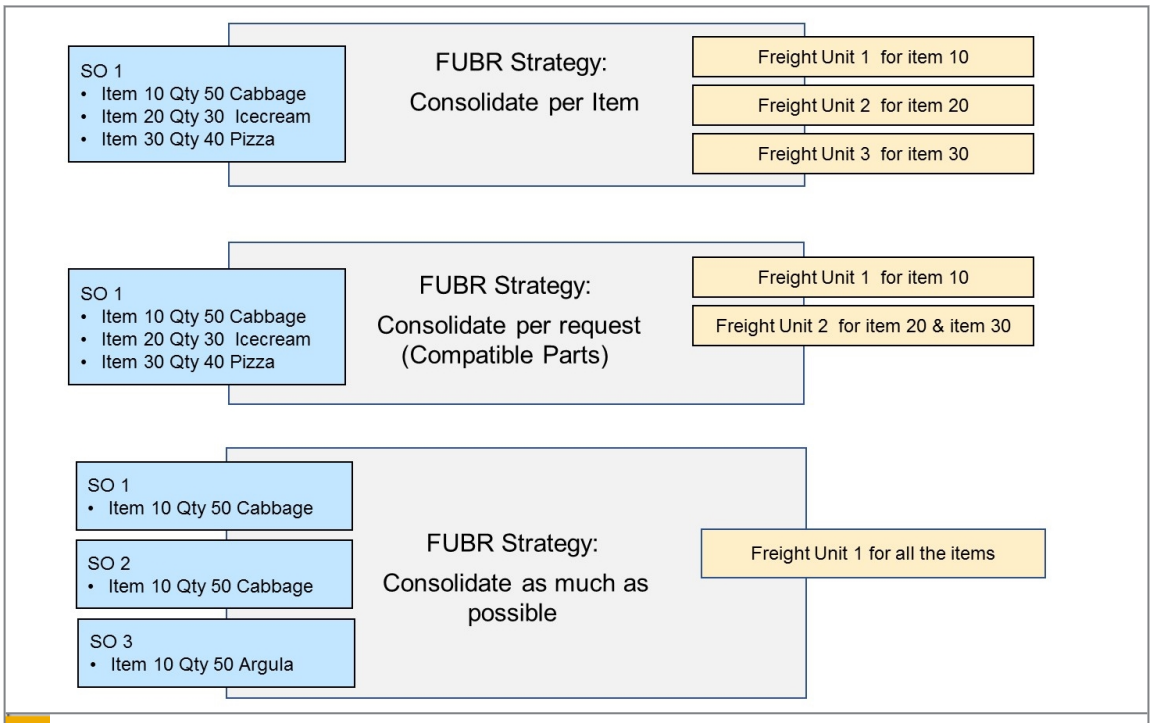

Figure 37: FUBR Strategy

Consolidate Per Item

One freight unit building rule strategy is to consolidate per item. This strategy creates separate freight units for each item in the transportation requirement.

Consolidate per Request (Compatible Parts)

Another freight unit building rule strategy is to consolidate per request for compatible parts. The system groups all the items of a business to form a freight unit. It is assumed that compatibility rules are used to group similar items.

Consolidate as Much as Possible

Another freight unit building rule strategy is to consolidate as much as possible. This strategy can only be used with interactive FU creation via a batch report. It consolidates several transportation requirements into one freight unit, if there are no other reasons for a split.

LESSON SUMMARY

You should now be able to:

- Explain freight units and freight unit building rule

Conditions and Incompatibilities

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Understand the concept of conditions and incompatibilities

Conditions

BRFplus (Business Rules Framework plus) is a powerful rules based engine, and is used by TM conditions. TM Conditions empower users to process complex business rules and it reduces the need to develop, customize and configure. Conditions are used as filters for automatic decision making. A condition maps input values to output values. For example, determination of product type, determination of resource type, determination of execution organization.

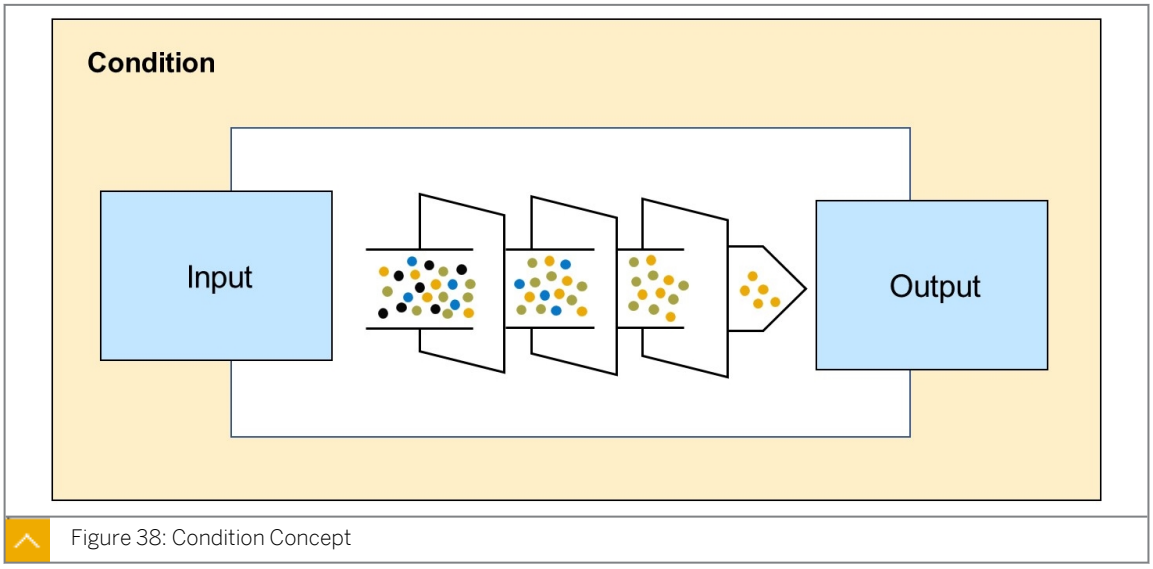

Figure 38: Condition Concept

There are different types of conditions for different areas. For example, document type determination, order type determination, loading and unloading durations, incompatibilities, printing, approvals, tolerances, and any customer-specific rule(s).

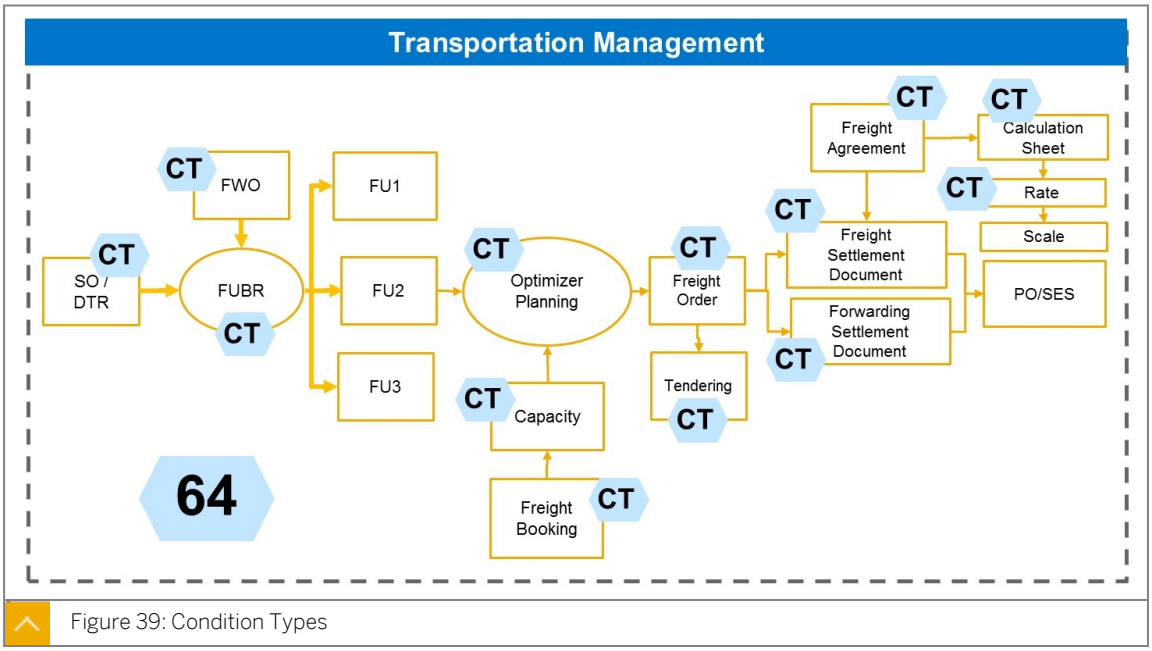

Figure 39: Condition Types

- Condition type: First, you define the condition type and specify the origin. Specify the condition type, the fields against which you are testing, and how you want to store the test results when creating a condition. This is referred to as the origin of the condition. The system provides the following three options for the origin of condition:
  - Direct business object access: The Direct Business Object Access condition returns directly the value determined by the data access definition. There is no evaluation of the data.
  - BRF+ Decision Table : The BRFplus Decision Table condition takes the input of the data access definition and evaluates it in a table. This condition table can be maintained from the condition user interface. This origin of condition is most commonly used by TM users.
  - BRF+ Expression: The BRFplus Expression is a logical expression.

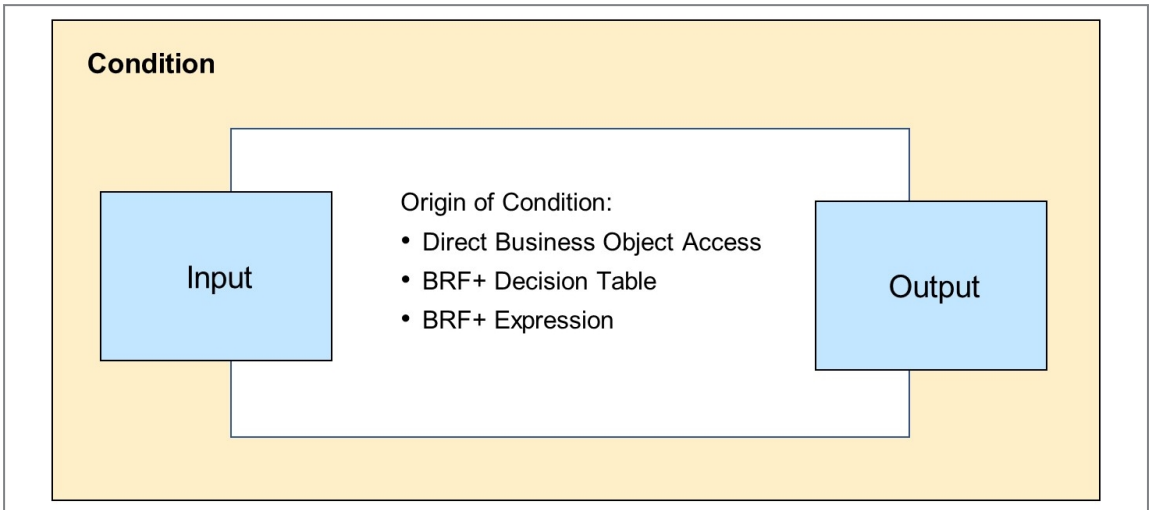

Figure 40: Condition Origin

- Input values: Input values originate in the fields of business objects (direct business object access) or user-specific fields (data crawler), or values determined in external determination classes. The available input values depend on the condition type chosen. The condition type defines the area in which the system is to take the condition into account. There are various input values and they are determined by the following factors:
  - Direct Business Object Access
  - Data Crawler
  - Determination Class
- Output values: The output of a condition may comprise several output values, all derived from the input values based on decision making. The output values are determined by the condition type. For example, the FUB rule is a result of FUB rule determination.
- BRFplus decision table: The system creates a condition based on BRFplus expressions. The system then processes this table from top to bottom during determination. As soon as the system finds a row in the BRFplus decision table whose input values match the current input values, it copies the corresponding output values and processes them in the area that made the call.

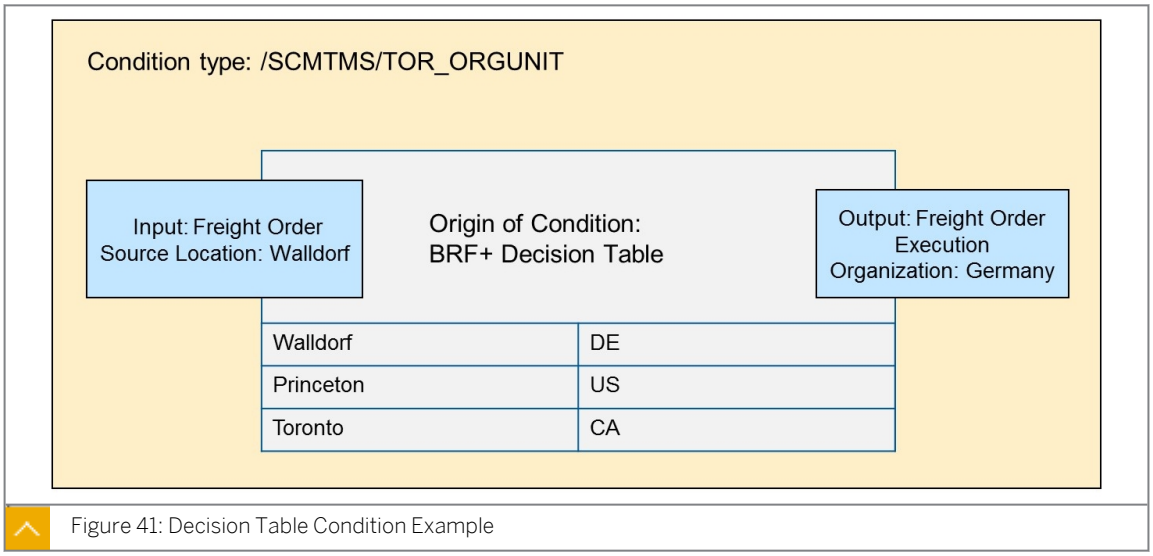

Figure 41: Decision Table Condition Example

Conditions are tests performed against various objects, such as transportation requirements or freight units, to determine whether a situation is true or false. For example, to decide if products on a single transportation requirement can be shipped together, each item on the OTR is checked for certain parameters. If a certain parameter is found, rules are built to determine where consolidation can take place. If an incompatibility exists, more than one shipment is necessary.

If you need additional fields for the condition types to be delivered as standard, or if you want to use customer condition types, create new data access definitions and extend the assignments in Customizing. You can also change or add to the data access definitions used by default. The condition type must be identified when defining a condition in SAP TM. A condition type is a configurable object that is based on field contents stored in various business object nodes. Each condition type is assigned to a business object (structure) and the node name (at the header or item level).

When defining a condition type, you can identify when a result is found, if it is stored in a structure, and if one or more conditions may exist for this condition type. Condition types are

then assigned to data access definitions. These objects specify what fields and in what sequence users can define specific condition records.

Incompatibility

During transportation planning, companies prepare a set of guidelines regarding shipping. For example, if a shipper has products that need to be transported via a refrigerated container, they cannot ship those products with frozen freight units. While planning transportation shipments, companies define rules regarding how they consolidate loads into a single freight order. There are many factors other than capacity that impact how freight orders are built. In SAP TM, these rules are called incompatibilities. This data defines the relevant parameters controlling when it is and is not appropriate to consolidate loads.

In the figure, a company has a variety of products to ship. The temperature at which items must be stored during transit is the attribute that signals if items can be consolidated. A test is executed to decide the temperature in which each product is shipped. A rule states that items classified as chilled cannot be shipped with items classified as frozen. This could lead to damage or spoilage if a product is shipped at the wrong temperature.

Incompatibilities are used in combination with conditions to influence the results in SAP TM during freight unit building, transportation planning, transportation proposals, and carrier selection. Incompatibilities are important when defining requirements for load building. For example, freight units with different incoterms must not be transported together. Refrigerated goods need to be transported in an appropriate means of transport. Certain means of transport cannot be loaded at a specific location because the location does not have a suitable loading ramp.

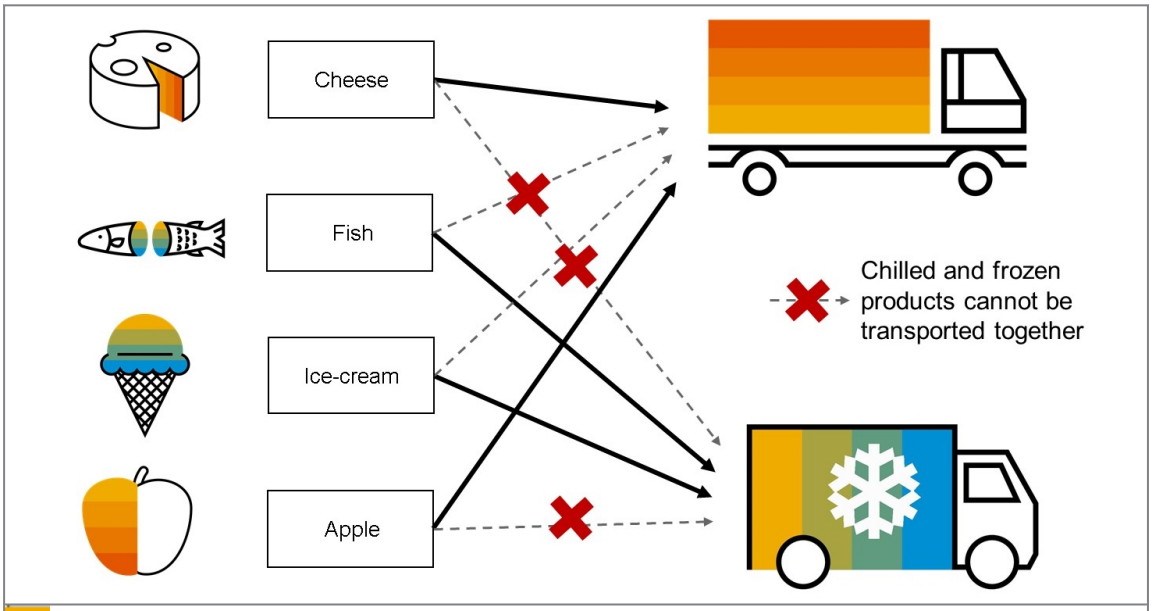

Figure 42: Incompatibility Example: Product (FU) and Vehicle Resource

When creating an incompatibility definition, you must specify a validity area. Validity areas are comprised of an incompatibility area and an incompatibility type.

Incompatibility areas define where an incompatibility can be used. Four incompatibility areas exist in TM: Vehicle scheduling and routing planning, Freight unit building, Carrier selection, Delivery proposals.

Incompatibility Types: Incompatibility types are delivered by SAP and define the objects that are the focus of the rule being enforced. The following list contains examples of

incompatibility types: Freight unit - Freight unit, Freight unit - Vehicle, Freight unit - Transshipment location, Carrier - Transportation Order.

In addition to the validity area, the incompatibility definition can determine how the rule is enforced in both manual and automatic planning by defining the reaction, for example, incompatibility is ignored, warning if ignored, must not be violated.

Incompatibilities can be defined between two attributes of two business objects. This requires that two conditions are defined and relevant results are specified. Two business objects are then incompatible if the result of the conditions matches the relevant results.

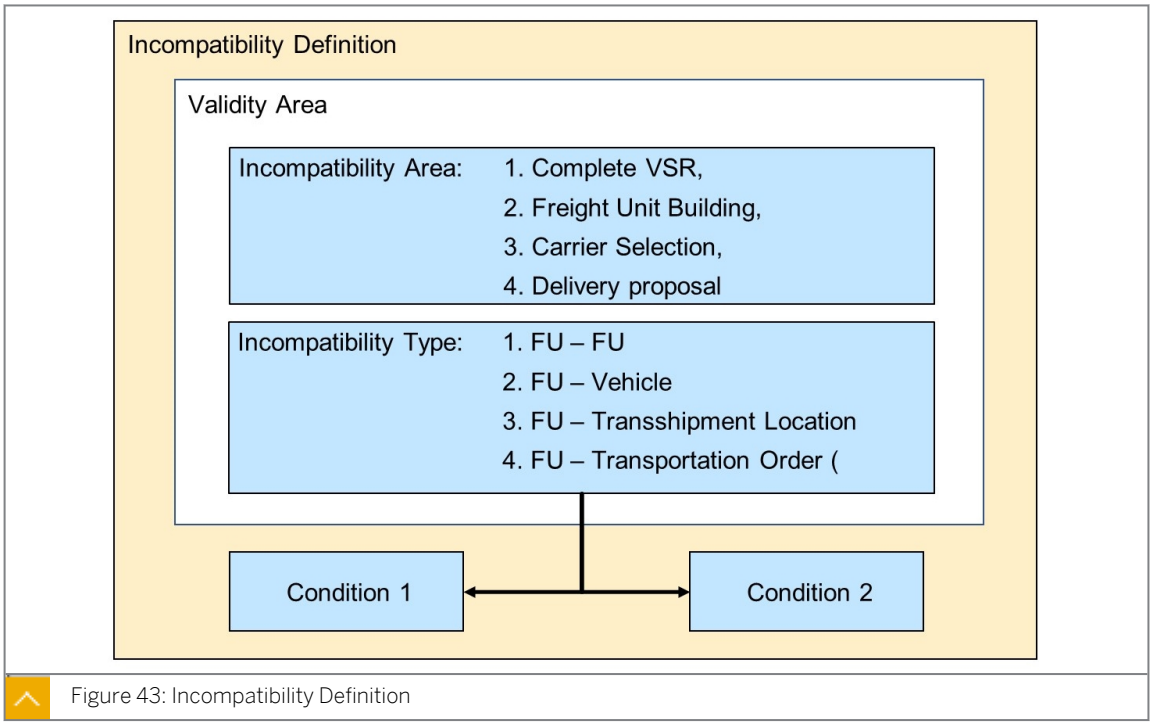

Figure 43: Incompatibility Definition

Setting the Identical Values Only checkbox in the incompatibility definition allows for an incompatibility to be defined between two instances of the same business object, for example, two freight units. In this case, a single condition is defined in the incompatibility definition. The two business object instances are then only incompatible if their values differ.

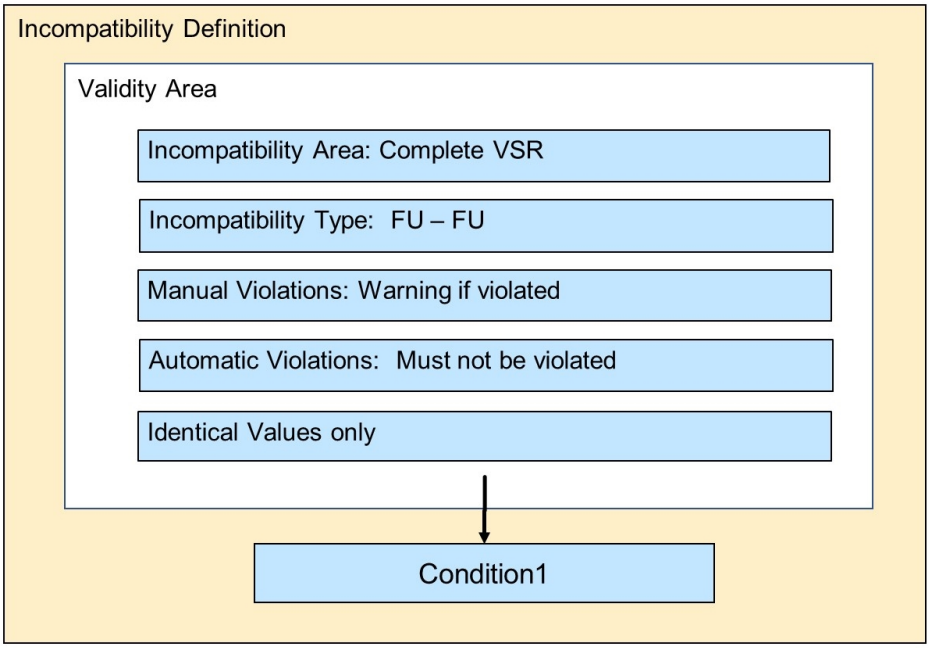

Figure 44: Incompatibility Identical Values and Violations

01 – VSR	04 – Freight Unit Building	05 – Carrier Selection	07 – Delivery Proposal
01 – Freight Unit- Freight Unit (Vehicle Level)	52 – Transportation Request Item	81 – Carrier –Transportation Order	51 – Transportation Request Header-Transportation Request Root
02 – Freight Unit- Freight Unit (Compartment Level)		82 – Transportation Order-Transportation Order	52 – Transportation Request Item-Transportation Request Item
03 – Freight Unit- Freight Unit (Means of Transp. Combination)			53 – Freight Unit- Freight Unit
04 – Freight Unit -Vehicle Resource			
05 – Freight Unit Transshipment Location			
06 - Freight Unit - Vehicle Compartment			
07 – Vehicle Resource – Vehicle Resource			
08 – Vehicle Resource- Location (Stay Level)			
09 – Vehicle Resource- Location (Loading/Unloading Level)			
10 – Vehicle MTR Combination – Location			
11 – Freight Unit – Freight Booking			
19 – Freight Unit Schedule			

Figure 45: Incompatibility Validity

Incompatibility Settings: Incompatibility settings can be maintained in planning profiles, carrier selection settings, delivery profiles, and the freight unit building rule. Transportation planning profiles specify when the system allows incompatibilities to be violated during manual planning, in VSR optimization, or in background processing. Incompatibility settings are assigned within these profiles. The incompatibility settings group together several incompatibility definitions that may apply to a planning run. Only incompatibilities for the same incompatibility area can be combined.

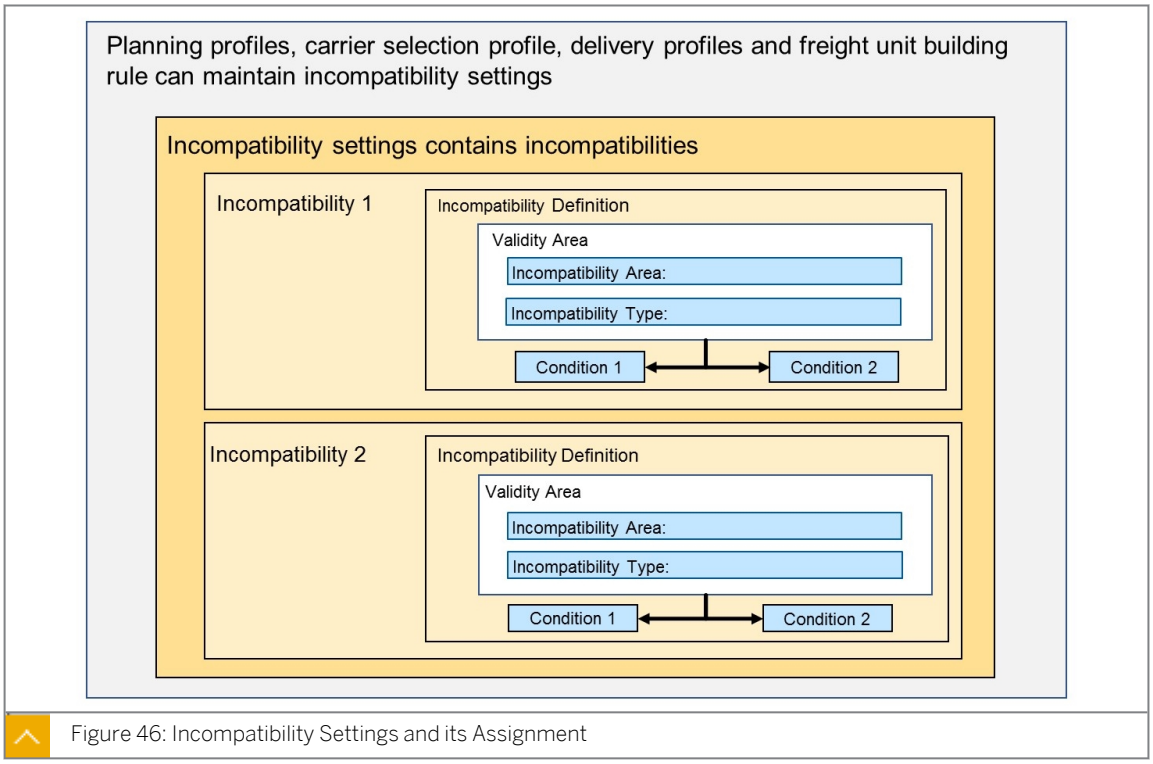

Figure 46: Incompatibility Settings and its Assignment

LESSON SUMMARY

You should now be able to:

- Understand the concept of conditions and incompatibilities

Trigger, Create, and Manage Deliveries

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Understand how to process deliveries

Delivery Overview

The decision about whether to start the process in TM with either the order or the delivery depends on the customer requirements and guidelines concerning transportation planning and execution. If shipping activities other than transportation planning are involved prior to the transportation process, the process based on the delivery is more likely to be used. If goods are sold with all shipping activities considered, the order will be the basis for transportation planning.

There is no difference in the continuation of the process between transportation requirements based on an order and those based on deliveries. As shown in the figure, both documents are capable of triggering the entire process.

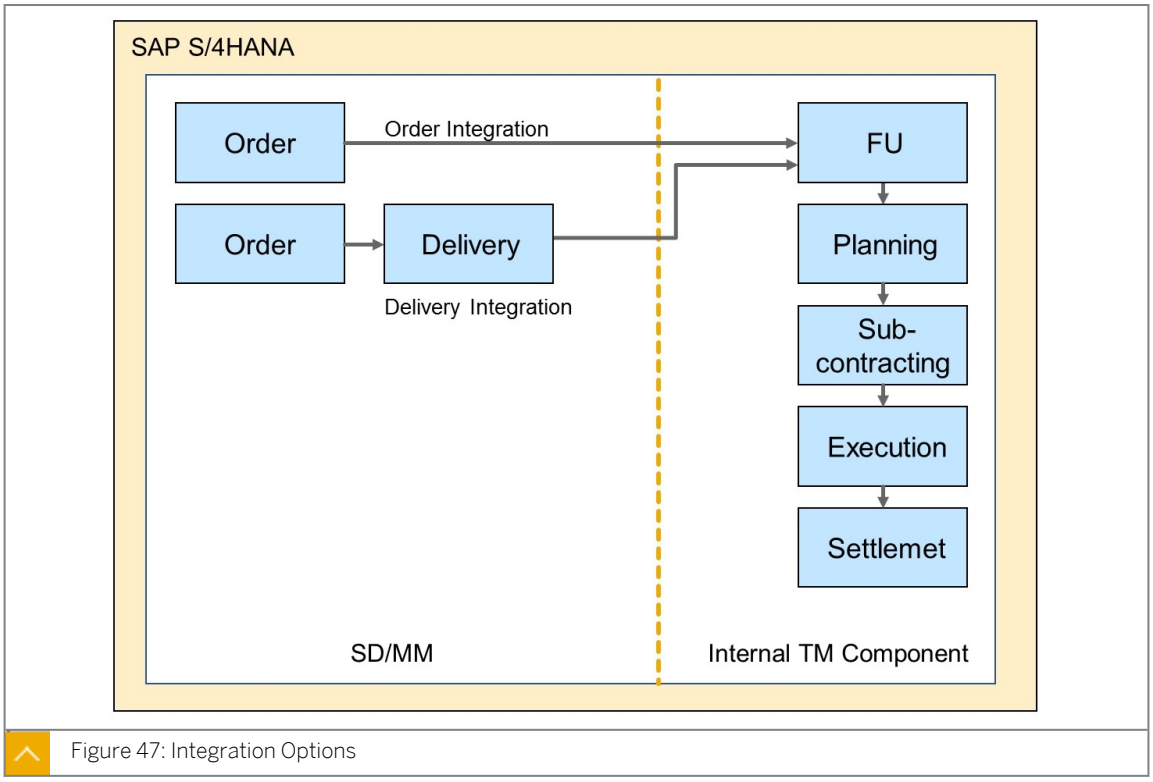

Figure 47: Integration Options

The following integration scenarios can be set up:

- Order Integration with delivery proposals

- Delivery Integration without delivery proposals

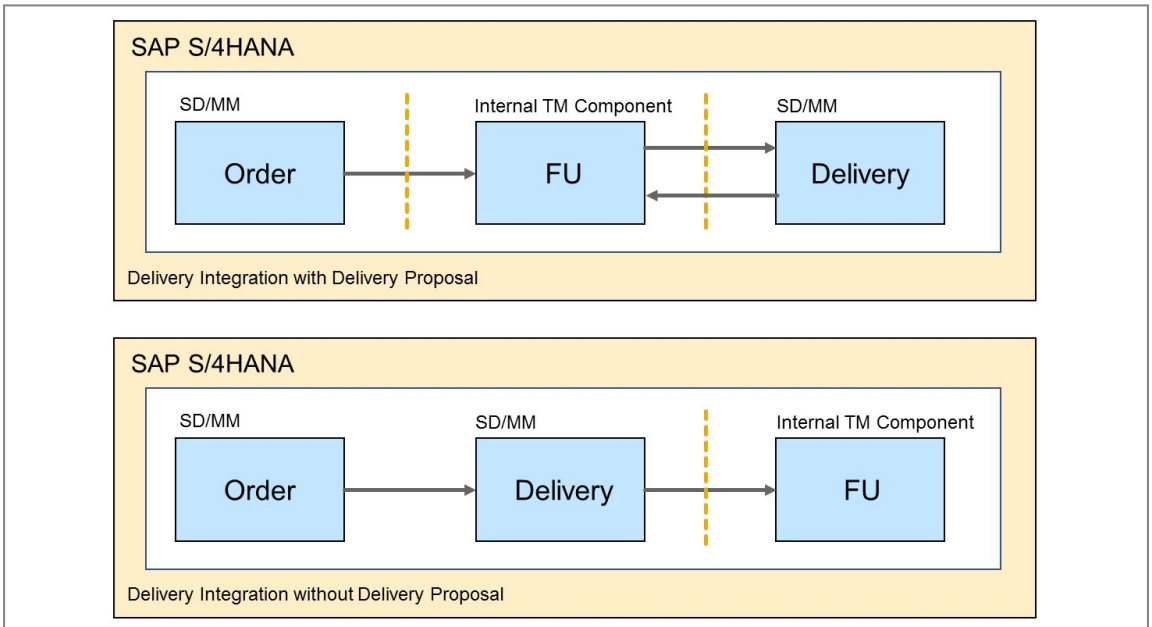

Figure 48: Integration Scenarios

Order Integration with Delivery Proposal

If the TM component is leading the transportation process, you will set up the integration scenario Order Integration with Delivery Proposal. The order is created in SD/MM and then integrated into the TM component. Freight units are created in TM automatically. After freight units on freight orders, the delivery date can be known. This information is relayed back to SD/MM, where delivery documents are created.

Delivery proposals are used to propagate planning information from TM to SD/MM. Deliveries are created in SD/MM. This process is called Delivery Proposal because TM is proposing the creation of deliveries. SD/MM decides how the delivery should be created.

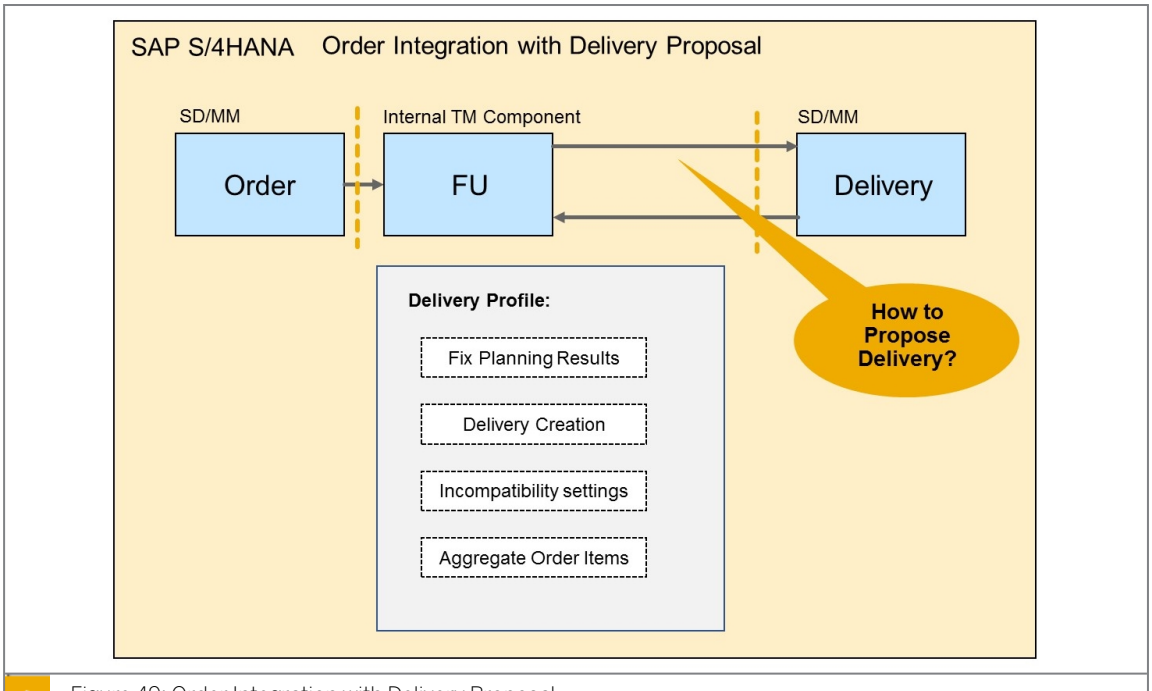

Figure 49: Order Integration with Delivery Proposal

SAP TM considers data for delivery creation from the order and from the assigned freight units, freight orders, and freight bookings. Based on the chosen input, SAP TM creates delivery proposals. A proposal consists of groups of freight units that can be delivered together.

- Dates: TM uses dates from the freight order or freight booking. If the freight unit is not planned, that is, no freight order or freight booking exists, then SAP TM uses dates from the freight units.
- Quantities: TM uses quantities from freight units.
- SD/MM Document References: TM retrieves document references (such as order document number) from the order / order-based transportation requirement.

Delivery profiles define how delivery proposals should be created. Although the delivery profile is optional, it makes sense to create a profile to reuse the same settings every time you want to create delivery proposals. The settings you can define here concern how and if freight units can be consolidated into one delivery proposal and which freight units may not be consolidated.

To see information related to delivery profiles, log into SAP Fiori, then choose *Profiles and Settings → Create delivery profile*.

You can define how the delivery proposals should be created (for example, one proposal per item, one proposal per freight unit, and so on). One option of the delivery profile is to “fix” the planning result for freight units and freight orders. Fixing the planning means after the planning results are transferred via the delivery proposals, they can no longer be changed in SAP TM. Incompatibilities in delivery profiles can be used to prevent certain freight units or items from being consolidated into one delivery proposal.

After the delivery proposals have been sent, deliveries are created. SAP TM receives information about the status of the delivery creation.

Delivery Integration Without Delivery Proposals

If the SD/MM component is the leading system for delivery creation and item order consolidation, you will set up the integration scenario Delivery Integration without Delivery Proposal. In this case, the order would not trigger the transportation management process and thus the freight unit creation. Only after the delivery is created for the order should freight units be created. These freight units now better represent the splits and consolidations that have been done previously in SD or MM. Planning can now start, although the planning results do not affect the delivery dates of the delivery anymore. Dates in the freight unit are considered as hard constraints during planning.

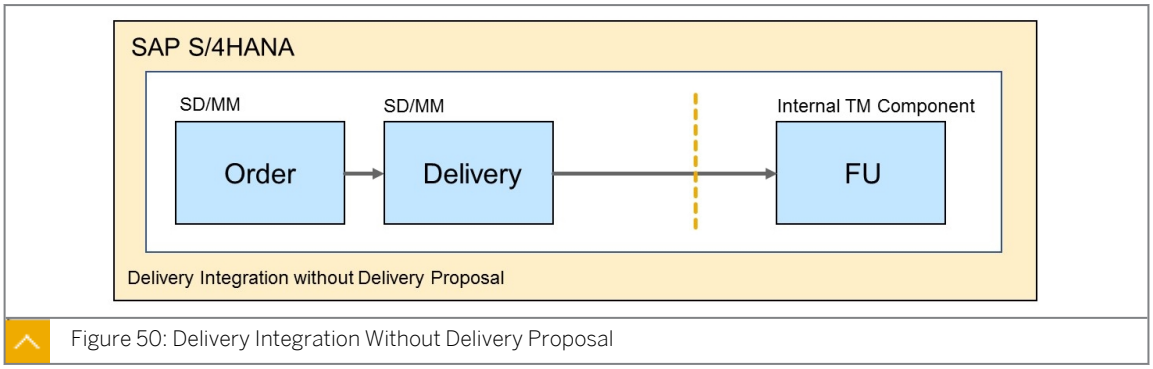

Figure 50: Delivery Integration Without Delivery Proposal

LESSON SUMMARY

You should now be able to:

- Understand how to process deliveries

Unit 3
Lesson 5

Building Packages

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Build packages

Handling Units

A handling unit (HU) is a logistic unit consisting of packaging materials and goods (materials). Typically, a company does not move individual pieces of different materials, rather, it moves quantities of materials grouped together as packages. You can depict this situation in the SAP System using Handling Unit Management.

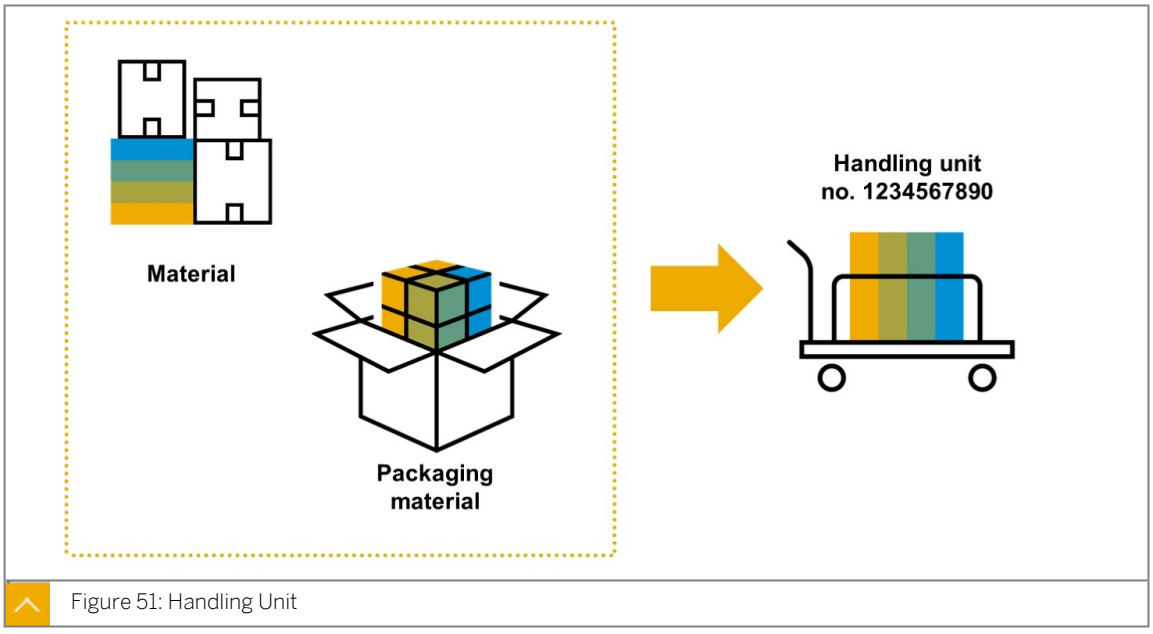

Figure 51: Handling Unit

When you use Handling Unit Management, the system tracks the entire HU rather than individual materials. The HU is the common unit for material and information flow. A business transaction for a HU implies corresponding business transactions in the background for the materials and packaging materials it contains. In this way, one business transaction entry takes the place of several individual material-movement entries.

You can use handling units and can pass them to partners throughout the supply chain. Handling units have a single identification number that uniquely identifies the handling unit across the various processes through which it moves. Using handling units in a cross-system logistics chain usually requires an identification number that is unique worldwide. You therefore have the option of assigning a Serial Shipping Container Code (SSCC) number to each handling unit.

Packaging Materials

Packaging materials are intended to enclose or hold together the materials that are to be transported. The packaging materials and the goods material together comprise the handling unit, as we have seen.

The material that is to be packed can be packed into or onto the packaging material. The packaging material can also be a load carrier, such as a pallet. The most important packaging materials include crates, boxes, containers, wire baskets, and pallets.

You have to maintain the material master data for each packaging material you want to use. When creating material master records for packaging materials, enter either material type, VERP (packaging) or a customer-specific material type that you have already defined in Customizing.

Handling Units and Freight Units

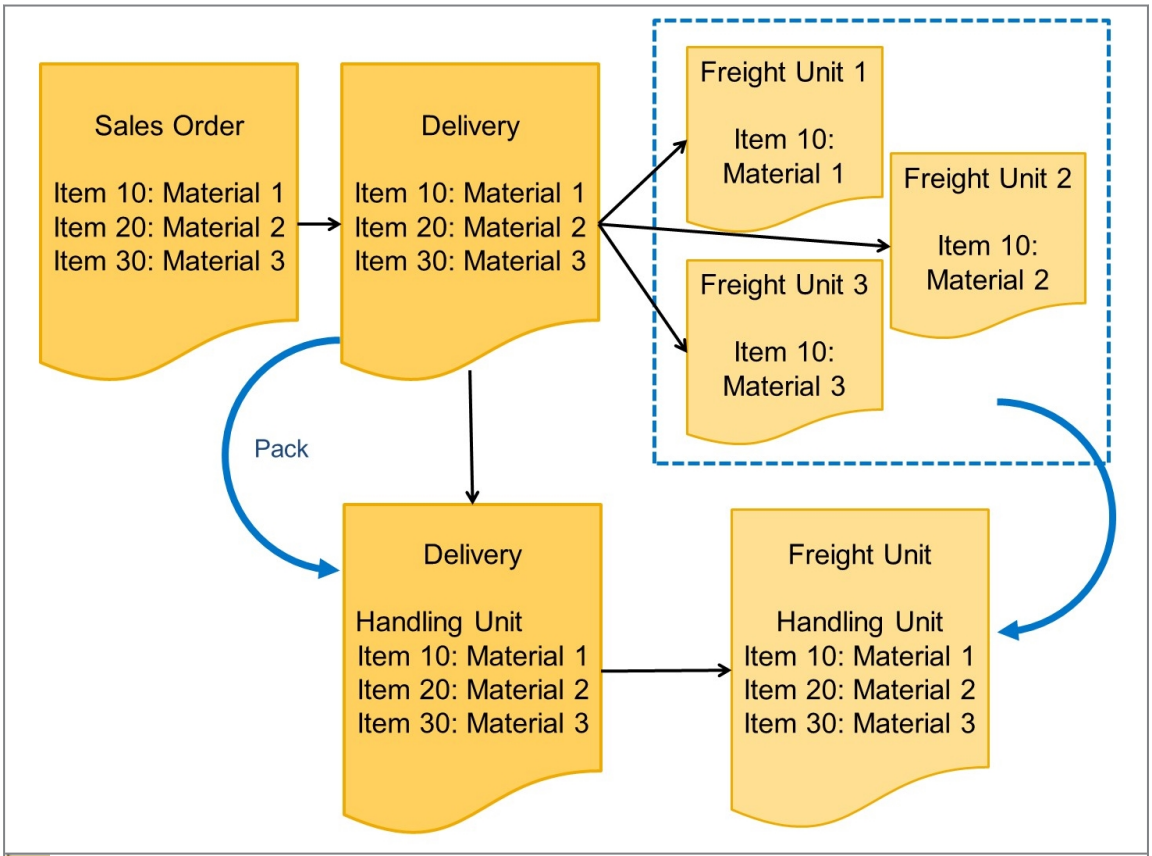

Figure 52: Handling Unit and Freight Unit

When a delivery includes handling unit items, the freight units are adjusted accordingly. All product items that have been packaged into one handling unit are included in one freight unit; they are not split across several freight units. In this way, it is ensured that parts of a handling unit are not assigned to different freight orders during transportation planning.

If, for example, separate freight units were built per product initially, and these products are consolidated into one handling unit, the separate freight units are merged into one freight unit.

There is not necessarily a one-to-one relationship between handling units and freight units. One freight unit can contain several handling units. If desired, freight unit building can be set up to create one freight unit per handling unit.

Package Building

Orders are placed on products which, during the real process, are packaged to create packages and pallets (HUs, TUs, main cargo items, and so on). Packaging is a warehouse process. Warehouse-specific information can influence the result (for example, pick sequence). For the end-to-end process, the package information is required long before the warehouse is reached.

The goal for SAP TM is to close the gap between orders based on products and the load planning happening for packages and pallets, as well as to enable a package building function that considers warehouse information. Therefore, readily available packaging components and product master data packaging-specific definitions are reused.

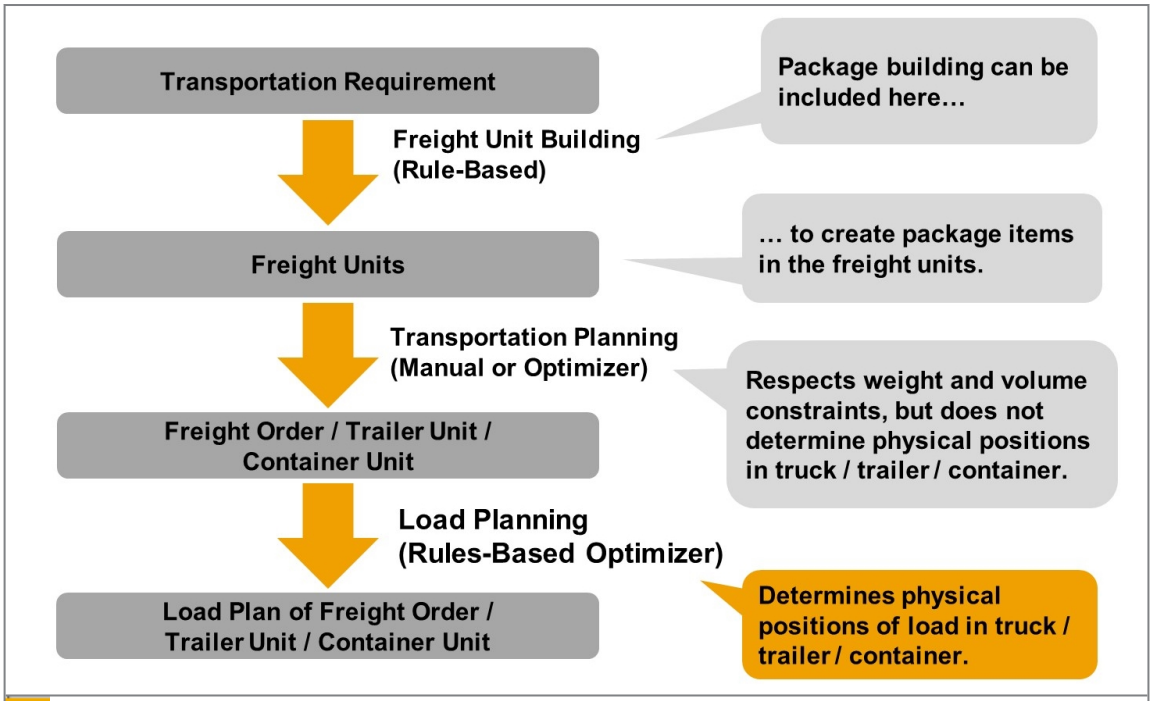

Figure 53: Package Building

Package Building is inserted into the overall planning process at the freight unit building step. It allows products to be combined into packages. These packages (within freight units) are later used in subsequent planning steps (manual and optimizer planning (VSR) to create freight orders and subsequent load planning).

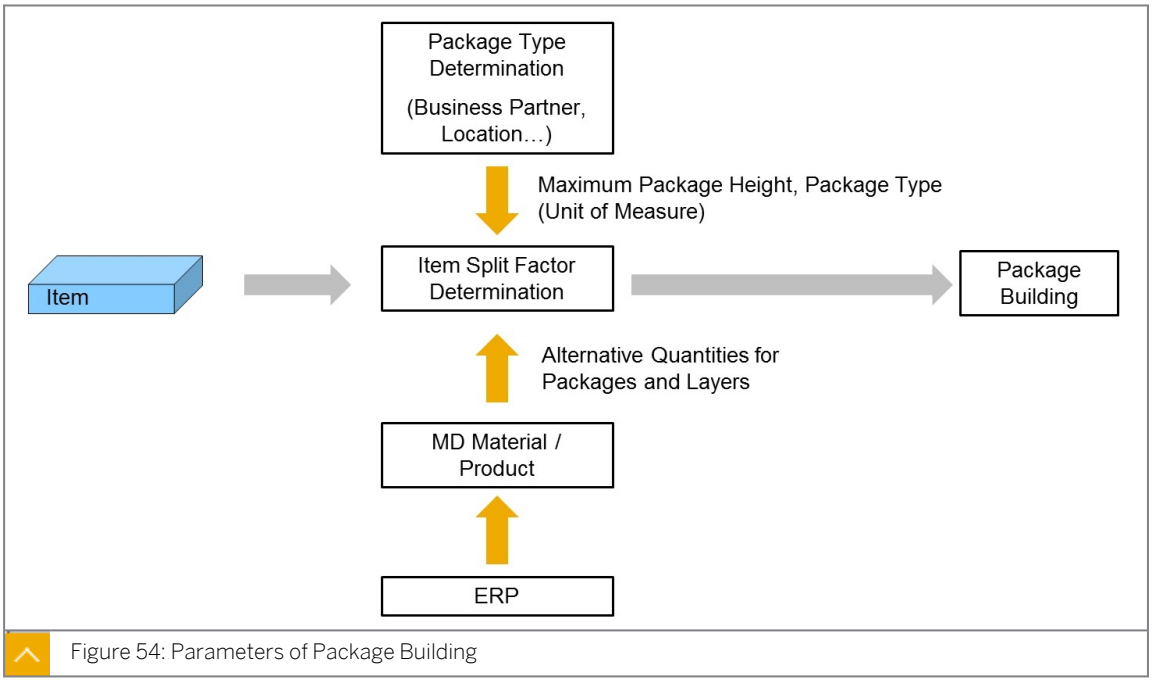

Figure 54: Parameters of Package Building

Package Building Parameters:

Package building is defined by the package building profile. This enables certain process steps to be switched on or off, specific behavior to be defined (especially when building mixed packages), and also offers default attributes that can be overwritten by product specific settings.

The following are examples of parameters:

- Process Products by Layer: This parameter can turn off the creation of full product packages. By default, this is very seldom required, but gives a mixed package building logic more freedom. For example, a certain customer always requires a specific product combination (even when ordering a high quantity), this can then be implemented in an enhancement receiving a full set of products.
- Keep Layers Together: When building mixed packages, the parameter controls of a product can be split over multiple mixed packages. In some situations, this might result in a better and more efficient plan. However, in more warehouse driven scenarios, it might not be efficient to process a product twice for two packages. Therefore, it can be turned off.
- Ignore Product Height: When consolidating leftover products that are not filling a complete package, nor a complete product layer, the system tries to build mixed layers combining products with the same height. This step can be skipped if the product height is not important. As a result, all of the leftover product quantities can be combined directly resulting in standard non-stackable layers.

The package building profile is assigned to the freight unit building rule. In addition, for freight unit building you can define the maximum number of package items that can be put into a single freight unit.

The relevant package building profile can be set depending on the process in:

- Freight unit building rule: define package building profile , store package estimate vs packaging hierarchy.

- Planning profile: define package building profile, enabling consolidation package building.

Product and Package Type Assignment:

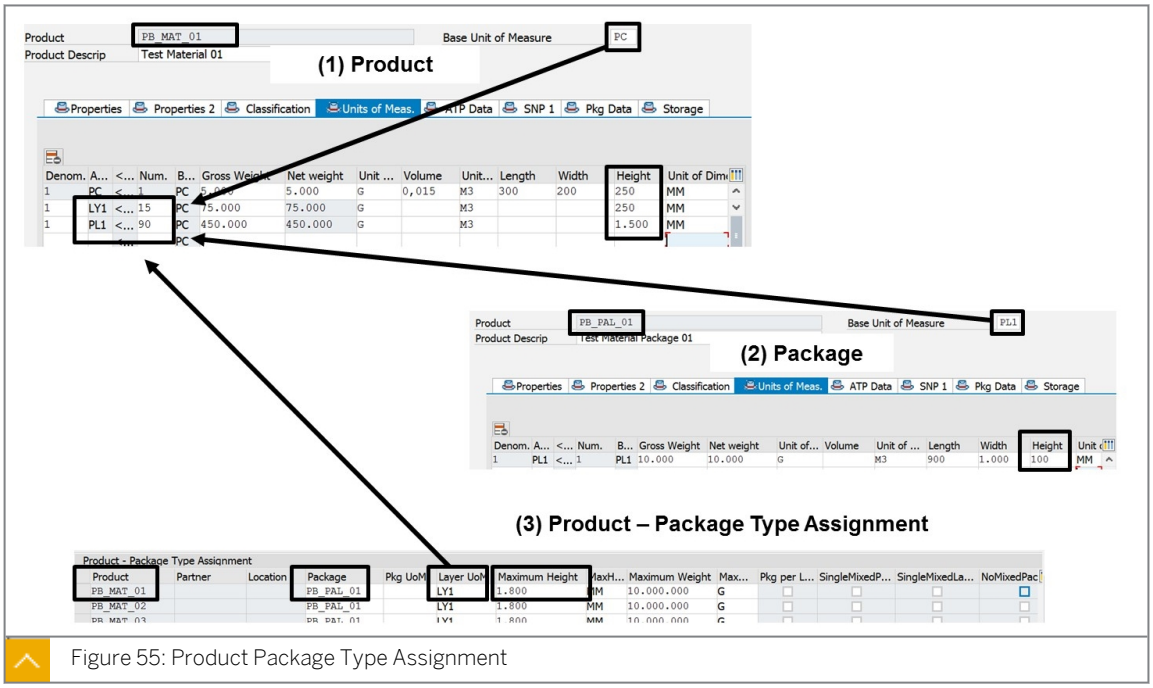

Figure 55: Product Package Type Assignment

The product and package type assignment is a new master data transaction that defines, for each product in the package builder, which package it goes into or onto.

To reduce the effort when maintaining those definitions, it is possible to work with generic patterns.

The definition can be dependent on the material/ product, business partner, and shipping location. For example, product A is usually delivered with an EU pallet stacked up to 1.5 meters (first entry). However, when delivering this product to customer X from your warehouse Y, you use a different pallet type containing product A stacked up to 1.3 meters, because the customer can only handle pallets up to this height (second entry as exception).

The package builder will always prefer the most specific entry. It will start to search for an entry matching all 3 key fields exactly. If nothing is found, it will score all other keys in the following manner:

- How many keys match exactly?
- How many keys match by pattern?
- How many keys are initial?

It will then select the key with the highest score.

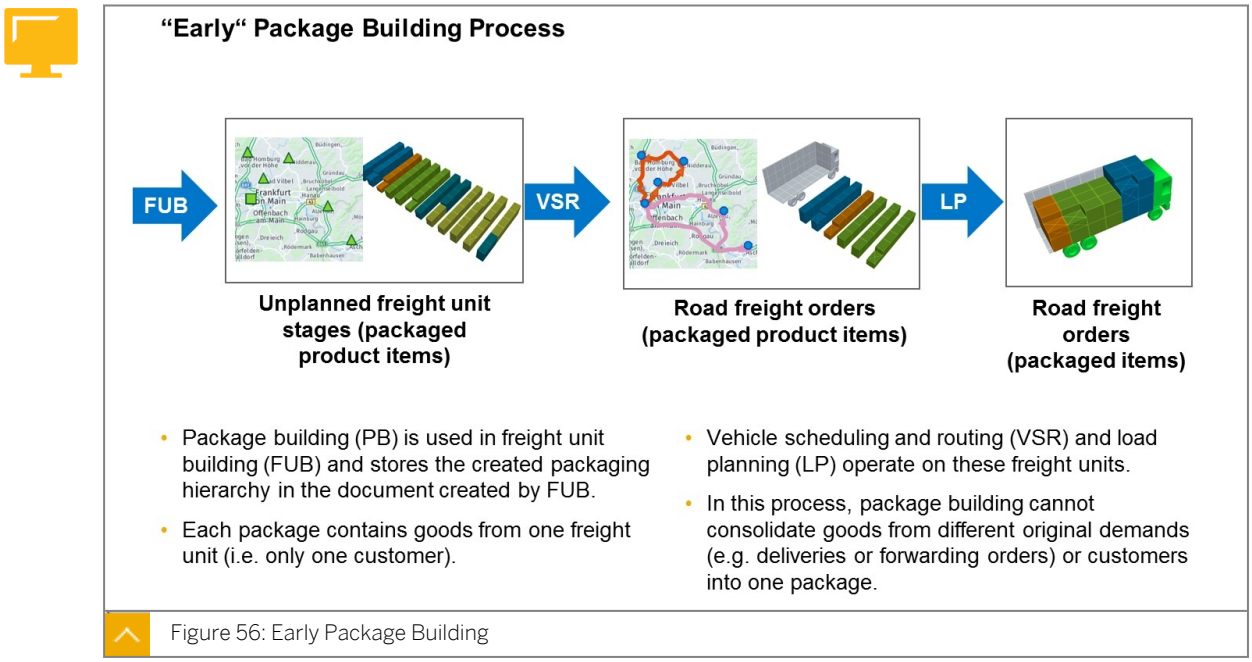

Figure 56: Early Package Building

Package Building Selected Features: During package building, the system bundles products into packages based on specific constraints, while also keeping the total number of packages to a minimum. The system can also specify the exact position and orientation of each product item. You can define these constraints for different combinations of product, business partner, equipment, and location. If several constraints apply, the system always uses the most specific constraint.

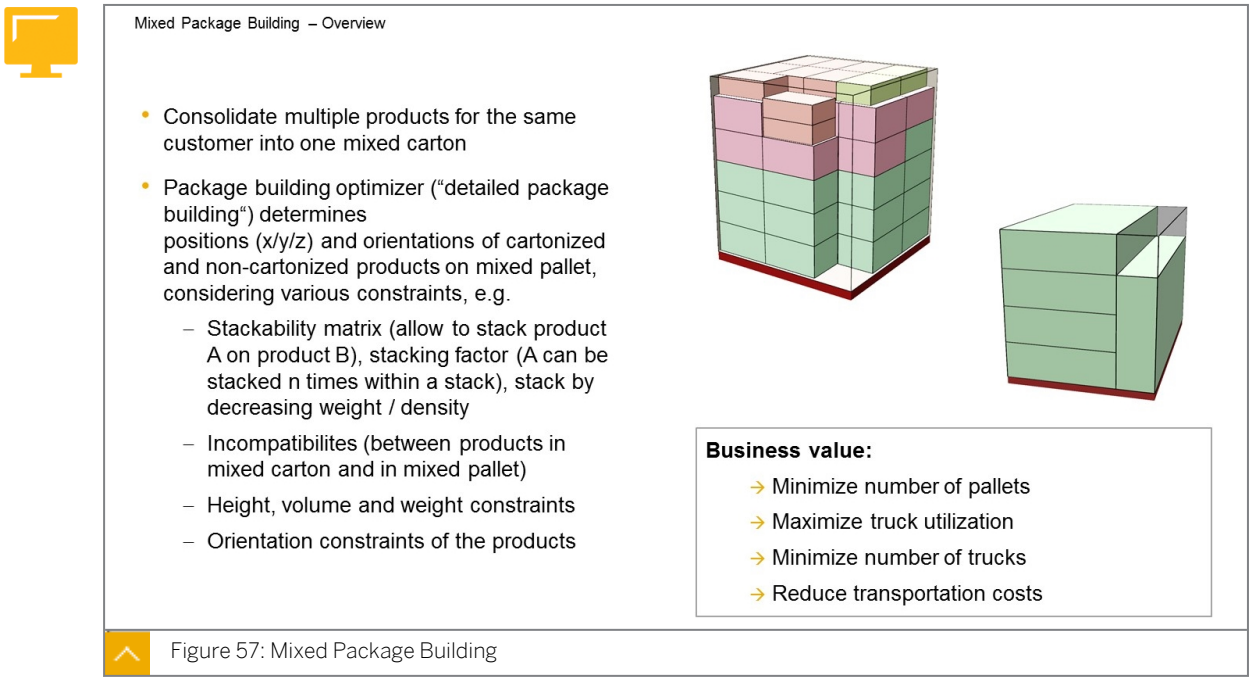

Figure 57: Mixed Package Building

The system creates mixed packages based on one of the following consolidation types:

- Volume
- Layer Definitions

- Incompatibilities, stacking rules, and product orientations (based on these values, the system determines the exact positions of each product item in the package (detailed mixed package building))

Furthermore, the definition allows specific limits to be set regarding the weight and height that the package builder will consider when packing the product. It is possible to set generally valid limits on the package material (that is, product master data). For example, you can only stack an EU pallet up to 1.8 meters and put 900 kg on it. In the product and package type assignment, you can lower the specific product, customer, and location limits.

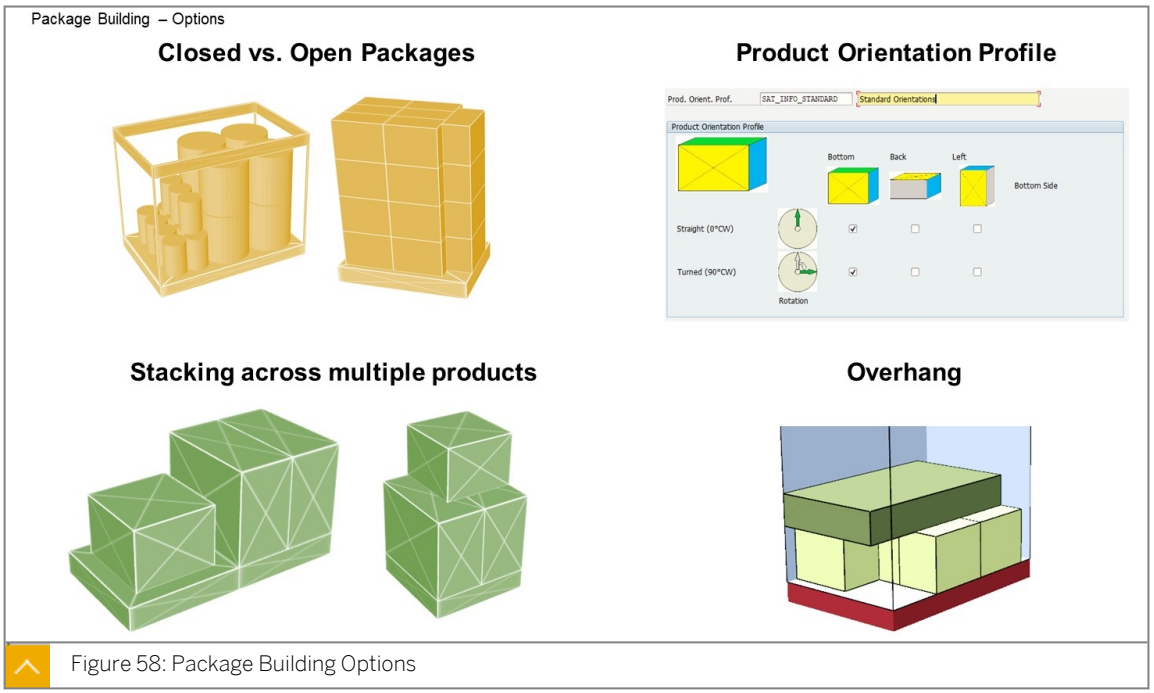

Figure 58: Package Building Options

When creating packages, the system can split the quantity of a product using the following criteria:

- Quantity per package
- Maximum height of the package
- Maximum weight of the package

If different products are to be packaged, the system considers the lowest maximum height and the lowest maximum weight for a product or a packaging material. For example, if each product has a different maximum height, the system uses the lowest maximum height.

The result of package building is different types of packages, as follows:

- Packages that contain only a single type of product
- Mixed packages that contain several different products
- Packages that consist of several layers: The layers within a package can also contain different products, which results in mixed layers.
- Nested packages, that is, a package in another package: For example, you can plan 24 cans in one box and 100 boxes in ten layers on one pallet.

- Full packages or incomplete packages: Incomplete packages provide room for further consolidation.
- Flat or uneven packages: Flat packages are a prerequisite for stackability.

"Late" Package Building: The "late" or "consolidation" package building process defers the package building process until the vehicle scheduling and routing process has created freight orders for the individual tours. This allows to add additional information into the package building process, that is, which products are to be delivered with the same truck/tour/freight order. Consequently, this information can be utilized to build packages/pallets across freight units/deliveries.

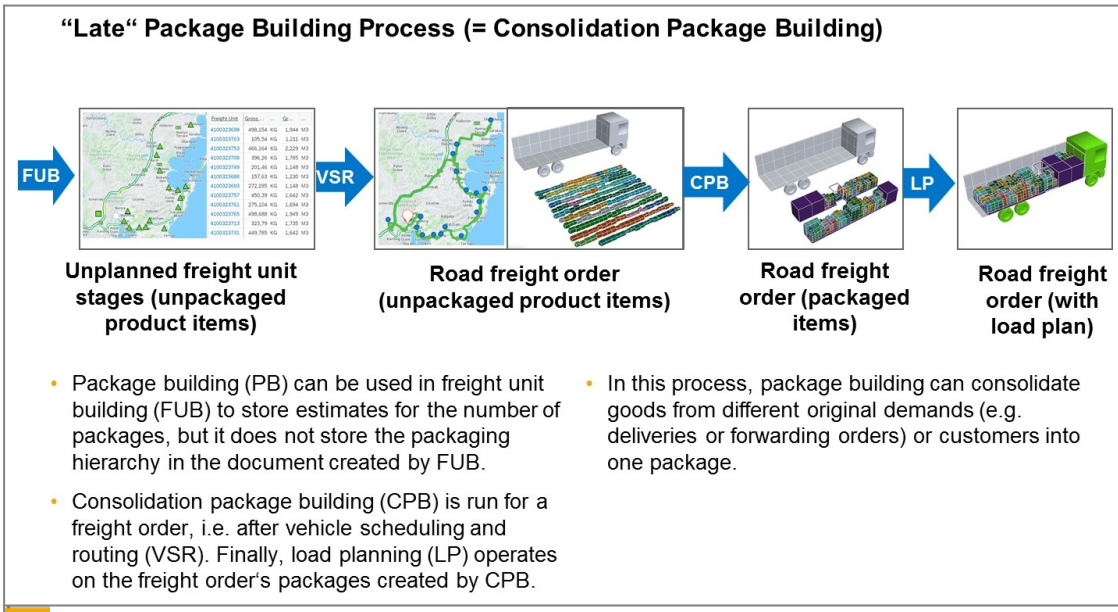

Figure 59: Late Package Building

Package Units: The Package Unit (PU) is an additional business document. It represents one or multiple packages to be transported together across multiple stages (capacity documents). The PU is not needed if there is only one stage. It can have a deep packaging hierarchy, for example, pallet – carton – product. It is (technically) a transportation unit (like container units, trailer units, and railcar units). It can represent both capacity document and demand document. That means, package units can be assigned to freight orders / bookings and container / trailer / railcar units, but at the same time freight units can be assigned to a package unit. Typical examples for package units are pallet, pallet cage, box, carton.

The package unit provides additional functionality to enable an integrated delivery and line haul planning process:

Integrated Delivery and Line-Haul Planning Process

- **Business Process:**
  Serve customers from regional hub by delivery tours with mixed pallets, which are built in warehouse and transported to hub by line haul tours. No re-building of pallets in hub.
- **Planning process:**
  - Plan delivery tours, build (mixed) pallets for delivery tours, create load plan for delivery tours
  - Plan line-haul tours based on mixed pallets from delivery tours, create load plan for line-haul tours
- New business document „package unit“ to represent transportation of mixed pallet by line-haul & delivery trucks
- Default route applied during freight unit building to define its regional hub
- **Business value:** Avoid re-packing of pallets in hubs

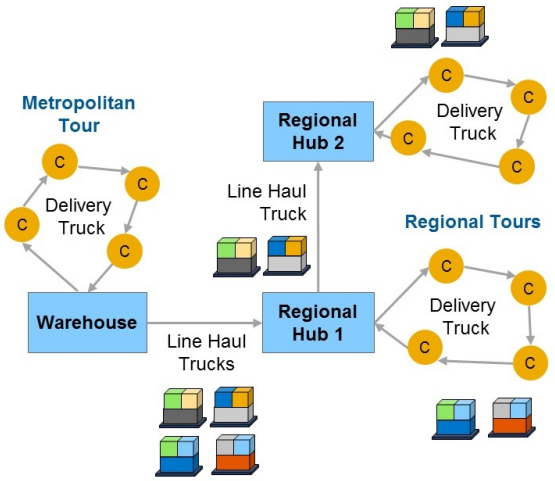

Figure 60: Integrated Delivery and Line-haul Planning Process

The PU type allows defining the flexibility of assigning predecessor documents to the PU:

- Completely: A freight unit is completely assigned to the PU. This is the standard approach of assigning freight units.
- Partially: A freight unit can be distributed among multiple PUs (multi-assignment), but the PUs are assigned to one single capacity document. This is a new approach, which helps to avoid freight unit splits and an increasing number of documents in scenarios with freight units' items distributed across multiple package units (for example, pallets).

If PUs containing the same freight unit get assigned to different capacity documents, the freight unit gets split to ensure the fundamental freight unit consistency principle (it represents the goods transported together across the whole transportation chain).

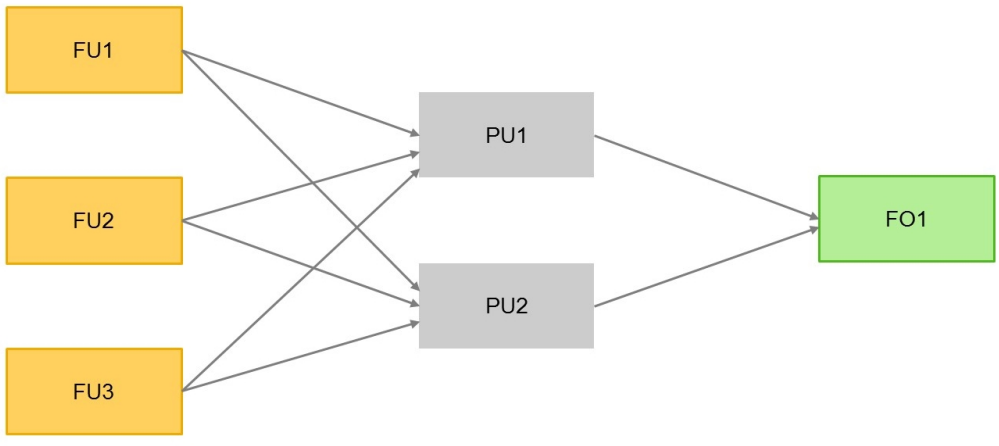

Figure 61: Package Unit - Multi Assignment

LESSON SUMMARY

You should now be able to:

- Build packages

Understanding Change Controller

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Explain change controller

Process Controller

The process controller is a framework with which you can define your own strategies, methods, and how your planning process is executed.

You can use strategies to define complete processes. By assigning a service, you define the area in which the process is to be used, for example, transportation charge management, freight unit building, or VSR optimization. SAP delivers a number of standard strategies.

Methods define the individual process steps of a strategy.

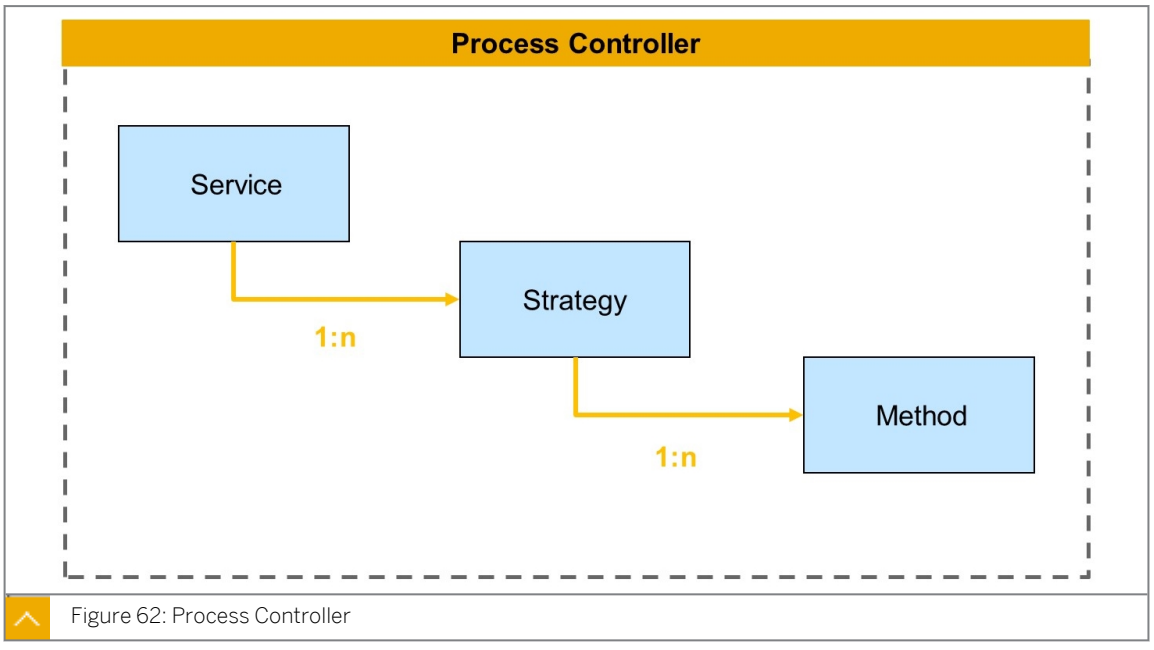

Figure 62: Process Controller

You use strategies in SAP Transportation Management in the following areas:

- Freight unit building
- Carrier selection
- VSR optimization
- Manual planning
- Change controller

- Definition of customer-specific functions

In this lesson, we are going to focus on change controller. The other areas listed will be explained in other units.

Change Controller

Whenever there are changes to transportation requirements, for which follow-up documents already exist, SAP TM provides support to react to these changes. For example, if the quantity of a sales order changes, and that sales order is already planned in SAP TM, you might have to adjust your transportation plan. SAP TM provides a configurable, flexible framework to support change processes. In the example of a quantity change, the system can check the resource capacity and remove freight units from planning if the resource is overloaded. In addition, a user could be informed of changes via an alert.

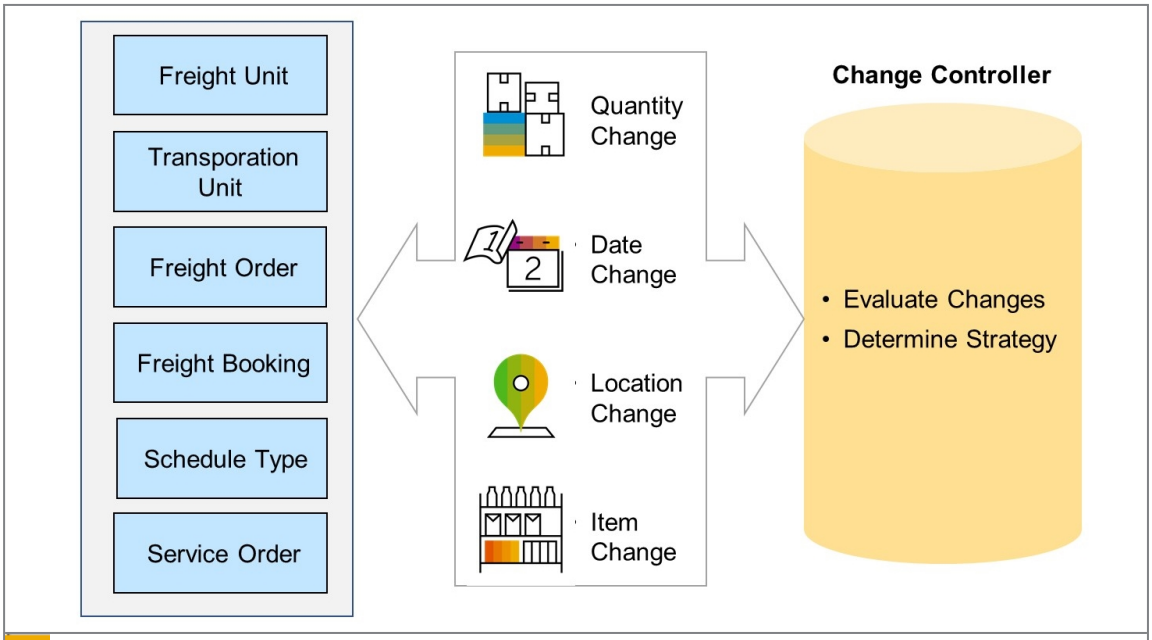

Figure 63: Change Controller

The change controller checks whether one of the following business documents/objects has changed and how the system is to process these changes:

- Freight unit
- Transportation unit
- Freight order
- Freight booking
- Service order
- Schedule type

The change controller can react to the following planning-relevant changes:

- Changes to quantity
- Changes to dates/times
- Changes to source locations, intermediate stops, and destination locations

- Reported execution information
- Additional or deleted freight units or locations

Note that this is not an exhaustive list.

The following is an example of change controller actions in response to changes:

- Remove corresponding freight units from the transportation plan
- Invalidate successor business documents such as freight orders
- Stop the current associated tendering processes
- Stop and restart the current associated tendering processes
- Issue alerts

You can also define your own actions. You can also react to other changes, and even to custom fields. If you want to enhance the standard logic of the change controller for determining changes to business documents, you must make the necessary settings for the following BAdI:

Determination of Changes for Change Controller

SAP TM provides a set of predefined change strategies. You use strategies to define complete processes. Methods define the individual process steps of a strategy. You can also define your own strategies and methods, and in doing so, the way in which your process is executed.

If the system is unable to process a change controller strategy due to a locking issue, you can use the background program /SCMTMS/PROCESS_TRIGGER_BGD to reprocess the strategy.

The configuration settings relating to how changes should be processed on a freight unit, freight order, or freight bookings are located in the type customizing of these documents. You can specify the change controller settings for the business document types in SAP TM Customizing:

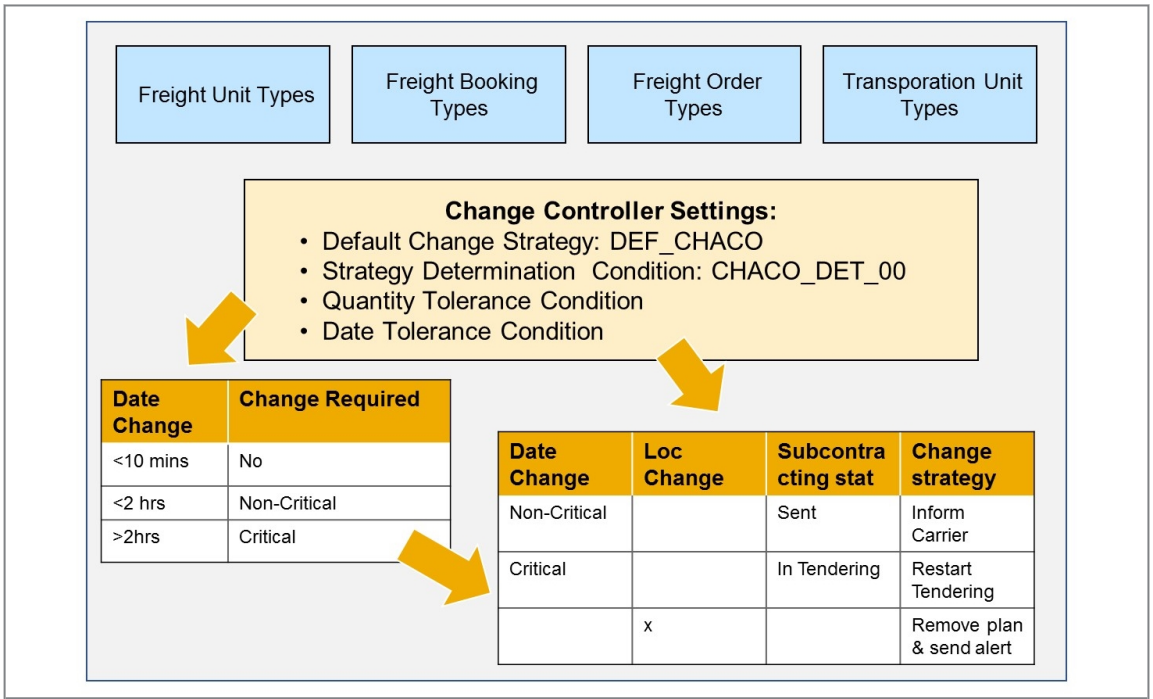

Figure 64: Change Controller Settings

- Default Change Strategy: You can assign a default change controller strategy (default strategy) to each business document type. If you have defined several change controller strategies, you can use a condition for determining the adequate change controller strategy.
- Strategy Determination Condition: If you indicate a strategy determination condition, the system uses the change strategy found via the condition. The system determines the change controller strategy at runtime based on the strategy determination condition. If you do not indicate a condition or if the condition does not return a strategy, the system automatically uses the default change strategy.
- Quantity Tolerance Determination Condition: You can use a tolerance determination condition to determine tolerances that are to be taken into account in the case of a quantity change in a business document (freight unit, freight booking, or freight order). This means that if a quantity is changed, the change controller evaluates this condition to dynamically check if a quantity change can be tolerated. If no condition of this type is assigned to a business document, only the standard logic to classify quantity changes is processed. The standard logic classifies all quantity changes as relevant quantity changes. This means that in case of a quantity change, the change controller evaluates this condition to dynamically determine if this quantity change can be classified as relevant or if it can be ignored. You assign this quantity tolerance determination condition to your business document type (for example, freight unit type). The result of a tolerance determination condition has an impact on the evaluation of the change controller condition that is assigned to the same business document type. The indicator for a quantity change that is provided as a data access definition to the change controller condition can change from "Relevant Quantity Change Determined" to "No Relevant Quantity Change Determined" if the quantity change is within the tolerances found.
- Date tolerance determination condition: You can use a date tolerance determination condition to determine the tolerances for a date change in a business document. This means that in case of a date change, the change controller evaluates this condition to dynamically determine if this date change can be classified as critical or uncritical or if it can be ignored. If you want to classify date changes according to your own logic, you can use this condition to enhance the standard logic. If no condition of this type is assigned to a business document (freight unit, freight booking, or freight order), only the standard logic to classify date changes is processed. The standard logic classifies all date changes as critical changes. You assign this date tolerance determination condition to your business document type (for example, freight unit type). The result of a date tolerance determination condition has an impact on the evaluation of the change controller condition that is assigned to the same business document type. The indicator for a date change that is provided as a data access definition to the change controller condition can change from “Critical Change” to “Non-Critical Change” or “No Change” if the date change is within the tolerances found.

LESSON SUMMARY

You should now be able to:

- Explain change controller

Learning Assessment

1. You can assign logistics integration profile to a sales order document type?

   Determine whether this statement is true or false.

   ☐ True

   ☐ False

2. In SAP S/4HANA, a freight unit can be manually created.

   Determine whether this statement is true or false.

   ☐ True

   ☐ False

3. How are input values for a condition determined?

   Choose the correct answers.

   ☐ **A** Using direct business object access

   ☐ **B** Using the data crawler

   ☐ **C** Using a determination class

   ☐ **D** Using a process controller strategy

4. Which of the following settings can be maintained in the delivery profile?

   Choose the correct answers.

   ☐ **A** Fixing of planning results

   ☐ **B** Consolidation options for planned freight units

   ☐ **C** Incompatibilities

   ☐ **D** Inclusion of blocked documents

5. What are the allowed relationships between freight units and handling units?

   Choose the correct answers.

   - ☐ A 1:1
   - ☐ B 1:n
   - ☐ C n:1

6. The change controller allows you to react to changes in quantities, dates/times, and locations.

   Determine whether this statement is true or false.

   - ☐ True
   - ☐ False

Learning Assessment - Answers

1. You can assign logistics integration profile to a sales order document type?

   Determine whether this statement is true or false.

   [X] True

   [ ] False

   Correct. You can assign logistics integration profile to a sales order document type.

2. In SAP S/4HANA, a freight unit can be manually created.

   Determine whether this statement is true or false.

   [ ] True

   [X] False

   Correct. A freight unit cannot be manually created in SAP S/4HANA.

3. How are input values for a condition determined?

   Choose the correct answers.

   [X] A Using direct business object access

   [X] B Using the data crawler

   [X] C Using a determination class

   [ ] D Using a process controller strategy

   Correct. Input values for a condition are determined by data access definitions based on either direct business object access, the data crawler, or a determination class.

4. Which of the following settings can be maintained in the delivery profile?

   Choose the correct answers.

   - [X] A Fixing of planning results
   - [ ] B Consolidation options for planned freight units
   - [X] C Incompatibilities
   - [X] D Inclusion of blocked documents

   Correct. Consolidation options for planning freight unit are not maintained.

5. What are the allowed relationships between freight units and handling units?

   Choose the correct answers.

   - [X] A 1:1
   - [X] B 1:n
   - [ ] C n:1

   Correct. One freight unit can contain 1 or more (n) handling units, but a handling unit cannot be split across freight units.

6. The change controller allows you to react to changes in quantities, dates/times, and locations.

   Determine whether this statement is true or false.

   - [X] True
   - [ ] False

   Correct. The change controller allows you to react to changes.

UNIT 4 Transportation Planning Preparation

UNIT OBJECTIVES

- Understand the transportation planning process
- Understand the selection and planning profile
- Understand the transportation cockpit

Unit 4
Lesson 1

Transportation Planning

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Understand the transportation planning process

Reasons for Transportation Planning

The goal of SAP TM is to provide customers with the ability to either manually or automatically plan and optimize their transportation requests. This includes the ability to perform order consolidation, where a company can group orders with the same ship-from and ship-to locations for more efficient transportation quantities. If multiple orders are being shipped within a predefined transportation zone, your company can try to efficiently schedule and route the multiple orders, and choose the appropriate carrier. The planning and selection can be determined using the most cost effective and timely route from source to destination while considering real-world constraints, costs, and penalties. The optimizer is capable of making multi-modal decisions such as sea, air, truck, train, and any combination thereof. The SAP TM planning function can also perform multi-pickup and stop options.

Transportation planning activities in SAP TM can be performed manually and automatically as well as interactively and in the background. For interactive planning, the central planning UI is the transportation cockpit. Both manual and automatic planning activities are performed there based on planning strategies (for example, one-step optimization).

Order Consolidation

Order consolidation is the grouping of orders with the same ship-from and ship-to locations to create more efficient shipment quantities.

The result of order consolidation is that one or more freight units are combined into one freight order. A freight unit is a business object representing the smallest possible transportation unit. Business examples of order consolidation are multiple orders that have been received over time and can be planned to be shipped together. This can be at individual line item level. Customers who make-to-order, and do not ship complete orders to their customers, may consolidate line items from multiple orders as they are produced and as their delivery-due lists are created.

Routing and Scheduling

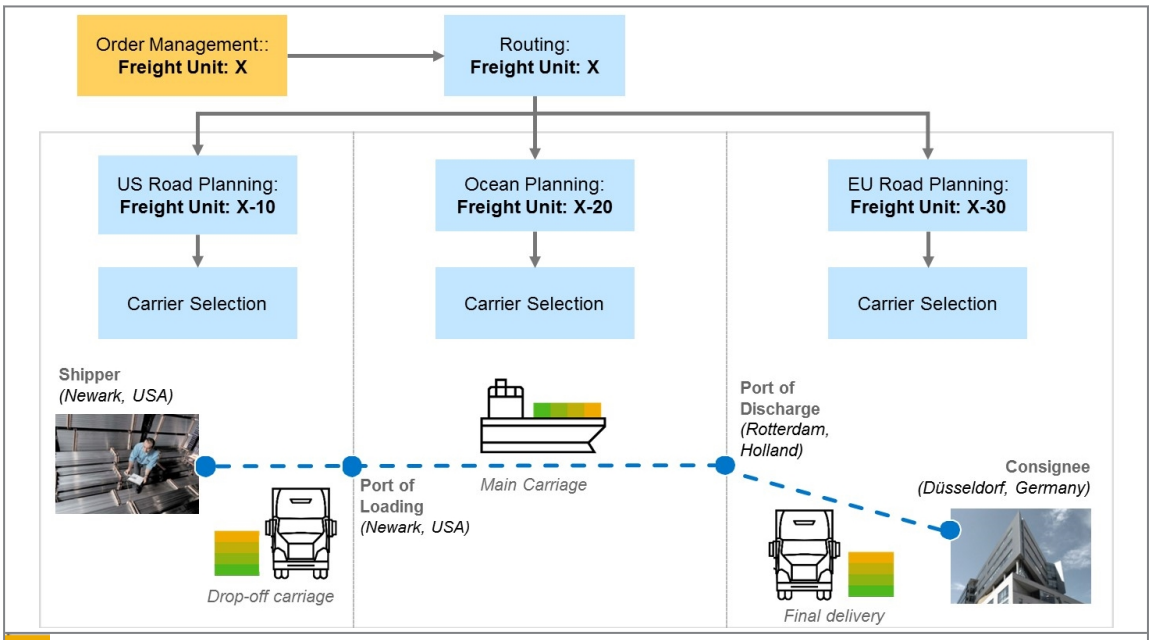

Figure 65: Routing, Scheduling, and Carrier Selection

The figure *Routing, Scheduling and Carrier Selection* outlines the process of routing and scheduling in the following way: a freight unit X is first routed using the transportation planning function, for example, a transportation proposal. Based on this routing, three stages are created for freight unit X, as follows:

- A stage for US road pick-up transport
- A stage for the ocean voyage
- A stage for EU road delivery transport

Up to a certain point, these stages are planned independently of each other because different (local) planners may be responsible for scheduling each of the three stages. A freight order is created as a result of this stage. Finally, carriers are selected based on specific criteria. This is described as a three-step process but a planner can decide whether to perform planning and carrier selection in two steps or three. It is also possible for the SAP TM optimization function to plan all three steps in one run – this planning strategy is called one step optimization.

Process Steps

The steps involved in the process, whether one, two, or three step, can be described as follows:

- Three step
  1. Determine routing (transportation proposal)
  2. Vehicle scheduling and routing to create a freight order
  3. Carrier selection
- Two step

1. Vehicle scheduling and routing to create a freight order
2. Carrier selection

- One step
  1. One-step optimization determines the route and plan, creates a freight order and selects a carrier

Manual and Automatic Transportation Planning

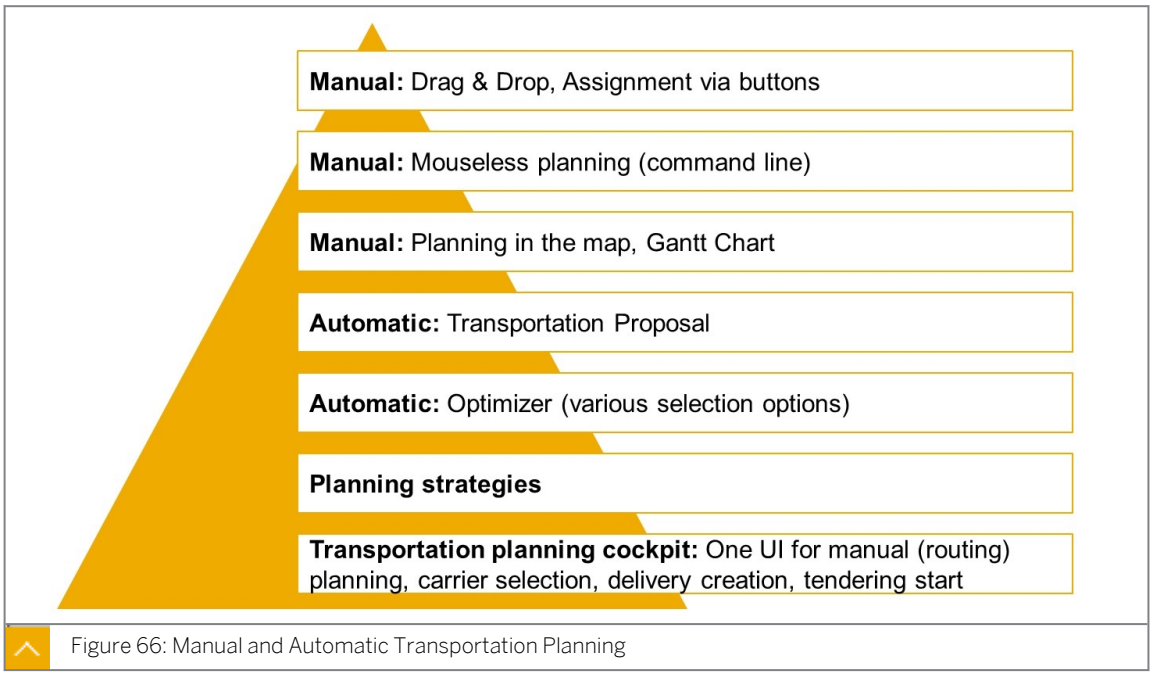

Figure 66: Manual and Automatic Transportation Planning

Transportation planning activities in SAP TM can be performed manually and automatically, as well as interactively and in the background. For interactive planning, the central planning UI is the transportation cockpit. Both manual and automatic planning activities are performed there based on planning strategies (for example, one-step optimization).

Planning Constraints

SAP TM can consider numerous constraints during planning. Which ones are relevant and should be used in a specific scenario largely depends on the scenario itself. Constraints can have physical root causes, such as vehicle capacity or handling capabilities for loading and unloading at certain facilities. On the other hand, constraints can have process-related root causes. For example, a delivery tour should have a maximum of 25 drops in a day. This is a maximum that will fit in a driver's daily schedule, assuming they have to unload at the door and do some paperwork for each customer drop.

Assets, Facilities, Resources and Times

There are a number of assets, facilities, resources, and times:

- Vehicle capacity
- Vehicle combinations (truck and trailer)
- Compartments
- Depot locations

- Handling resources, opening hours (calendars and shift patterns)
- Schedules
- Incompatibilities – constraints by design

Process and Execution Constraints

There are a number of process and execution constraints:

- Decreasing capacities
- Max number of transshipment locations
- Max limits on distance, duration, or stopovers
- Pick-up and deliver time windows
- Min and max storage time at hub – cross-docking changeover
- Loading and unloading durations
- Scheduling constraints

Freight Orders

The freight order's execution is planned by a carrier or the shipper. The freight order contains the following:

- When and onto which vehicle freight units are to be loaded
- Planned departure times for the vehicle
- Execution data

Freight orders are used for land transportation and freight bookings are used for sea and air transportation. Freight orders contain the following information:

- Planning information, for example, planned means of transport and stages, routing, planned pickup and delivery dates, durations, and distances
- Document dependencies, as well as predecessor and successor documents
- Transportation charges and cost distribution
- Cargo information: quantities and weights, goods information
- Execution information
- Business partner information
- Output management
- Status information and blocking information
- Subcontracting information

Methods/Ways of Creating Freight Orders:

1. Manually: Manual creation is generally used when you already know the most important transportation data, such as source location, destination location, and business partner, because you regularly transport goods for a certain customer using a certain carrier.

2. Work-list: Some of the information, like source and destination location, are automatically populated in the freight order if you create the freight order from the freight unit work-list.
3. Copying: You can create a freight order by copying an existing one (a reference document). The system copies the header data and the logistical data. However, it does not copy references to freight units and execution information.
4. FUBR rule: You can create freight orders via the short-cut process on the basis of a freight unit building rule, which will be explained in more detail later in this lesson.
5. The more advanced features of creating freight orders are their interactive creation in the transportation cockpit, VSR optimization, and the use of transportation proposal functionality. These topics will be covered once we have finished the relevant configuration.

A freight order type defines parameters that influence how the system processes the freight order. When manually creating a freight order, the user has to select a freight order type. If freight orders are created during planning and have associated settings in the planning profile, the system determines the freight order type according to the Customizing settings.

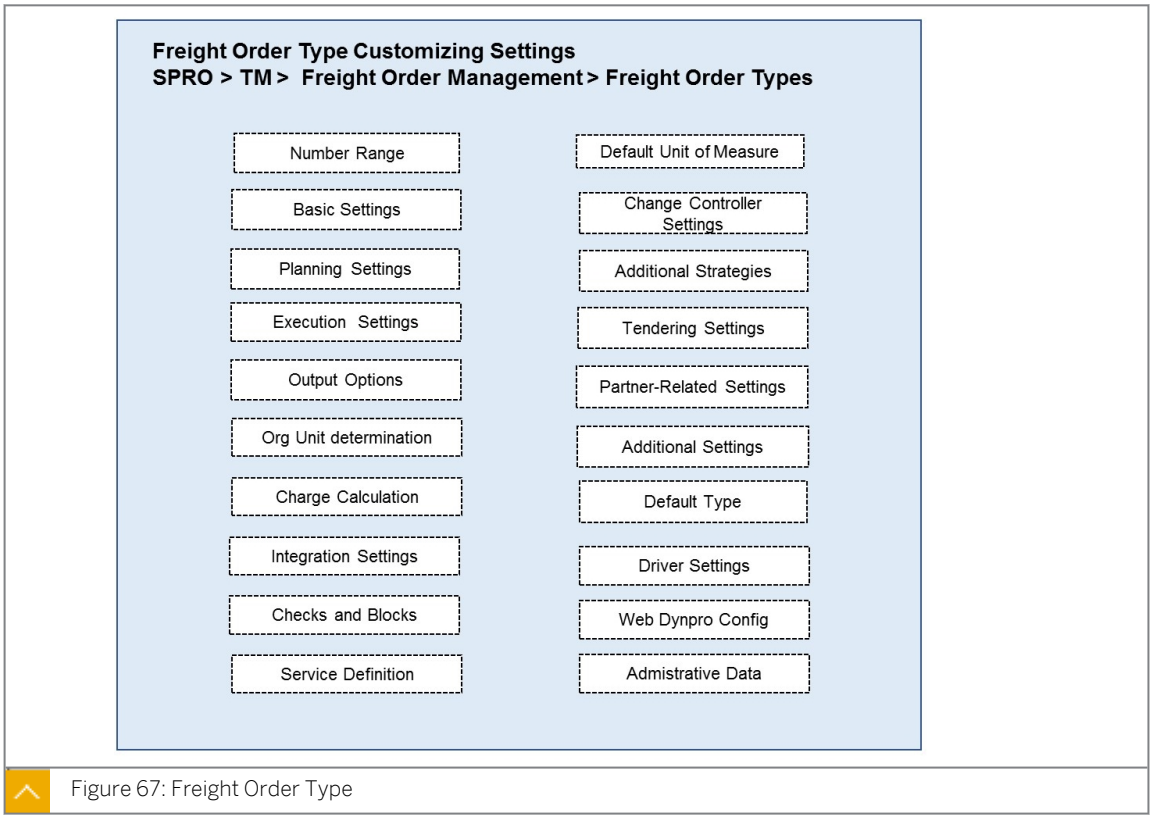

Figure 67: Freight Order Type

- Number range intervals
- Basic Settings:
  - Determining shipper and ship-to-party
  - Specifying if a freight order can be subcontracted
  - Defining whether a freight order is to be deleted or only canceled
  - Define subcontracting relevance

- Define sequence types:
  - Defined and Linear: The sequence of stages is linear, which means that there is a single start stage and all other stages have one predecessor stage. There is also a single end stage and all other stages have one successor stage.
  - Non-Linear (Star-Shaped): All stages have the same start location but different end locations. The graphical structure of the transportation chain has a star shape.
  - Disconnected: All stages are separate from each other and each stage has its own start and end location.
  - Star-Shaped Based on FU Stages: Based on the information from the freight units, the stages have the same start location but different end locations (for example, for parcel freight orders or freight orders for customer pick-up).
  - Star-Shaped Based on FU Stages (Reversed): Based on the information from the freight units, the stages have the same end location but different start locations (for example, for freight orders for customer self-delivery).
  - Linear with (De-)Consolidation Stages: This sequence type contains three parts.
    - In the first part (pre-carriage), all stages have different start locations but the same end location at which consolidation takes place. The graphical structure of the transportation chain has a star shape.
    - In the second part (main carriage), the sequence of stages is linear.
    - In the third part (on-carriage), all stages have the same start location at which deconsolidation takes place but different end locations. The graphical structure of the transportation chain has a star shape.
  - Undefined: There is no sequence of stages since there are no stages, only locations.

- Charge Calculation and Settlement Document Settings:
  - Enabling charges and settlement
  - Enable cost distribution
- Execution Settings: You can define, for example, whether the system is to perform the execution steps within Transportation Management. You can define additional conditions that need to be fulfilled so that the status Ready for Execution can be set. Moreover, you can define settings for integration with SAP Event Management.
- Organizational Unit Determination: You can define how the system determines the purchasing organization and the execution organization. The system first checks the *Condition* field. If you have not entered a condition or if the condition does not return a result, the system checks whether the *Consider Organization Unit of User* checkbox is selected and whether the user is assigned to a purchasing organization and an execution organization. If the user is not assigned to a purchasing organization and an execution organization, the system uses the data maintained in the *Default Org Unit* area.
- Change Controller Settings: You can define settings for the change controller, for example, a default change strategy and a condition for change strategy determination.
- Output Options: You can define an output profile and a text schema, for example.

Freight Bookings

Freight bookings are used to reserve freight space on a vessel or in an airplane. The corresponding mode-specific freight documents are called ocean freight bookings and air freight bookings. They provide mode-specific information, such as the vessel name or flight number. The space reserved by freight bookings is consumed by assigning freight units or container units to the bookings.

An ocean freight booking represents ocean transportation from a port of loading to a port of discharge, and an air freight booking represents air transportation from an airport of departure to an airport of destination. Freight bookings can cover a consolidation location before the source and de-consolidation location after the port. These consolidation and de-consolidation locations are called container freight stations (CFSs) in the ocean case and gateways for the air case.

Methods/Ways of Creating Freight Bookings:

- Manually
- Work-list
- Copying

A freight order type defines parameters that influence how the system processes the freight bookings.

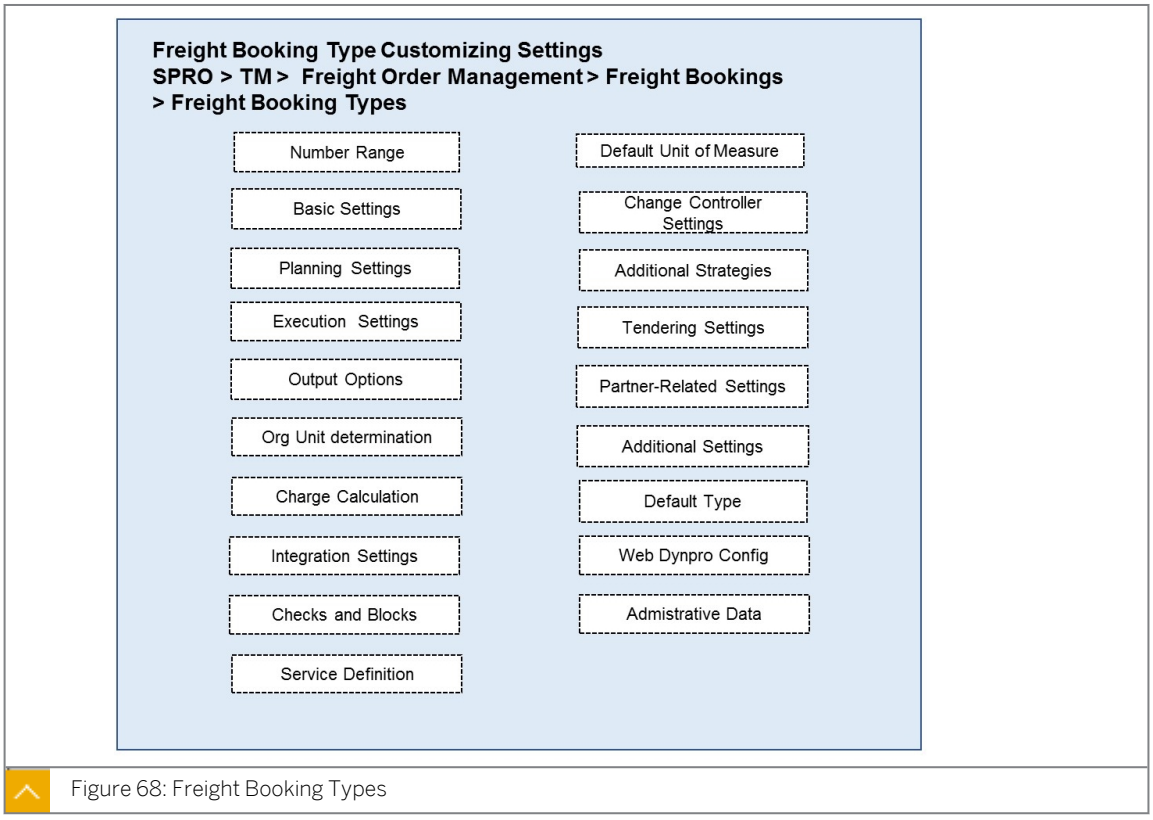

Figure 68: Freight Booking Types

The following are a few differences between freight orders and freight bookings:

- All booking types can be subcontracted, in contrast to freight order types, which can forbid subcontracting to cover transportation businesses fully relying on their own fleets. Although carrier selection and tendering are offered for freight orders, only carrier

selection is possible for freight bookings. In most scenarios, the carrier is already known at the time of booking creation.

- Whereas freight orders allow star-shaped, unrelated, and other stage structures, freight bookings allow only sequential stages.
- Freight orders cover self-delivery and self-pickup scenarios, which are not relevant for freight bookings.
- You can create pickup and delivery freight orders for the stages from consolidation location to source (air-) port and from destination (air-) port to de-consolidation location, respectively. The freight booking type can define the pickup freight order type and delivery freight order type.
- You cannot assign drivers to bookings.

LESSON SUMMARY

You should now be able to:

- Understand the transportation planning process

Selection and Planning Profiles

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Understand the selection and planning profile

Selection Profile

Freight units are selected based on the dates and times they were originally scheduled to be picked up (loading start) and delivered.

Within each section, you define an inclusive or exclusive set of location values that determine which freight units are relevant for planning. Each section allows users to define specific values or ranges of values. Using these parameters of greater than, less than or not equal to users are able to define precise criteria for planning.

Selection profiles are used to select documents/objects (freight units, freight orders, freight bookings and transportation units). The selection profile is a user-specific grouping of business documents that is considered during transportation planning. The system takes into account the selection profile created during interactive planning, VSR optimization, and carrier selection.

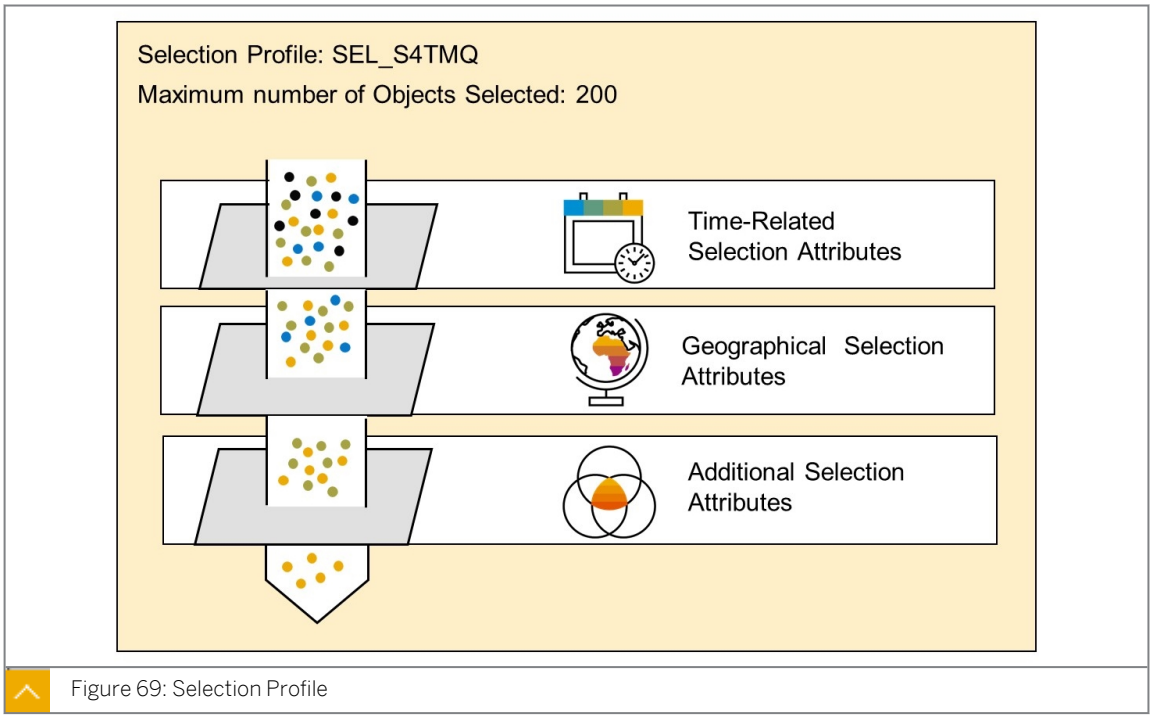

Figure 69: Selection Profile

In the selection profile and in the assigned selection attributes, you define which business documents the system is to take into account, as well as the maximum number of documents. You can assign the following selection attributes to a selection profile:

- Time-related selection attributes in which you define the demand horizon.
- Geographical selection attributes in which you define source and destination locations or zones.
- Additional selection attributes in which you define additional attributes for database queries.

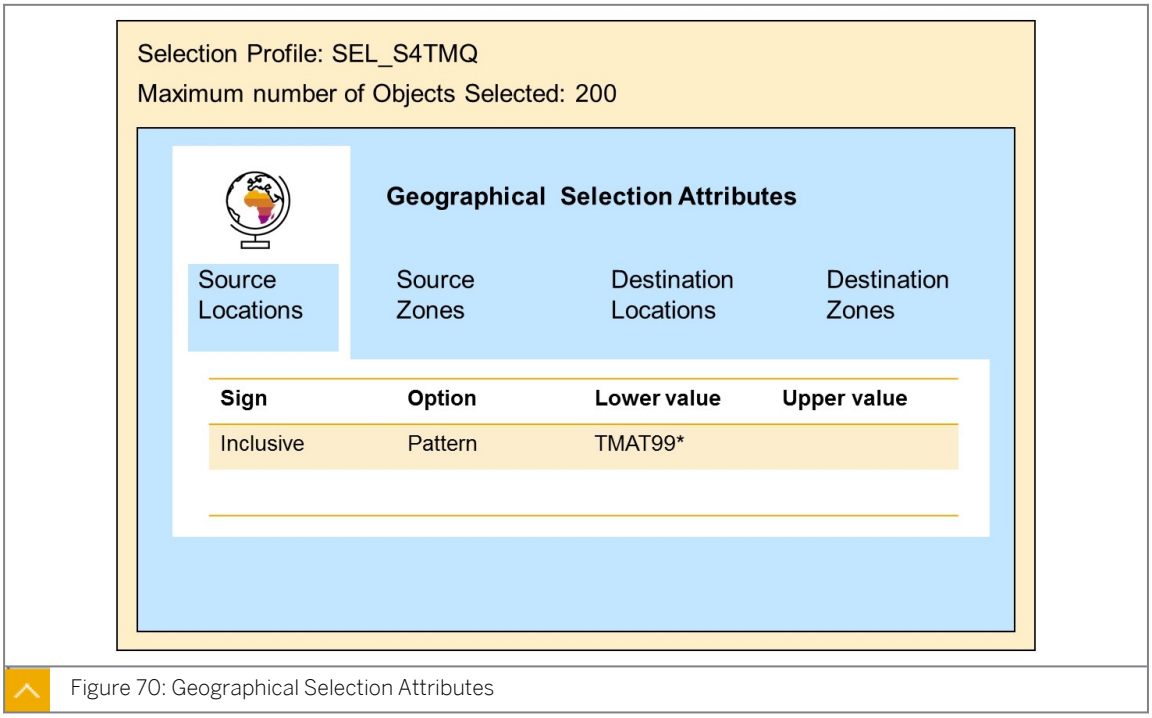

Figure 70: Geographical Selection Attributes

Geographical Selection Attributes: In a company's planning department, geography is often used as a way to allocate planning responsibility. For example, an individual or team might be responsible for a specific plant, distribution center or group of customers in a geographical area. The geographical selection attributes in the selection profile allow the team to limit their view in such a way that they only see FUs or FOs for which they have responsibility.

The geographical profile distinguishes which source and destination locations are relevant for freight unit selection. The geographical profile is split into four sections:

- Source Locations
- Source Transportation Zones
- Destination Locations
- Destination Transportation Zones

Within each section, you define an inclusive or exclusive set of location values that determine which freight units are relevant for planning. Each section allows users to define specific values or ranges of values, using the logical greater than, less than, or not equal to, to provide precise.

Time-Related Attributes: You can define the demand horizon as absolute or relative. With absolute time periods, you define the demand horizon precisely by defining a start and end date and a start and end time (calendar date). If using relative times, you do not define the demand horizon with precise dates and times, but specify instead a duration starting from the current date. The system automatically determines the start and end date and the start and end time. If the demand horizon is not to start on the current date, you can define an offset.

The relative demand horizon is then defined as follows:

- Start of demand horizon = current date + defined offset. The offset is made up of the offset in days and the additional offset in hours and minutes.
- End of demand horizon = start of demand horizon + defined duration of demand horizon. The duration of the demand horizon is made up of the duration in days and the additional duration in hours and minutes.

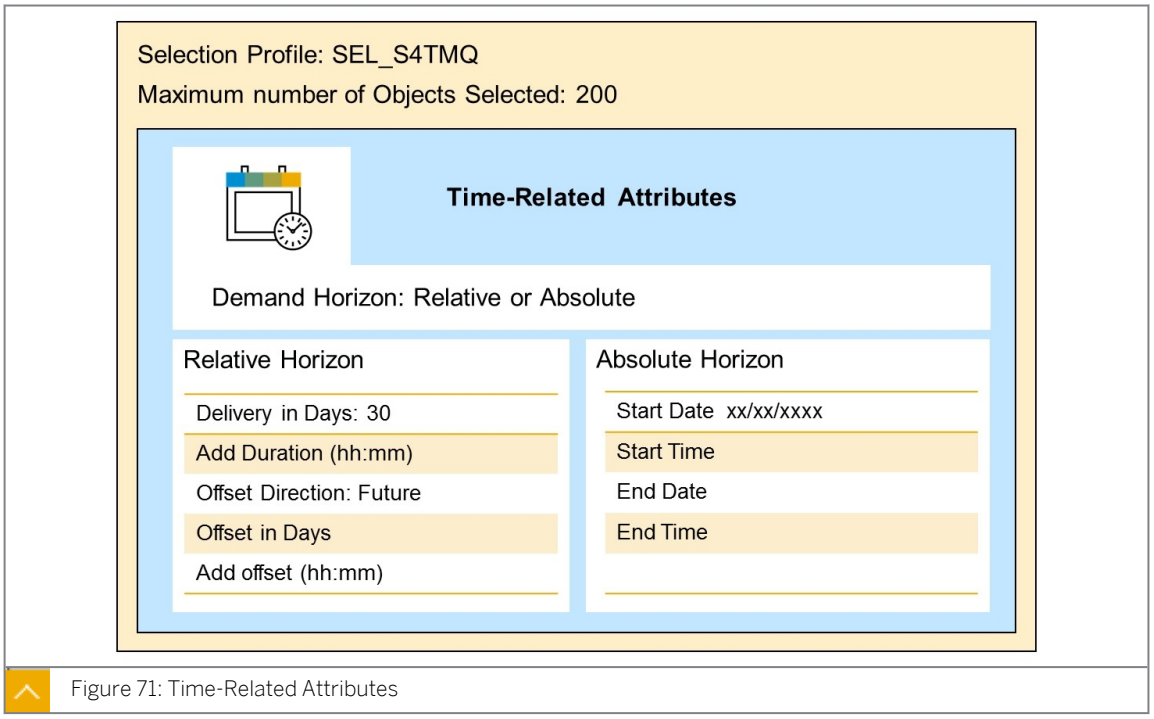

Figure 71: Time-Related Attributes

If you specify a factory calendar, the system considers non-working days when calculating the start of the horizon. In this situation, the planning horizon always begins on a working day.

You can round the horizon to full days and define the time zone to be used for this rounding.

Additional Selection Attributes: More selection criteria can be defined using additional selection attributes. You can select objects and their fields and the criteria.

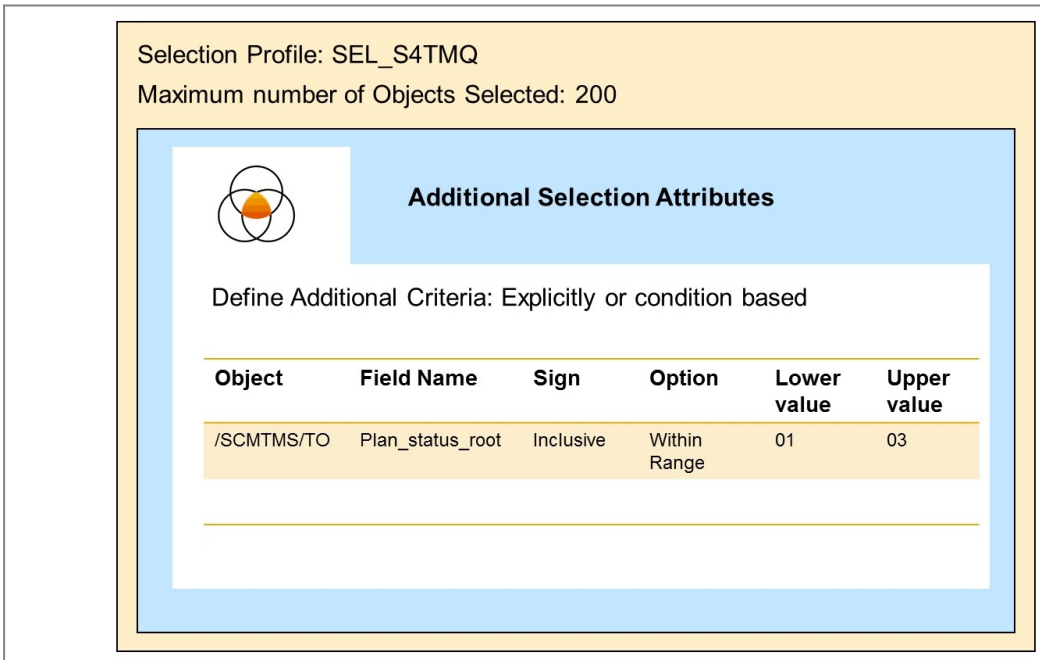

Figure 72: Additional Selection Attributes

Planning Profile

Planning profiles are used to influence and control the outcome of the planning process. A planning profile must be specified for a background optimizer run as well as for interactive planning (manual planning) in the transportation cockpit. During planning, the system considers the settings that you make in the various planning profiles.

A user defines various settings on the planing profile, these settings determine how planning is to be performed. Settings belonging to a certain area are grouped together, for example, all the settings required for load planning are grouped under load planning settings. The following figures shows the eight settings that are defined in the planning profile. All these settings can be maintained independently and can be used for other planning profiles as well.

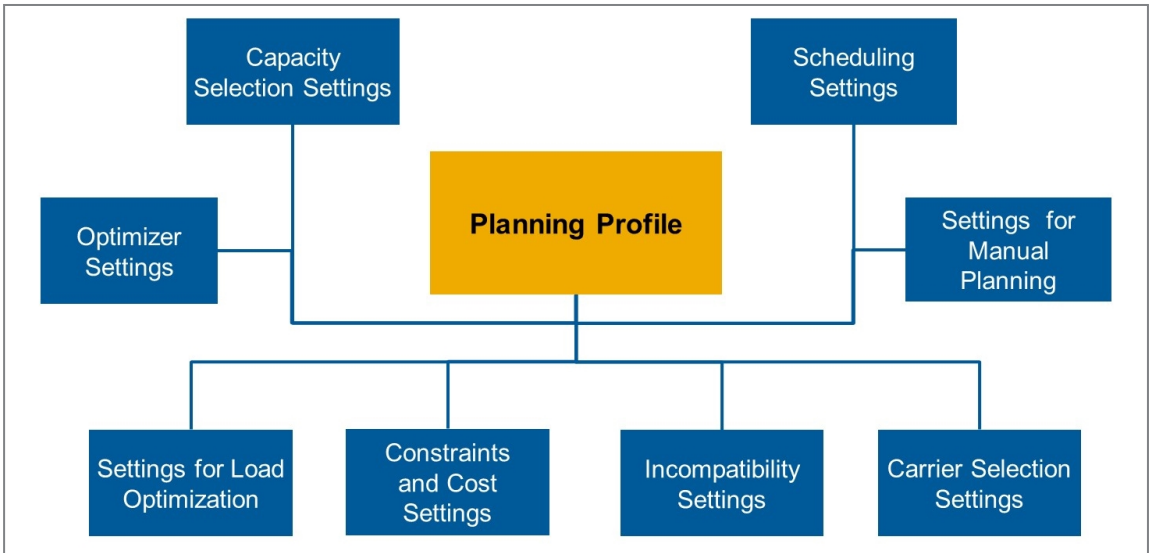

Figure 73: Planning Profile Settings

In addition to these settings, the following functionality is defined in the planning profile as well:

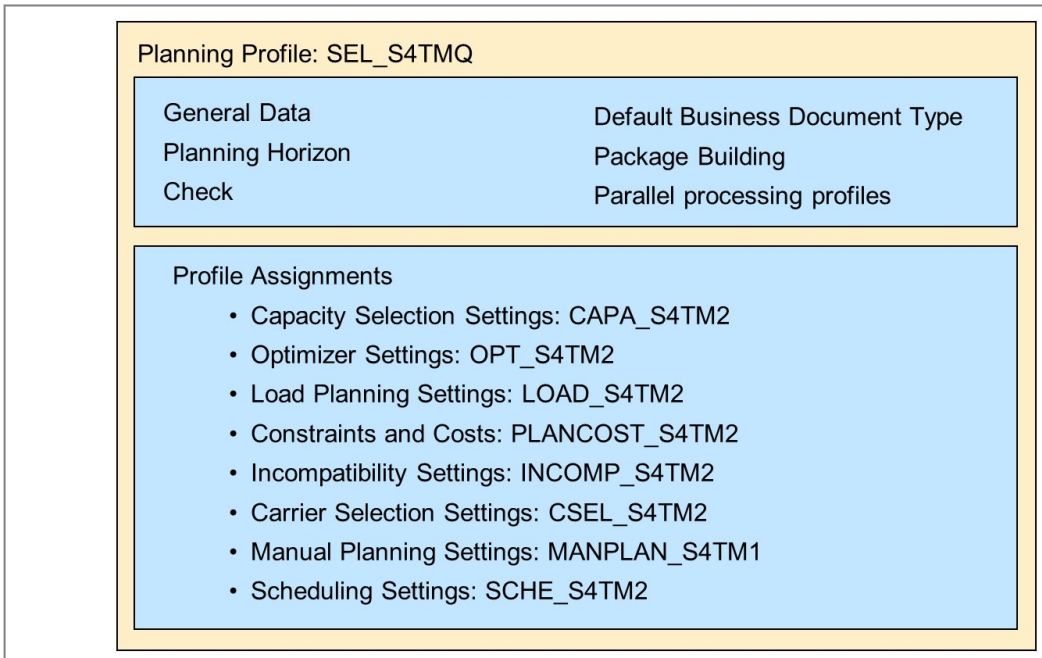

Figure 74: Planning Profile

- Planning Horizon: Planning horizon defines the horizon in which new freight documents can be created by planning. The planning horizon is defined in the planning profile in days, hours, and minutes. The planning horizon starts at the current system time unless an offset is defined in the planning profile. The offset can be defined in both the past and the future.
- Default Business Document Type: The business document determination rule defines which document types are used when freight orders and freight bookings are created during planning. The business document determination rule is defined for each planning profile and applies to documents created either manually or by the VSR optimizer. Freight order type and freight booking type can be determined in the following 3 ways:
  - The default type is defined in customizing
  - The type is defined in the planing profile directly
  - A condition can be used determine the result
- Check: The check defines the check strategy and for handling capacity violation.
- Package building profiles: The package building profile is a collection of parameters with which you control the creation of packages. When you are doing package building based on the capacity documents then you assign package building profile to planning profile. The package building profile is defined in customizing.
- Parallel processing profiles: By defining parallel processing the run-time for big optimization scenarios can be reduced. The parallel processing profile is defined in customizing and assigned to planning profile.

  Strategies: The planning profile includes settings to control the different steps of the optimization. These steps are controlled by strategies. Strategies are made up of various programs. If you wish to perform manual planning or a scheduled planning run, there is a standard strategy for each function. Standard strategies are delivered by SAP. However, unique strategies can be created using process controller.

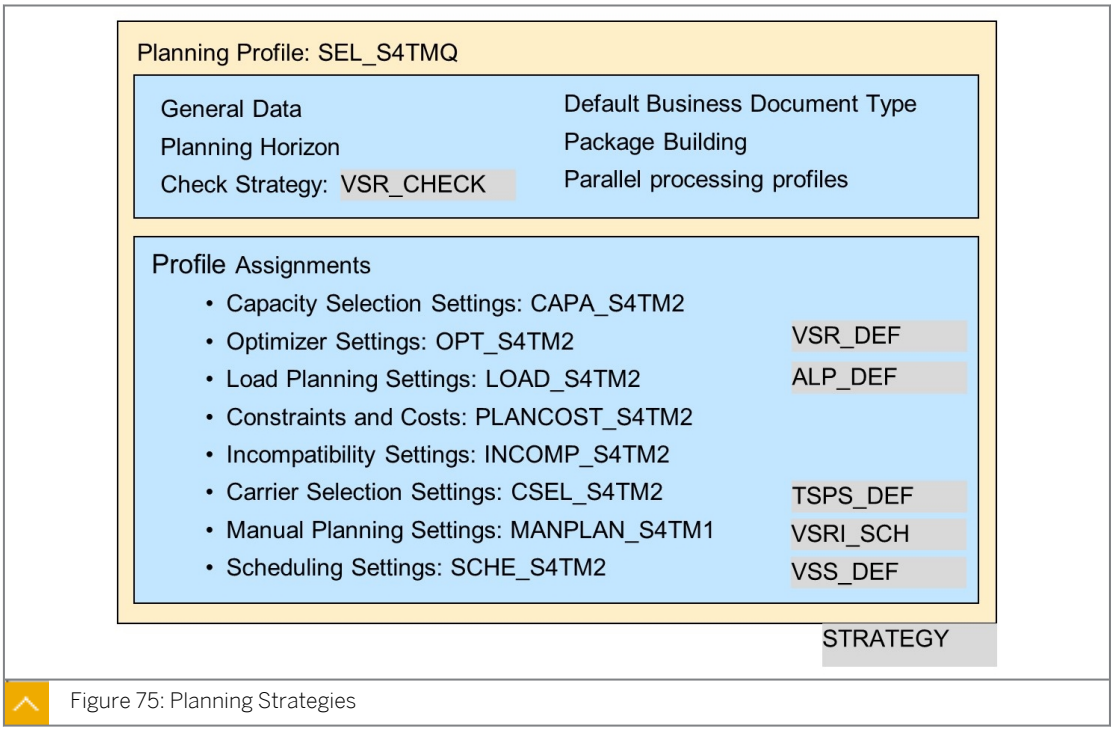

Figure 75: Planning Strategies

1. Capacity selection settings: The capacity selection settings define which vehicle resources, containers, drivers, and schedules are selected for transportation planning. This setting involves selecting the resource capacity in the transportation cockpit. Schedules are also selected based on the criteria defined in the capacity selection settings. The mode of transportation can be maintained explicitly. Many fields in the resource can be used for selection. A few of them are listed below:

   - Location
   - Equipment types
   - ID
   - Planning Block
   - Resource owner

   Note: If you use resources for which you have defined an ADR limit, VSR optimization takes into account the number of ADR points for this resource during the optimization run. Moreover, you can specify that resources for which you have set a planning block are not displayed in the resource lists of the transportation cockpit.

   Note: The Agreement concerning the international carriage of Dangerous Goods by Road (ADR) is an international standard governing the transport of dangerous goods by road. The agreement describes an exemption based on the calculation of points for dangerous goods. If the points total calculated according to the method described does not exceed 1000 points, the exemption can be applied.

2. Optimizer Settings: Here, you can define the optimizer run-time, the maximum number of transshipment locations and processes, and the freight order building rule, for example. You also specify whether you require rough or detailed information for your planning activities, define the required process controller strategy, and configure the settings for generating transportation proposals.

SAP delivers the planning strategies VSR_DEF and VSR_1STEP as standard for the optimization. You can use the planning strategy VSR_1STEP to control whether the system is to perform carrier selection immediately after VSR optimization. The results of the VSR optimization run are explained in the explanation tool.

In the advanced settings, you can also specify whether the main aim in your transportation proposals is to ensure the lowest transportation costs possible or the shortest transportation duration possible, based on the planned delivery date/time. You can also define preferences in relation to your relative weighting of the variance of carriers, routes, and departure dates, or activate or deactivate capacity constraints at transportation mode level. You can also specify whether the system is to ignore certain settings such as the capacity or ADR limit of a resource during VSR optimization.

VSR optimization generates a transportation plan from the optimization data consisting of planned freight orders. It processes freight orders already available from a previous VSR optimization run or manual planning. VSR optimization inserts the freight units into the transportation plan and modifies these initial solutions by, for example, loading a freight unit on to another capacity or by changing the delivery sequence of a capacity.

The optimizer tries to minimize the total costs while adhering to the constraints. At the end of the planning run, VSR optimization returns the best solution found. You can generate multiple alternative transportation proposals for each freight unit. You can then choose to use one of them.

3. Load optimization settings for: Here, you can define the optimizer run-time, the planning strategy, and various rules for load planning. For example, you can define the maximum height difference between stacks in a row, stack height ascending in driving direction. The standard strategy used for load optimization is ALC_DEF.
4. Constraints and costs settings: Here, you define costs related to freight units and means of transport. In most cases, these costs are not actual costs. They simply offer a means of controlling the result of the optimization run (for example, earliness costs and lateness costs).
5. Incompatibility settings: Here, you define settings for your incompatibilities.
6. Carrier selection settings: Here, you specify whether the system is to use transportation allocations or business shares. The planning strategy used for carrier selection is TSPS_DEF. Additional strategy for cost, priority, cost+priory or cost* priority is defined.

   With Cost +Priority, Carrier 1 is ranked highest.

   With Cost*Priority, Carrier 2 is ranked highest.

Carrier(s)	Cost	Priority	Cost+Priority	Cost*Priority
Carrier 1	1000	20	1020	2000
Carrier 2	1100	10	1110	11000
Carrier 3	1200	30	1230	36000

7. Settings for manual planning: Here, you specify how you want the system to behave when it assigns documents and resources:

- Assignment of documents: You use these settings to control how the system is to assign one or more requirement documents to a capacity document.
- Removal of the assignment of documents: You use this setting to control how the system is to remove the assignment of requirement documents to capacity documents.
- Assignment of resources and creation of documents: You use these settings to control how the system is to assign resources to documents and how it is to create and assign reference documents.
- Driver Assignment: You use these settings to control how the system will assign trucks to the drivers.

8. Scheduling Settings: You define loading and unloading durations for scheduling. The schedule strategy defines the actions that are performed when scheduling is launched for a freight order or freight booking in the transportation cockpit. Standard strategy used for scheduling settings is VSS_DEF. The schedule strategy is assigned to the planning profile. Here, we define if the system considers the dates in the freight unit as constraints and whether a backward or forward scheduling direction is used.

LESSON SUMMARY

You should now be able to:

- Understand the selection and planning profile

Unit 4
Lesson 3

Transportation Cockpit

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Understand the transportation cockpit

Transportation Cockpit

The transportation cockpit is the main UI for performing planning. Transportation planning, including freight order creation, is conducted in the transportation cockpit. Transportation requirements lists (freight unis), capacity lists (vehicle resources and schedules), order lists and order details can be all seen in the transportation cockpit. The following are transportation cockpit tasks:

- Manual planning
- Creation of transportation proposals
- VSR optimization
- Load planning
- Carrier selection
- Triggering of a tendering process
- Creation of delivery proposals
- Creation of freight bookings

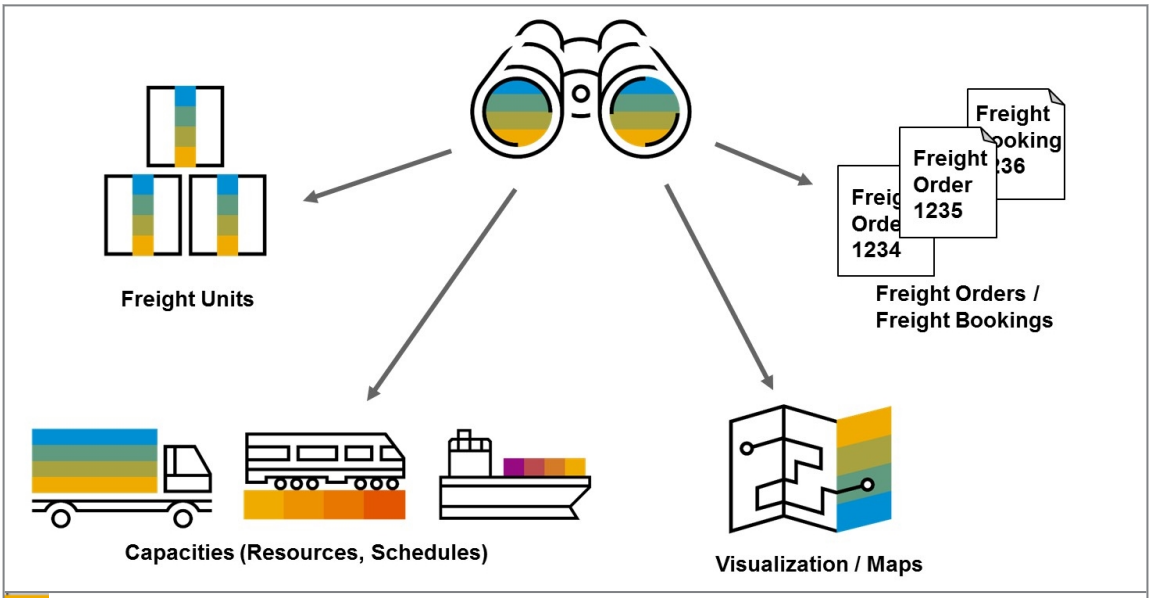

Figure 76: Transportation Cockpit

The cockpit requires users to enter several profiles that govern the content of generated result lists. The selection profile determines what is to be planned, that is, what freight units or freight orders are pertinent for a particular objective. The planning profile determines how the selected freight units are planned. The capacity selection profile restricts the planning run in relation to the transportation resources that can be used. Once the profiles have been determined, planners can use the cockpit to create freight bookings or manage existing freight orders.

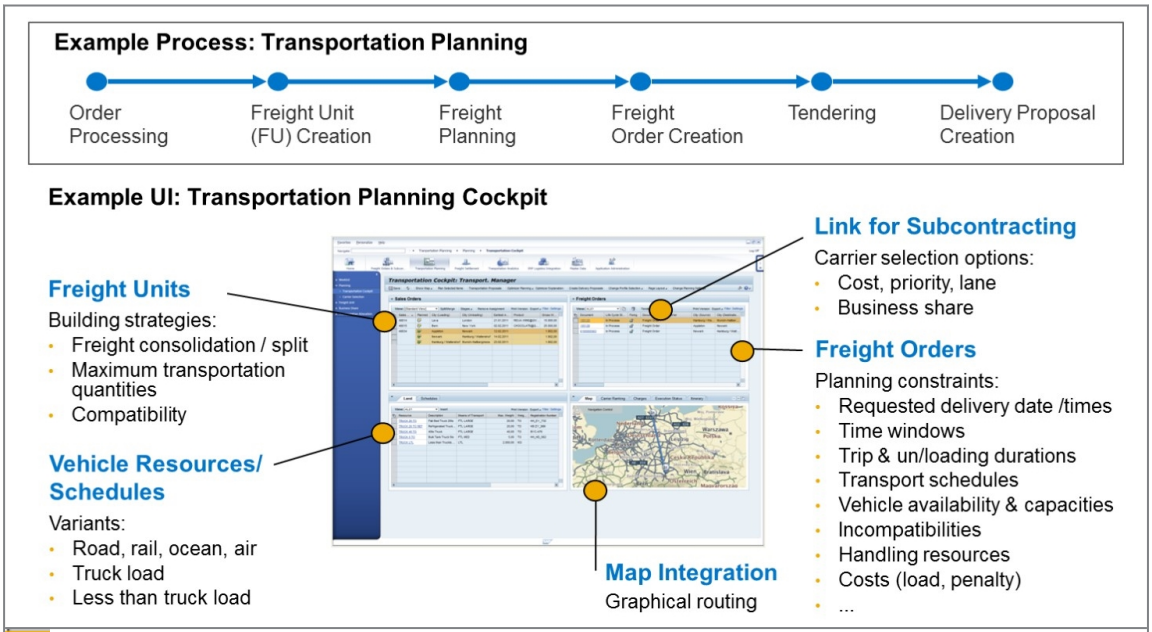

Figure 77: Transportation Cockpit Standard Layout

The transportation cockpit is dynamic and can be configured as per users requirements. The transportation cockpit layout offers flexible settings to control what information is presented and the processing options available. Depending on the user requirements, certain elements can be hidden or visible on a page. Page layouts are used to define a view the user wants to see during planning. A page layout defines the buttons, functions, levels and hierarchies that are displayed in the transportation cockpit, carrier selection and delivery creation application UIs.

A combination of selection and planning profile together with a page layout can be assigned to a profile and layout set, such that this specific planning scenario is always shown in this layout, while another planning scenario requires another layout. Profile and layout sets are used to distinguish between different planning areas or functions. One profile and layout set can be assigned as the default. Such a profile and layout set is based on the specific information requirements of a planner. For example, in one scenario, a planner has to plan liquids on tank trucks and must be able to see the volume of product, while in another scenario, the liquids are in barrels on pallets and the planner requires the pallet count to be displayed. It is possible to switch between different layouts on-the-fly, for example, if a multi-step planning process leads to different needs in each step. The following are a few examples of different layout sets:

- A set for a planner who plans the next day
- A set for a dispatcher who makes the planning changes for today
- A set for an air and ocean planner

- A set for carrier selection
- A set for each area planner per country or region

In the standard layout, the main screen is broken up into four quadrants (views). The maximum number of views in any layout is 6. If a user works with several screens, they can choose a separate layout for each screen. The transportation cockpit can be deployed in multiple windows on up to three screens. Note 2551221 provides additional information on this topic: https://launchpad.support.sap.com/#/notes/2551221.

Hierarchical view: You organize the view in the transportation cockpit by creating hierarchical views for freight orders, freight bookings, and transportation units (trailer units, rail-car units, container units, and package units). If you organize these business documents into hierarchies, you can filter and sort various areas in the transportation cockpit according to specific criteria, such as the vehicle resource. Defining hierarchical views simplifies your rescheduling activities and the coupling and uncoupling of trailers. The following notes provide additional information on this topic:

- 2768608
- 2182927

Maps: The map can be displayed as one screen area in the transportation cockpit or in full screen. However, having the map displayed as one screen area enables the planner to directly see the selected freight units, freight orders or bookings, transportation units, and resources on the map. You can perform the following actions on the map:

- Address Search: You can use the context menu of the map to start the address search and display the search results on the map. The address search is based on the geocoding of the location. This allows you to perform several address searches and display the search results simultaneously on the map. You can use the context menu of the map to hide the search results individually or completely.
- Route Display: You can use the context menu of a connection line to determine a route display along real street routes. This function is dependent on the geographical information system available in the system. Alternatively, you can use the context menu of a resource to display the connection lines of all freight orders assigned to this resource.
- Dynamic Adjustment: You can adjust the map display to meet your individual needs by selecting the option *Show Display Profile* from the context menu for the map. For example, you can specify whether map objects are to be shown or hidden, whether you want to display the descriptions, and whether you want to allow clustering for overlapping nodes.
- Create Location and Transportation Zone: You can use the context menu for the map to create locations and transportation zones directly on the map. The locations or transportation zones are created where you open the context menu. However, you cannot use the context menu to change the positioning of an object on the map.
- Proximity Search: You can use the context menu of the map to find resources as well as unplanned freight units or transportation units that are close to a particular point on the map.
- Resource Item: You can use the context menu of the map to specify the exact location of a resource at any time.
- Differentiate Between Business Documents Using Colors: You can use the context menu of the map to display different colors for multiple business documents selected

simultaneously. This enables you to better differentiate between the documents. The color of each respective document is displayed in the Color column in the document list.

Gantt Chart: The Gantt chart is fully integrated into the transportation cockpit. The Gantt chart is a screen area in the transportation cockpit, which can be enabled in a page layout of the transportation cockpit. You can also update maps, generate transportation proposals, and run optimizer planning for the selected items in the Gantt chart and in the lists and hierarchies of the transportation cockpit. The Gantt chart has the following features:

- Transparent availability of resources and drivers: The chart panel presents you with an overview of the availability of vehicle resources, handling resources, and drivers over time. For example, different colors indicate whether a truck has a document assigned to it, or whether it is traveling, in downtime, or in non-working time. You can also check whether a handling resource is available or in downtime at a location and if a drivers is available or if he is absent. You can use the Operating Time Calendar hierarchy to visualize the operating time configured for a specific location. The Operating Time Calendar displays the non-working times and activities occurring in that location. These activities are: loading, unloading, prepare, and finalize. The hierarchy also displays the overlaps between loading activities.
- Visibility of utilization of resources: You can display the level of consumed capacity of a vehicle resource at a specific point in time. The system displays the utilization curve of the selected vehicle resource in the chart panel. The tool-tip along the utilization curve displays the loading utilization of a vehicle resource in terms of volume, weight, alternative quantity, or normalized quantity, depending on your settings in customizing. The tool-tip along the utilization line of a handling resource presents you with information on the available capacity, required capacity, and over-capacity of this handling resource at a specific point in time. You can display loading or unloading activities that are planned for a handling resource at different times.
- Option to display or hide document separators in the Gantt chart: The Gantt chart presents you with document separators indicating the precise document start and document end. You can choose to display or hide document separators in the Gantt chart by selecting the corresponding checkbox in the legend area. Document separators apply to the resources (truck, trailer, driver, locomotive, rail-car and container).
- Option to display or hide time windows in the Gantt chart: The Gantt chart presents you with time windows indicating when goods are to be picked up and delivered. In the Gantt chart, time windows are shown as dotted lines and solid lines. You can choose to display the time windows by using the corresponding check-boxes in the legend area.
- Option to display and solve warnings in the Gantt chart: The Gantt chart presents you with warnings such as the Missing Stage warning or the Incorrect Driver Assignment warning that are indicated by a warning icon. You can solve a warning using the context menu. You can choose to display or hide this type of warning in the Gantt chart by selecting the respective checkboxes in the legend. The legend area also displays the number of warnings for each warning type. Moreover, the number is dynamically updated once a warning of a certain type is solved or generated. Besides of the legend area, the Number of Warnings column in the table area shows you the total number of warnings on each row in a real-time manner. You can also deselect a certain warning type in the legend area so that warnings of that type are not considered when calculating the total number.
- Insights into planning and execution status of documents and transportation activities: If you transfer event-related data from SAP Event Management to SAP Transportation Management, you can gain real-time insights into the planning status and execution status

of the documents and transportation activities in the chart panel. The statuses of documents and activities are presented in predefined colors and patterns, as described in the legend. Note that the Gantt chart automatically hides a legend item in the legend area if no corresponding documents or activities are shown in the chart area.

- Flexible and dynamic switch between different views: You can switch between a single view and a dual view (with its horizontal and vertical versions). In the chart panel of each view, you have the option to switch between a document view and an activity view. The dropdown lists and the related pushbuttons in the toolbar enable you to switch dynamically between views and hierarchies that are pre-defined in Customizing. For example, in a horizontal dual view, you can choose to display freight orders in the upper view and trucks in the lower view, so that you can assign unplanned freight orders to trucks using drag and drop.
- Flexible rendering of hierarchical structures: You can simplify the hierarchical structure of document flows in Customizing so that stage documents can be directly shown under a higher-level parent, instead of their direct parent. This provides you with more flexibility to render document flows in the Gantt chart.
- View all objects with one click: Bird Eye provides you with the capability to have a panoramic view of all objects with one click. With this feature turned on, the system intelligently adjusts the zoom rate so that all items are displayed on the chart without a need to move the horizontal scroll bar. This feature can be implemented on all rows or just on visible rows. This can be configured in Gantt Chart customizing.
- Personalize table area appearance: You can personalize the appearance of the table area with the following options:
  - Display or hide a column
  - Modify the column sequence
  - Adjust the column width

  Moreover, you can save all personalization settings as a variant so that the table area is presented with the saved settings for the next time you load the Gantt chart.
- Configurable visualization of notifications: You can define the color and height of a certain type of notifications in the Gantt chart. Moreover, you can configure when to display the following types of notifications by specifying a utilization range value of vehicle resources:
  - Empty run
  - Low utilization
  - Overcapacity

Transportation Cockpit Customization Settings

The following changes can be made to the layout of the transportation cockpit:

- The time zone in which to present time-related information
- Unit for distance
- The position and width of the tabs on screen
- The visibility of tabs
- The sequence and number of rows and columns visible

You can change the layout to suit your requirements by choosing the *Page Layout* button. For example, you can change to a layout that displays the command line and so allows command line planning.

LESSON SUMMARY

You should now be able to:

- Understand the transportation cockpit

Learning Assessment

1. Planning is carried out on the freight unit, which must first be created. Which of the following options can trigger the creation of a freight unit?

   Choose the correct answers.

   - ☐ A Freight Order
   - ☐ B Purchase Order
   - ☐ C Forwarding Order
   - ☐ D Sales Order

2. Which of the following do you assign to a selection profile?

   Choose the correct answers.

   - ☐ A Geographical selection attributes
   - ☐ B Capacity selection settings
   - ☐ C Carrier selection settings
   - ☐ D Additional selection attributes

3. Which of the following planning constraints can be considered in SAP Transportation Management?

   Choose the correct answers.

   - ☐ A Vehicle resource capacities
   - ☐ B Compartment capacities
   - ☐ C Depot locations
   - ☐ D Driver qualifications

Learning Assessment - Answers

1. Planning is carried out on the freight unit, which must first be created. Which of the following options can trigger the creation of a freight unit?

   Choose the correct answers.

   - [ ] A Freight Order
   - [X] B Purchase Order
   - [X] C Forwarding Order
   - [X] D Sales Order

   Correct. All of the options except the freight order can trigger the creation of a freight unit. The freight order is a successor document to the freight unit.

2. Which of the following do you assign to a selection profile?

   Choose the correct answers.

   - [X] A Geographical selection attributes
   - [ ] B Capacity selection settings
   - [ ] C Carrier selection settings
   - [X] D Additional selection attributes

   Correct. You assign geographical selection attributes and additional selection attributes to a selection profile.

3. Which of the following planning constraints can be considered in SAP Transportation Management?

   Choose the correct answers.

   - [X] A Vehicle resource capacities
   - [X] B Compartment capacities
   - [X] C Depot locations
   - [ ] D Driver qualifications

   Correct. Capacities for vehicles resources and compartments as well as depot locations are planning constraints considered in SAP Transportation Management.

UNIT 5 Interactive Transportation Planning

UNIT OBJECTIVES

- Perform interactive planning
- Practice freight order scheduling
- Plan drivers to freight orders

Unit 5
Lesson 1

Performing Interactive Planning

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Perform interactive planning

Drag and Drop Freight Order Creation

Manual planning is done in the transportation cockpit. Manual planning allows you to manually create or change a transportation plan. To create a transportation plan, you assign requirement documents, for example freight units, to capacities, for example vehicle resources. The system creates capacity documents, for example freight orders, which you can process further. For example, you can assign drivers to your freight orders or perform load planning. If you assign freight units to a container, for example, a container unit is created that you can directly assign to a freight booking.

Planning strategies determine the steps that the system is to carry out during the planning process and the order in which it does so. In the planning profile, you can specify which planning strategy you want to use. The following are a few manual planning strategies:

- VSRI_DEF for manual planning
- VSS_EMBED for embedded. This strategy does not consider scheduling constrains defined in customizing
- VSRI_SCH for manual planning with subsequent scheduling
- VSRI_1STEP for manual planning with carrier selection

Drag and Drop Freight Order Creation:

A freight order can be created using the drag-and-drop functionality. Dragging an unplanned freight unit stage to a resource or dragging a resource to an unplanned freight unit stage creates a freight order. Changes to existing documents can also be made using drag and drop. It is possible to drag additional freight unit stages to a freight order. Freight units can be assigned from one freight document to another. Blank capacity documents can be created (that is, capacity documents that do not contain a freight unit), which you can then process at a later time. It is possible to drag and drop between various hierarchy levels.

The main drag and drop functionalities are as follows:

- Change relative stop sequence of a freight order or transportation unit
- Reassign stop to a different vehicle, freight order, or transportation unit
- Reschedule a freight order or transportation unit
- Assign a freight order or transportation unit to a resource (truck or trailer)

Manual planning can be done with multiple windows. The transportation cockpit can be deployed in multiple windows on up to three screens.

- Run the transportation cockpit on multiple windows, select a separate layout for each screen.
- Drag and drop from any list/hierarchy in one window to any other list/hierarchy.
- Actions triggered from global toolbar (for example, undo, redo, assign selected items, update map or optimization) consider selected objects from all windows.
- A change in one window automatically updates the other windows.

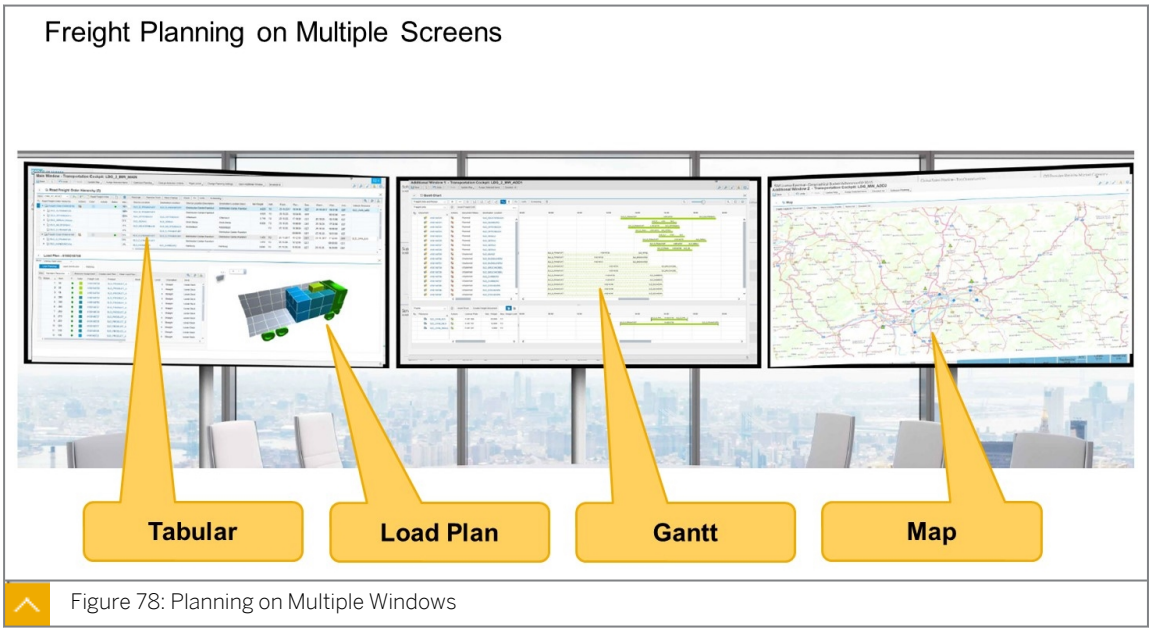

Figure 78: Planning on Multiple Windows

Command Line Freight Order Creation

Command Line Freight Order Creation: The command line enables mouse-free planning and is an alternative to drag-and-drop planning. Using the command line, the planner instructs the system to assign freight unit stages to vehicles via a single character string.

To enable command line planning, an index is assigned to each resource and freight unit stage. The index acts as a unique identifier for every object in the transportation cockpit. Note that vehicle resources are assigned low numbers so that the planner can easily remember them.

Planning with the Command Line: When planning with the command line, the planner first enters index numbers that represent the freight unit stages, followed by a dash (-) and a vehicle resource index. Press Enter, and a freight order is created with the relevant stages and resource assigned. Multiple commands can be specified in one string by using a plus (+) sign to separate them.

Example: Simple Planning of Freight Units on a Vehicle Resource

The freight units that you want to plan have the indexes 5, 6, and 7. The vehicle resource that you want to use to transport the freight units has an index of 2. To assign the freight units to the vehicle resource, you enter the following command in the command line: 5 6 7 — 2.

The following are prerequisites for using command line planning:

- The display of the command line must be activated for the page layout for the transportation cockpit.
- The index field should be displayed for the freight unit stages and vehicles in the transportation cockpit.

The help field of the command line provides additional information. Choose *More Field Help* in the context menu for the field by clicking the right mouse button.

Interactive Map Freight Order Creation

Interactive Map Freight Order Creation: Freight orders can be created using the interactive map. Freight unit stages and vehicles are both displayed on the map.

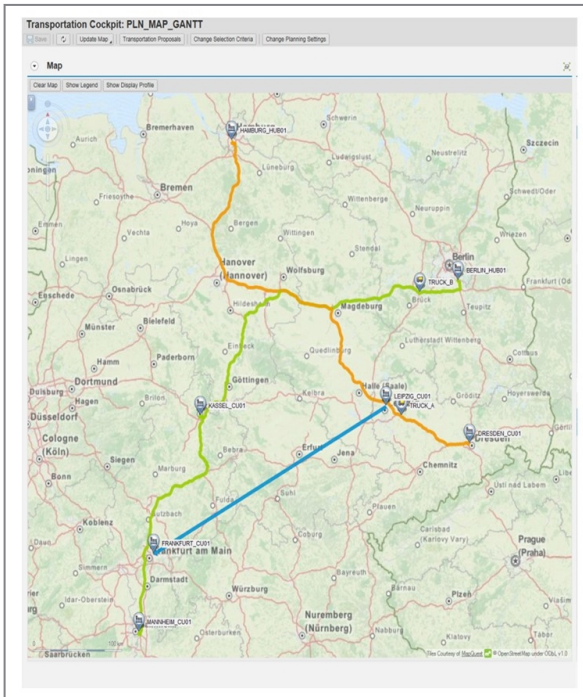

Figure 79: Interactive Planning on the Map

You can carry out your planning activities on the map. If you select *Unplanned Freight Units* and *Start Planning* from the context menu, for example, the system shows the possible assignments of the freight units to the resources. Select the assignments that you require.

You can also assign unplanned freight units or multi-relations that contain unplanned freight units to resources by using drag and drop. When you do so, you can either assign the freight units to the resource or the resource to the freight units.

If you want to split a stage that is displayed on the map, you can assign an unplanned freight unit or multi-relation to a location using drag and drop. Once you have selected the required planning option, the system adds the selected location to the freight unit stage and updates the map accordingly. This process also applies to freight orders.

You can also display transshipment locations that are not part of your planning activities. You display these locations by choosing *Show Related Transshipment Locations* from the context menu.

If a freight order does not have a vehicle assigned to it, you can also assign the vehicle using drag and drop. To do so, you assign the freight order to a single vehicle resource or a multi-spot that contains at least one vehicle resource or passive vehicle resource and then select the relevant planning option from the menu.

The system displays all of your transportation planning activities on the map. When you leave the full display of the map, your planning activities are also displayed in the table view of the transportation cockpit.

Interactive Planning on the Map: You can carry out your planning on the map.

- If you select *Unplanned Freight Units* and *Start Planning* from the context menu, for example, the system shows the possible assignments of the freight units to the resources. Select the assignments that you require.
- You can also assign unplanned freight units or multi-relations that contain unplanned freight units to resources by using drag and drop. When you do so, you can either assign the freight units to the resource or the resource to the freight units. You can use the proximity search in the context menu to find unplanned freight units and transportation units that are within a specific radius of a resource or a location.
- If you want to split a stage that is displayed on the map, you can assign an unplanned freight unit or multi-relation to a location using drag and drop. Once you have selected the required planning option, the system adds the selected location to the freight unit stage and updates the map accordingly. This process also applies to freight orders.
- You can also display transshipment locations that are not part of your currently selected planning activities. You display these locations by choosing *Show Assigned Transshipment Locations* from the context menu.
- In the context menu for a freight unit, you can add locations.
- If a freight order does not have a vehicle assigned to it, you can also assign the vehicle by using drag and drop. To do so, you assign the freight order to a single vehicle resource or a multi-spot that contains at least one vehicle resource or passive vehicle resource and select the relevant planning option from the menu. You can use the proximity search in the context menu to find available resources that are within a specific radius. You can also specify the exact position of a resource at any time in the context menu of the map.
- In the case of resources on the map, you can find the assigned business documents by selecting the corresponding option from the context menu for the resource. The system searches for already planned freight orders and adds these to the map.
- You can use the context menu of the map to display different colors for multiple business documents selected simultaneously. This enables you to better differentiate between the documents. The color of each respective document is displayed in the Color column in the document list.
- The system displays all of your transportation planning activities on the map. When you leave the display of the map, your planning activities are also displayed in the table view of the transportation cockpit.

Gantt Chart Freight Order Creation

Using a Gantt chart, which is often used in project planning as well, helps to visualize the availability of resources and the sequential order of transports. The Gantt chart is fully integrated into the transportation cockpit.

In the Gantt chart, freight orders and vehicle resources are displayed as a time bar and planners can manually plan transports by using drag and drop. The Gantt chart is a screen area in the transportation cockpit which can be enabled in a page layout for transportation cockpits. All standard functionalities, like positioning the Gantt chart anywhere on the transportation cockpit or maximizing the screen area to full screen, are available for the Gantt chart too.

A zoom bar on top of the screen area can zoom in and out to see a more detailed view of a day or week, or a more general view of the year.

Visibility

- Usage of trucks and trailers
- Load utilization of trucks and trailers
- Downtimes and nonworking times
- Execution status and reported times for freight orders, trailer units and their activities
- Notifications for overload, empty movements, and time conflicts

Usability & Flexibility

- Time zoom in and out
- Aggregated and detailed view
- Hierarchical views
- Single and dual view (horizontal and vertical)

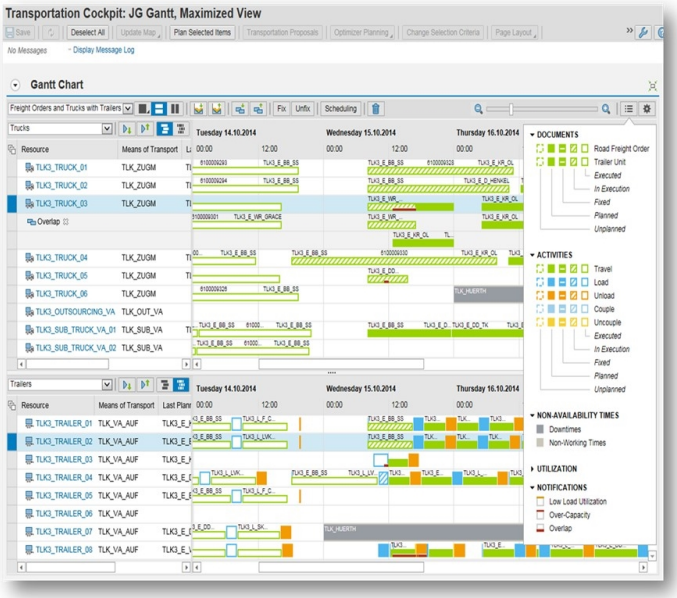

Figure 80: Gantt Chart: Display of Resources and Documents

An important factor for transportation planning is the utilization of a vehicle. The utilization of the vehicle can be displayed with the utilization view, which can be enabled when needed. The utilization view shows the utilization of the vehicle over time in a graph. The graph is displayed in a detail line below the actual resource or document. In this case, the single-view is chosen. This enables the user to see all of the execution information within one screen. Multiple loading acts are only displayed as one item in the Gantt chart. This keeps the chart clean and easy to understand.

Interactive planning can be performed in the Gantt chart using drag and drop. Unplanned freight orders can be assigned to resources. Likewise, resources can be assigned to freight orders. The freight order is dropped on the time bar of the resource. If the freight order is not dropped at the same date it was originally planned, the date where it was dropped is taken over into the freight order. Scheduling is only performed when requested using the *Scheduling* button on top of the Gantt chart. The dual-view can be selected to have the unplanned freight orders displayed on top and the available resources below. This enables the user to work with one window to plan freight orders. The dual-view can either be displayed horizontally or vertically. The size of each area can be changed by dragging with the mouse.

Interactivity

- Assign and schedule trucks and trailers by drag and drop
- Re-sequencing by drag and drop
- Fix and unfix freight orders, trailer units, and their activities
- Context menus and hyperlinks

Planning Scenarios

- Truck planning (freight orders and truck resources)
- Truck and trailer planning (trailer units and trailer resources)
- Re-planning based on events from execution

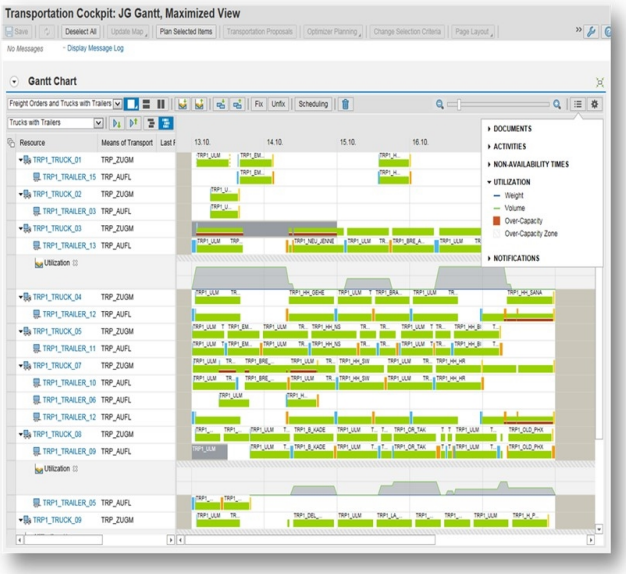

Figure 81: Gantt Chart: Interactivity and Planning Scenarios

The Gantt chart enables the planning of unplanned freight orders by dragging on vehicle resources, as well as the creation of transportation units. When dragging and dropping the loading activity of one freight order into the time bar of another freight order, both freight orders are combined.

Overlap means the resource was planned multiple times and is therefore not executable. For example, if the trailer is already planned and newly planned in a later step, this would cause an overlap which the user gets displayed as a red line.

Similar to the utilization view, an overlap view shows if several documents on a resource overlap. This overlap can be overcome by scheduling the resource.

LESSON SUMMARY

You should now be able to:

- Perform interactive planning

Unit 5
Lesson 2

Practice Freight Order Scheduling

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Practice freight order scheduling
- Plan drivers to freight orders

Scheduling

Scheduling determines start and end times for a set of dates and times such as the departure and arrival of a freight order, the pick-up and delivery of the assigned freight units, or the coupling and uncoupling of trailers. In scheduling, the system considers multiple constraints like a predefined relative ordering among the activities of the freight order as well as the pick-up windows and the delivery windows of the assigned freight units. Scheduling can be triggered for one or more selected freight orders and is based on your settings in the planning profile.

Freight Order Scheduling

The scheduling of freight orders can be initiated in the following ways:

- From the transportation cockpit using the *Scheduling* button
- From the freight order user interface using the *Scheduling* button
- Automatically, by entering the departure date of a freight order and choosing Enter on your keyboard (if the user parameter /SCMTMS/SCH_FORCE is active)

Scheduling considers the following constraints:

- Time windows for loading and unloading activities for your freight units
- Appointments for the freight order to which your freight units are assigned
- Loading and unloading durations of your freight units
- Location sequence of your freight order
- Existing freight orders on resources
- Coupling and uncoupling durations
- Calendar resources as well as the calendars and capacities for the loading and unloading activities of handling resources
- Calendars of the involved vehicle resources for loading, unloading, transportation, coupling, and uncoupling activities

Scheduling Unplanned Requirement Documents

You can quickly generate the approximate transportation time for requirement documents without needing to plan the documents. In addition, the Gantt chart can display the stage sequence to provide a useful visual aid.

There are multiple ways to schedule an unplanned requirement document, as follows:

- Applying a default route to the document
- Choosing *Schedule*
- Starting the freight unit building process

You can view the scheduling results on the Gantt chart and in the requirement document. After scheduling, the requirement document contains the transportation times for each stage (planned arrival and planned departure times) but the document is still unplanned.

Forward and Backward Scheduling

In **forward** scheduling, the system first defines the start and end time of the **first** activity to be scheduled. Afterwards, the system assigns start and end times for all succeeding activities.

Figure 82: Forward Scheduling

The following example illustrates the use of forward scheduling.

Customer A orders 50 pallets of product X and asks for a delivery date in three weeks. Currently, the capacity of your depot is 100 m³. Product X takes up 95 m³ of your depot. Therefore, you decide to move the goods out of your depot as soon as possible in order to minimize your inventory. That is why you decide to use forward scheduling.

In **backward** scheduling, the system first defines the start and end time of the **last** activity to be scheduled. Afterwards, the system assigns start and end times for all preceding activities.

Figure 83: Backward Scheduling

Customer B orders 50 pallets of product Y and asks for a delivery date in three weeks. Currently, the capacity of your depot is 100 m³. Product Y takes up 5 m³ of your depot. Therefore, you decide to stick to the delivery time window as closely as possible. That is why you decide to use backward scheduling.

Scheduling Constraints and Settings

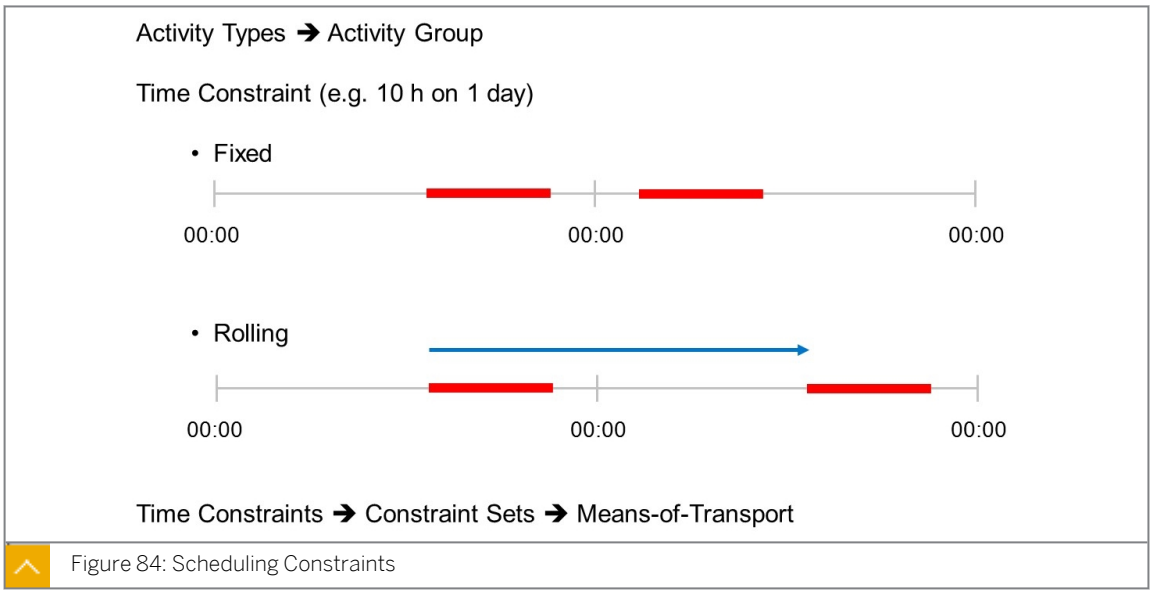

Figure 84: Scheduling Constraints

You can use the scheduling constraints function to consider constraints for scheduling during VSR optimization. This allows VSR optimization to, for example, extend the transportation plans for long trip durations so that a driver can take his required breaks. This function only applies to vehicle resources. For example, a truck requires two days for a trip from the east coast to the west coast of the United States. However, since the driver must take breaks along the way, a longer trip duration must be scheduled.

Resource Availability

Resource availability is considered for the following resources:

- Vehicle resources
- Calendar resources
- Handling resources

Resource Availability Considerations

Resource availability considers the following:

- Factory calendar
- Capacity variants
- Downtimes
- Existing activities assigned to the resource

Scheduling Strategy

Scheduling strategies are assigned in the scheduling settings in the planning profile. The standard strategy is VSS_DEF. In the scheduling settings, you can specify the forward/backward scheduling direction and maintain coupling/uncoupling durations.

Driver Management

A driver is any person who can operate vehicles and perform transportation-related tasks as a result of certain qualifications. Drivers are no longer maintained as resources but are defined as business partners. Drivers can get assigned to existing freight orders and vehicle resources. It is also possible to create freight orders to which the system assigns drivers automatically as soon as they are created. This function is available only for road freight orders and trucks.

One or more drivers can be assigned to an existing freight order or to the individual transportation stages of an existing freight order. In a driver team, the individual drivers take turns to drive. The person who is not driving sleeps.

A prerequisite of this process is that drivers are created as business partners with business partner role TM Labor Resource. The following are the properties of the driver:

- Home location
- Org unit
- Validity period
- Absences (for example, sickness, vacation)
- Non-working times (for example, Monday – Friday)
- Offered qualifications
- Last planned location and availability time

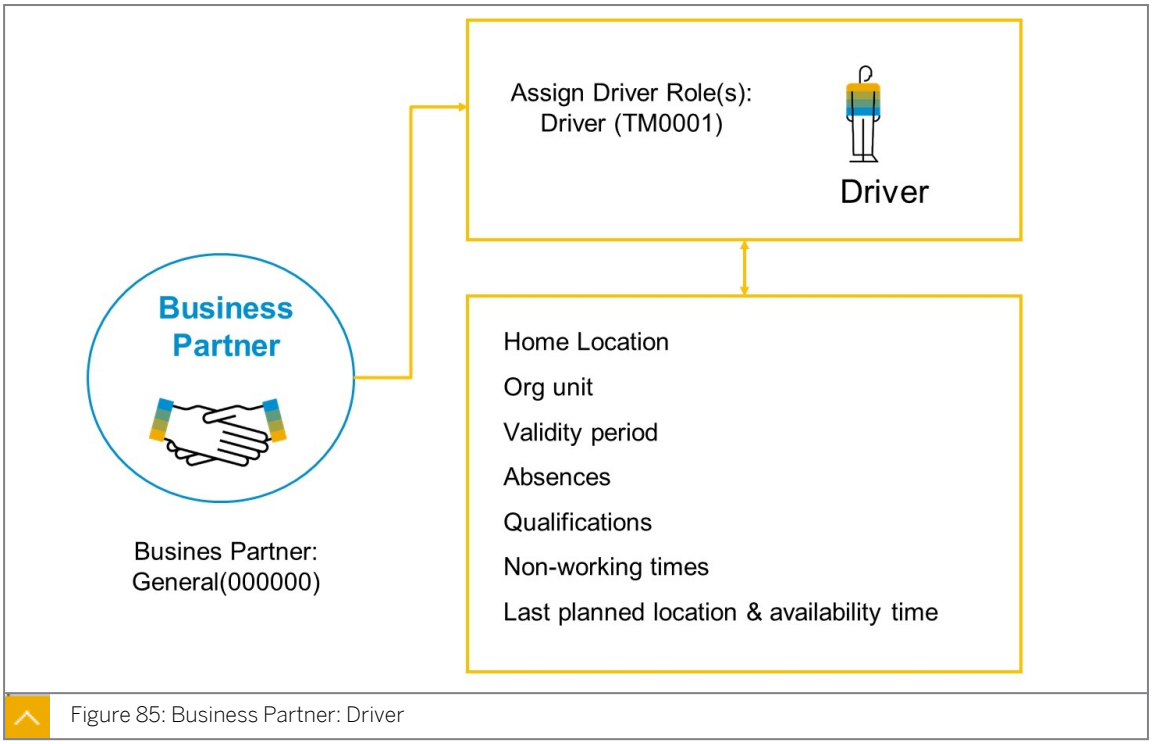

Figure 85: Business Partner: Driver

In freight order customizing, you can define the following settings related to drivers:

- Settings can be changed in freight order
- Number of required drivers

- Driver assignment type

In the manual planning settings, you can define default truck handling settings. This defines how the default truck of a driver is considered when assigning a driver to a freight order. You can ignore the default truck or use the default truck if no other truck is assigned to the freight order.

- Create driver as business partner
- Assign default driver to a resource/truck
- Maintian customization settings in the freight order
- Maintain default truck handling settings in the manual planning profile

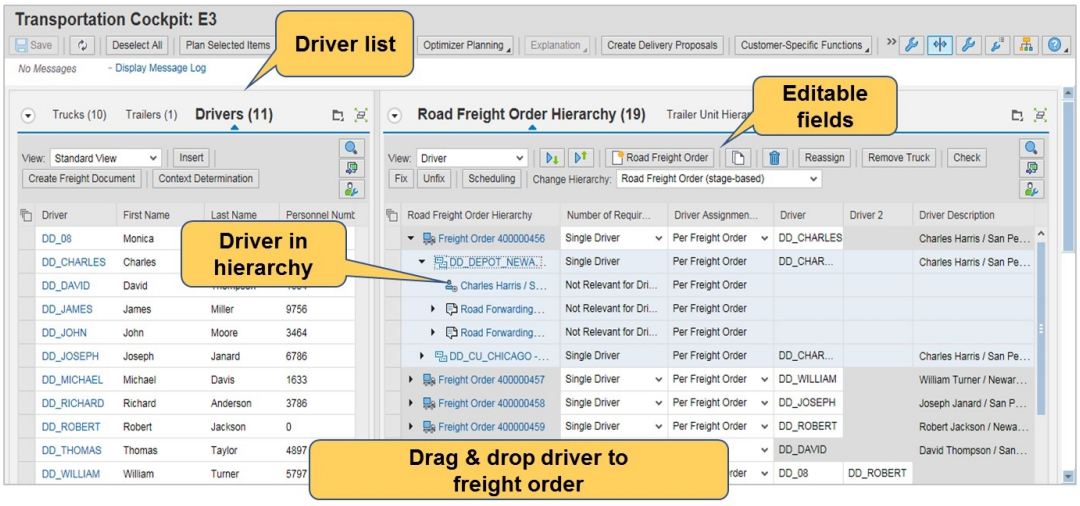

Figure 86: Driver Freight Order Assignment

Automatic Assignment of Drivers

Automatic assignment of drivers to freight orders happens if the driver assignment is requested via the freight order type and the driver is assigned to the resource master data of the vehicle resource as default driver. Other than that, manual assignment of drivers is possible in the transportation cockpit as follows:

- Drag and Drop: It is possible to drag and drop drivers from the list of drivers in the transportation cockpit to the freight order being planned in the road freight order hierarchy or in the road freight order list. If it has been specified in the freight order type that drivers have to be assigned per transportation stage, it is possible to drag and drop drivers in the road freight order hierarchy to the individual transportation stages.
- Manual creation and change: It is possible to enter or change drivers manually in the Driver column in the road freight order hierarchy or in the road freight order list. If specified in the freight order type that drivers have to be assigned per transportation stage, it is possible to enter or change drivers for individual transportation stages in the Driver column in the road freight order hierarchy. If driver assignment has been activated in the order details area in the layout for the transportation cockpit, it is possible to select a freight order in the road freight order hierarchy or in the road freight order list and manually enter or change a driver in the details for this freight order.
- Dialog box: Finally, it is possible to select a freight order in the road freight order hierarchy or in the road freight order list and choose the *Assign Driver* pushbutton. A dialog box

appears in which drivers can be entered. Then, the user can decide in the dialog box whether to replace the currently assigned drivers with new drivers or whether to add drivers to the existing drivers.

LESSON SUMMARY

You should now be able to:

- Practice freight order scheduling
- Plan drivers to freight orders

Learning Assessment

1. What visual elements support planning in the transportation cockpit?

   Choose the correct answers.

   - ☐ **A** Analytics
   - ☐ **B** Map
   - ☐ **C** Gantt Chart
   - ☐ **D** Load Plan

2. Which of the following statements are correct?

   Choose the correct answers.

   - ☐ **A** Several freight units can be assigned to a freight order.
   - ☐ **B** One freight unit can be assigned to several freight orders.
   - ☐ **C** One freight unit stage can be assigned to multiple freight orders.

3. Which of the following statements is correct?

   Choose the correct answer.

   - ☐ **A** Drivers are business partners
   - ☐ **B** Drivers are resources

Learning Assessment - Answers

1. What visual elements support planning in the transportation cockpit?

   Choose the correct answers.

   - [ ] A Analytics
   - [X] B Map
   - [X] C Gantt Chart
   - [X] D Load Plan

   Correct. In the transportation cockpit, you can activate a map, a Gantt chart, and the load plan as visual elements.

2. Which of the following statements are correct?

   Choose the correct answers.

   - [X] A Several freight units can be assigned to a freight order.
   - [X] B One freight unit can be assigned to several freight orders.
   - [ ] C One freight unit stage can be assigned to multiple freight orders.

   Correct. Several freight units can be assigned to a freight order and one freight unit can be assigned to several freight orders. However, each stage of a freight unit can only be assigned to one freight order.

3. Which of the following statements is correct?

   Choose the correct answer.

   - [X] A Drivers are business partners
   - [ ] B Drivers are resources

   Correct. Drivers are defined as business partners.

UNIT 6 Automatic Transportation Planning

UNIT OBJECTIVES

- Understand VSR optimization
- Execute VSR optimization
- Explain the VSR optimizer result
- Configure a planning scenario with hubs
- Configure and execute transportation proposals

Unit 6
Lesson 1

Plan with the VSR Optimizer

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Understand VSR optimization
- Execute VSR optimization
- Explain the VSR optimizer result

Vehicle Scheduling and Routing Optimizer

The vehicle scheduling and routing (VSR) optimizer considers routing, and the sequence in which resources arrive at certain locations (as well as the scheduling of tasks running in parallel). It evaluates potential changes to the routing and the effect such changes would have on scheduling, helping to avoid the possibility of delayed deliveries and follow-on costs.

The goal of the optimizer is to assign freight units to vehicles/resources and determine the route and sequence of freight units per vehicle/resource such that all constraints are met and total costs are minimized. The optimizer achieves this goal by evolutionary local search, a population-based meta-heuristic that borrows selection principles from evolutionary algorithms and relies heavily on local optimization.

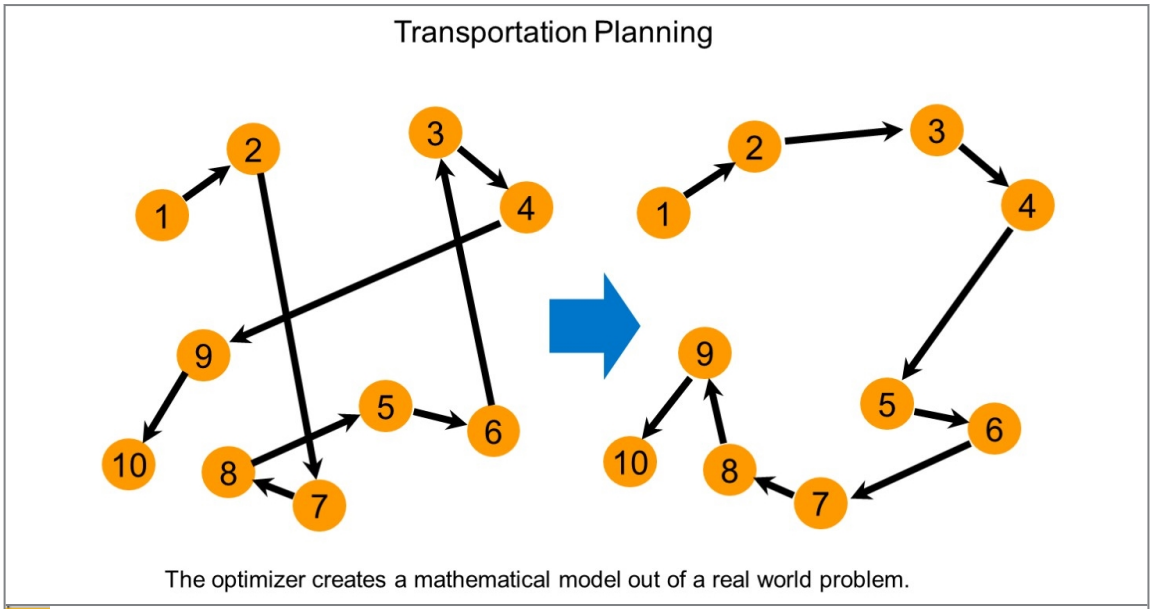

Figure 87: Mathematical Model

The transformation displayed in the figure is obviously a reduction of the driven distance.

Costs and Constraints

The total cost, which the optimizer is designed to minimize, is a weighted sum of the following items:

- Non-delivery/execution penalty (per freight unit (FU))
- Earliness and lateness penalty (per FU)
- Fixed cost (per vehicle or tour)
- Travel-dependent costs (per vehicle), for example, distance and duration.
- Load-dependent costs (per vehicle and tour)
- Sustainability costs, such as CO2 emissions

VSR Optimization Costs

Fixed costs are calculated once by the system for each capacity used in the VSR optimization run. Capacities include vehicle resources and schedules. For schedules, the fixed costs are incurred per departure.

In addition to fixed costs, other variable costs can be applied. The following are the variable transportation costs per unit for the following dimensions:

- Duration
- Distance
- Transported quantity per distance
- Intermediate stop

These costs refer to the use of the dimensions of a capacity, including empty runs, during the VSR optimization run.

Duration and Distance Costs

You can define the costs per duration for each VSR optimization run. You can also define a maximum value and a unit. The unit refers to both the costs and the maximum value. If you do not specify a unit, the system measures duration in seconds.

You can define the costs per distance for each VSR optimization run. You can also define a maximum value and a unit. The unit refers to both the costs and the maximum value. If you do not specify a unit, the system measures distance in kilometers. You can also specify the cost basis. This determines if the system uses the costs per distance from the *costs per distance* field in the planning profile or from the transportation lane. Alternatively, you can specify that the system is to take the sum of both values into account. When optimizing for destination-based distance costs, you have to define distance cost in the transportation lane.

Transported Quantity per Distance and Intermediate Stop Costs

You can define the costs per quantity for each VSR optimization run. You must also define a unit. You cannot define a maximum value for the costs per quantity. However, you can specify if the system is to use the costs per quantity from the transportation lane or from the costs per quantity specified in the planning profile.

For costs per quantity from the transportation lane, you can specify if the system is to calculate the costs in a distance-independent way or if it is to multiply them by the distance.

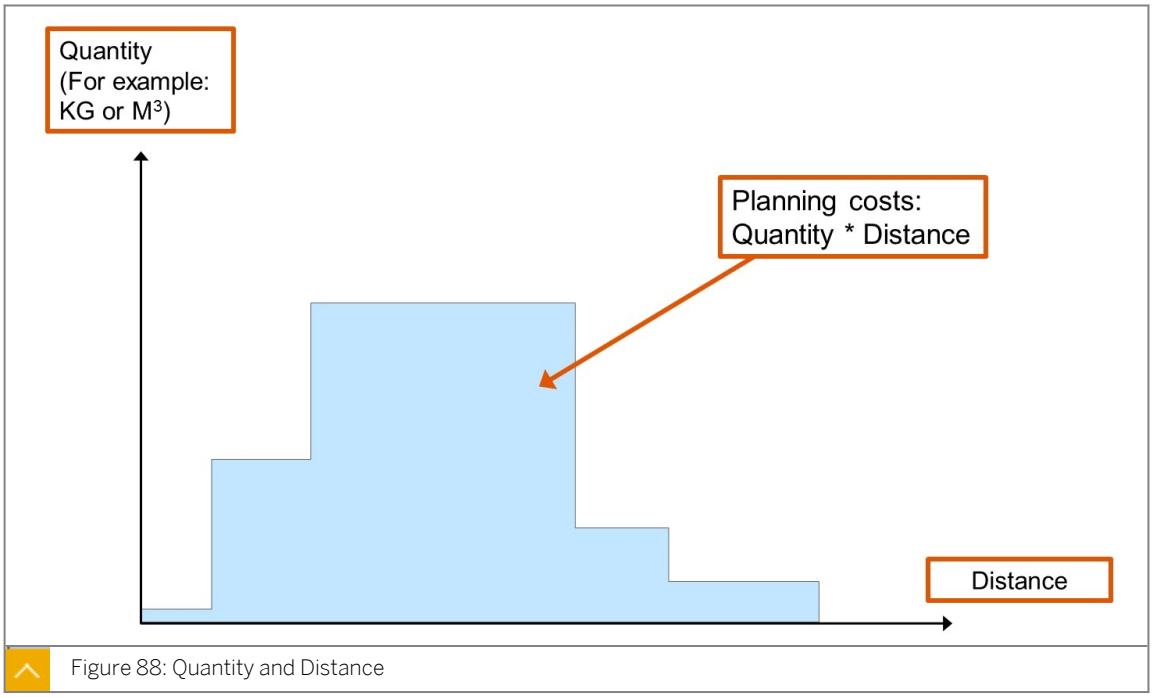

Figure 88: Quantity and Distance

For costs per quantity from the planning costs, you can specify if the system is to calculate the costs in a distance-independent way per transportation lane or if it is to multiply them by the distance. The system determines the costs per stage if costs are calculated in a distance-independent way. You are not allowed to define a unit. If multiplying by the distance, the system uses the fixed value that you have defined in the costs per quantity field.

You can define the maximum number of intermediate stops and the costs per additional stop.

Route-based Versus Destination-based Cost

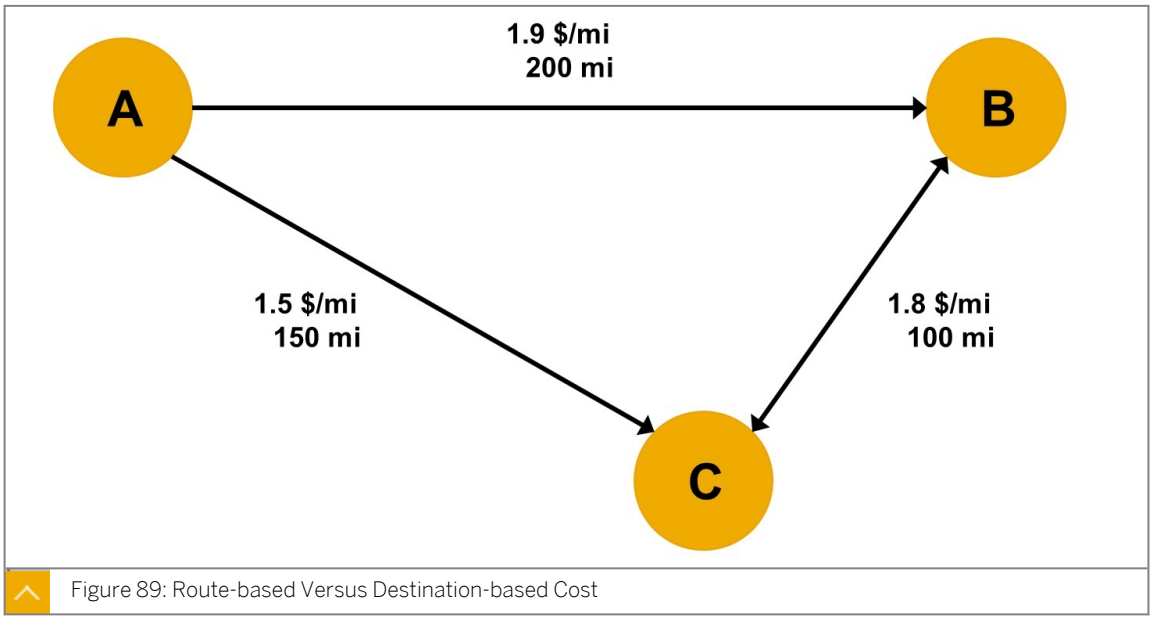

Figure 89: Route-based Versus Destination-based Cost

The figure, Route-based Versus Destination-based Cost, illustrates the route-based and destination-based costs as follows:

- Destination-based cost:
  - Freight order ($A \rightarrow B \rightarrow C$) = Distance ($A \rightarrow B \rightarrow C$) * Cost ($A \rightarrow C$) = 300 * 1.5 = $450.
  - Freight order ($A \rightarrow C \rightarrow B$)

    = Distance ($A \rightarrow C \rightarrow B$) * Cost ($A \rightarrow B$) = 250 * 1.9 = $475.
- Route-based cost:
  - Freight order ($A \rightarrow B \rightarrow C$) = Distance ($A \rightarrow B$) * Cost ($A \rightarrow B$) + Distance ($B \rightarrow C$) * Cost ($B \rightarrow C$) = 200 * 1.9 + 100 * 1.8 = $560.
  - Freight order ($A \rightarrow C \rightarrow B$) = Distance ($A \rightarrow C$) * Cost ($A \rightarrow C$) + Distance ($C \rightarrow B$) * Cost ($C \rightarrow B$) = 150 * 1.5 + 100 * 1.8 = $405.

Route-based and destination-based distance costs can yield different results. In North America, destination-based distance cost calculation is used frequently, whereas in Europe, route-based distance costs are primarily used.

Optimizer Considerations

The goal of the VSR optimizer is freight unit consolidation and the creation of a cost effective and timely route from source to destination.

VSR Goals and Objectives

- Goal: Determine a transportation plan that minimizes total costs and satisfies all constraints.
- Decisions:
  - Per freight unit: Transport or not?
  - Per transported freight unit: Select path through transportation network (stages).
  - Per selected stage: Select capacity or vehicle resource.
  - Per capacity or vehicle resource:
    - Select relative ordering of activities (= routing).
    - Assign start time to each activity (= scheduling).
- Total costs = sum of:
  - Penalty costs (non-delivery, earliness, or lateness).
  - Capacity or vehicle costs (fixed, duration, stops, quantity, and distance).

The total cost is the sum of penalty costs for non delivery, early and late delivery, and vehicle costs for duration, distance, stops, and quantity.

Optimizer Constraints

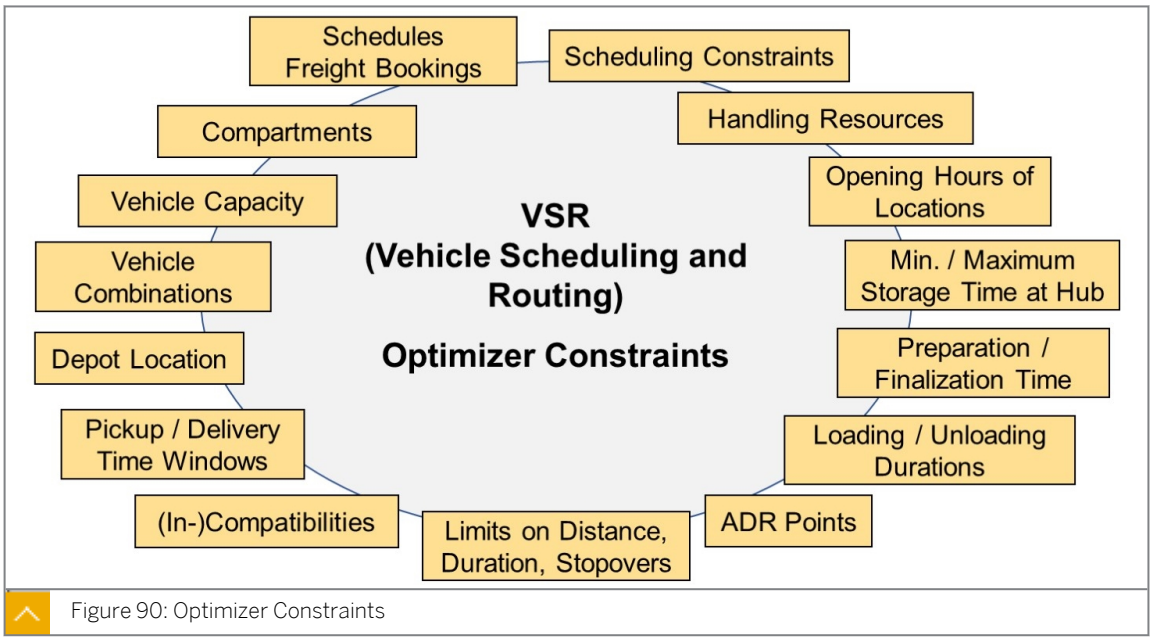

Figure 90: Optimizer Constraints

The optimizer operates within the constraints defined in the figure, Optimizer Constraints. The optimizer evaluates any changes in routing caused by constraints for their effect on the scheduling and timing. It communicates any change of time or date to all tasks on that resource or to any dependent tasks on any other resource. Considering both aspects in parallel ensures effective planning.

The optimizer tries to assign freight units to vehicles and determine an effective delivery order for each vehicle so that total transportation costs are minimized. It considers several constraints and takes penalty costs into account as part of the total transportation cost.

The following penalty costs are defined in the planning profile and can be used to control the decisions made by VSR optimization:

- Premature pick-up
- Delayed pick-up
- Premature delivery
- Delayed delivery

The optimizer calculates additional costs if the transportation plan deviates from the requested pickup and delivery dates. This is done when using soft constraints in the pickup and delivery time window and defining penalty costs in the planning profile.

There is a balance in the optimizer process between selecting the cheapest mode of transport and adhering to promised delivery dates and defined pickup dates. For example, the optimizer could decide to ship via an intermodal means of transport even if this means delivering a day late. This is on the condition that savings made by selecting a slower means of transport outweigh the penalty costs for delayed delivery.

Penalty Costs

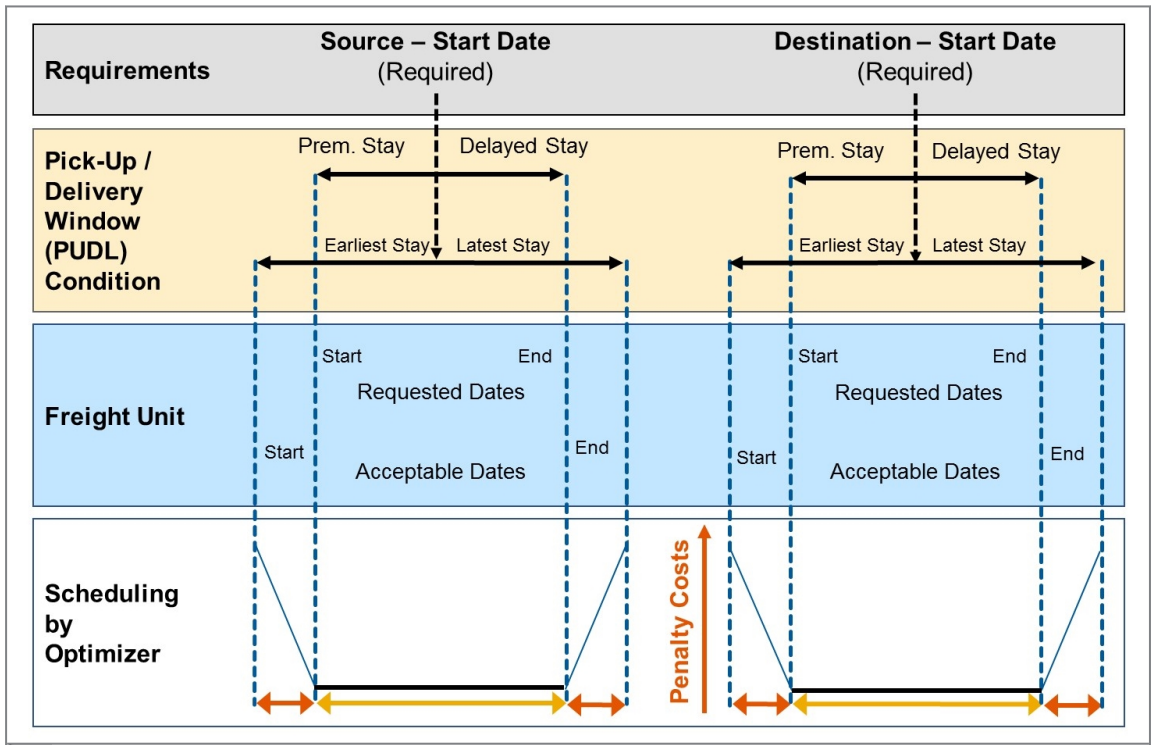

Figure 91: VSR Optimization Window

The penalty cost for premature pick-up is incurred when the scheduled pickup time falls between the earliest pickup time (hard constraint) and the allowed premature pickup (soft constraint).

The penalty cost for delayed pick-up is incurred when the scheduled pickup time falls between the allowed late pickup time (soft constraint) and the latest pickup time (hard constraint).

The penalty cost for premature delivery is incurred when the scheduled delivery time falls between the earliest delivery time (hard constraint) and the allowed premature delivery time (soft constraint).

The penalty cost for delayed delivery is incurred when the scheduled delivery time falls between the allowed late delivery time (soft constraint) and the latest delivery time (hard constraint).

Pickup and Delivery Window Definition

Defining Pickup and Delivery Windows

- Forwarding orders, SAP ERP-orders, and deliveries work only with single day and time for pick up and delivery.
- To allow more flexibility for freight consolidation and routing optimization SAP TM Planning uses Time Windows.
- Combination of pick up and delivery definition and penalty costs controls how the optimizer schedules within the time window.

Windows control when goods are to be picked up and delivered. VSR optimization schedules the pickup or delivery exactly in the window defined. If there were no windows, VSR optimization would schedule these dates to minimize the total costs.

You can also control the optimization when windows are not taken into account and goods are picked up or delivered too early or too late.

Defining Tolerances

You can create windows by defining tolerances within which a premature or delayed pickup or delivery is to be allowed. You specify for each tolerance if VSR optimization is to consider it a hard, soft, or hard and soft constraint. Specifying constraints controls if VSR optimization calculates penalty costs when the constraints are not adhered to.

The following tolerances can be defined:

- Maximum earliness
- Maximum delay
- Delay without penalty costs
- Earliness without penalty costs

The dates and times defined for the pickup and delivery in the freight unit are the basis for calculating the tolerances. The exact time for the pick-up date or delivery date can be considered.

Hard and Soft Constraints

Conditions are used to set up pickup and delivery windows. The condition is specified in the freight unit type.

Window Constraints

- None
- Hard (acceptable dates)
- Soft (requested dates)
- Hard and soft (both)

VSR optimization takes constraints into account when it assigns freight units to capacities. You can differentiate between hard and soft constraints:

- VSR optimization always adheres to hard constraints.
- You model soft constraints using penalty costs, for example, lateness costs that are part of the total costs.

The following are the relevant condition types:

- For pick up and delivery time window definition: /SCMTMS/TOR_TIMEWIND
- For earliness and lateness cost definition: /SCMTMS/FU_PNLT_COST

Means of Transport Cost Evaluation

Using the planning cost settings, the optimizer can determine the best means of transport to use. For example, a break-even analysis between a large truck and a small truck can be modeled with this setting.

There is a relation between pickup and delivery penalty time and cost per duration. Depending on business rules, it could be better to delay pickup or deliver early.

The maximum distance and durations are useful for deciding on rail or air transport instead of road. The maximum number of stops and costs are useful for reducing the number of visits during a week at customers or suppliers.

Stop Off Costs

The figure, Stop Off Costs, shows two stop-offs between locations A and D. Stopover costs are applied to influence the outcome of VSR optimization. The source and target location in a route are not taken into account when calculating the number of stopovers. Maintain the number of stopovers plus one.

Explanation Tool

You set user parameter /SCMTMS/EXP to X to allow for the logging of the optimizer data for optimization runs that you start interactively.

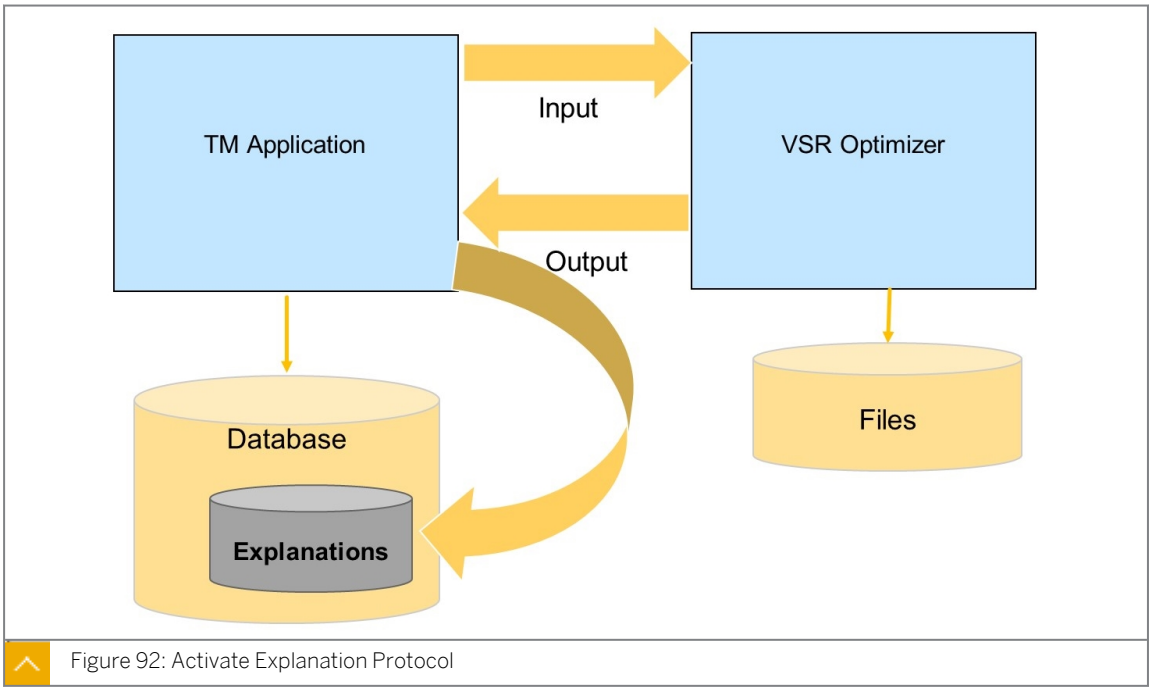

Figure 92: Activate Explanation Protocol

The explanation tool for VSR optimization displays the following information:

- Input for the VSR optimization run
- Results of the VSR optimization run
- Solution overview

Content of the Optimizer Planning Log / Explanation Protocol Input

- Freight units
- Transportation documents
- Freight bookings
- Resources

- Transportation network
- Incompatibilities
- Conditions
- Dimensions
- Parameters

Results

- Freight units
- Transportation documents
- Freight bookings
- Solution details
- Resources

LESSON SUMMARY

You should now be able to:

- Understand VSR optimization
- Execute VSR optimization
- Explain the VSR optimizer result

Unit 6
Lesson 2

Plan via Hubs

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Configure a planning scenario with hubs
- Configure and execute transportation proposals

Pooled Distribution

In the pooled distribution process, the SAP SAP TM system determines whether it is more cost-effective to deliver freight directly to the customer via truckload or using a pool location to consolidate freight.

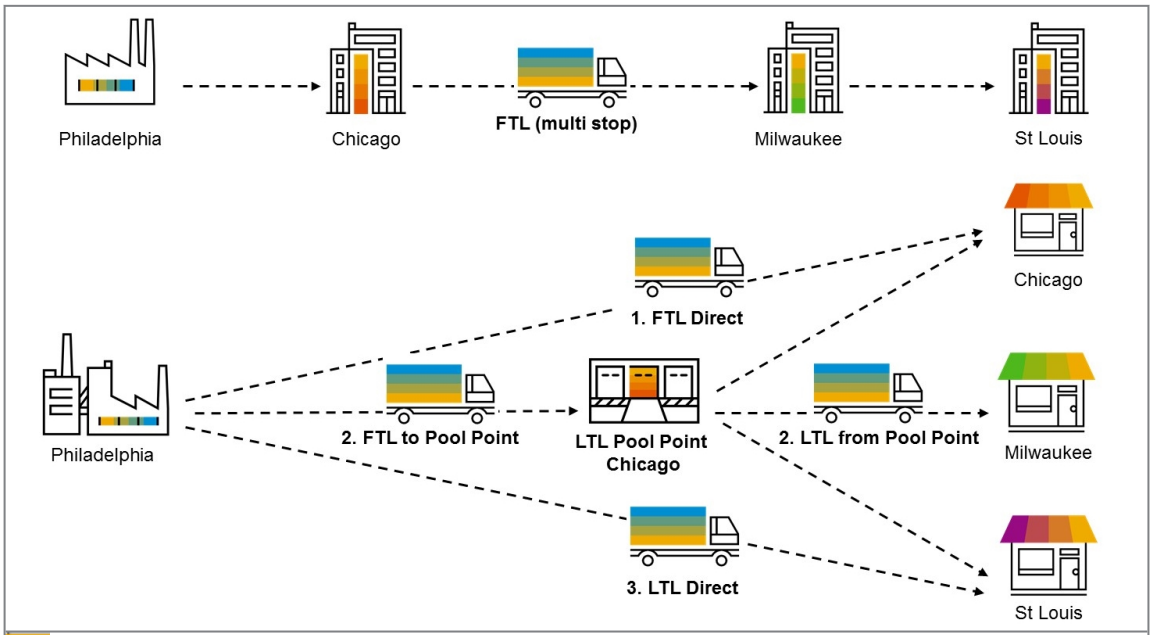

Figure 93: Scenarios

In the pool distribution process, a shipper wants to send goods from a shipping point to customers using pool or hub locations for consolidation.

The following figure lists master-data objects that are required. All the master data concepts are covered in Unit 2. We will revise transshipment locations here as they are important for this concept.

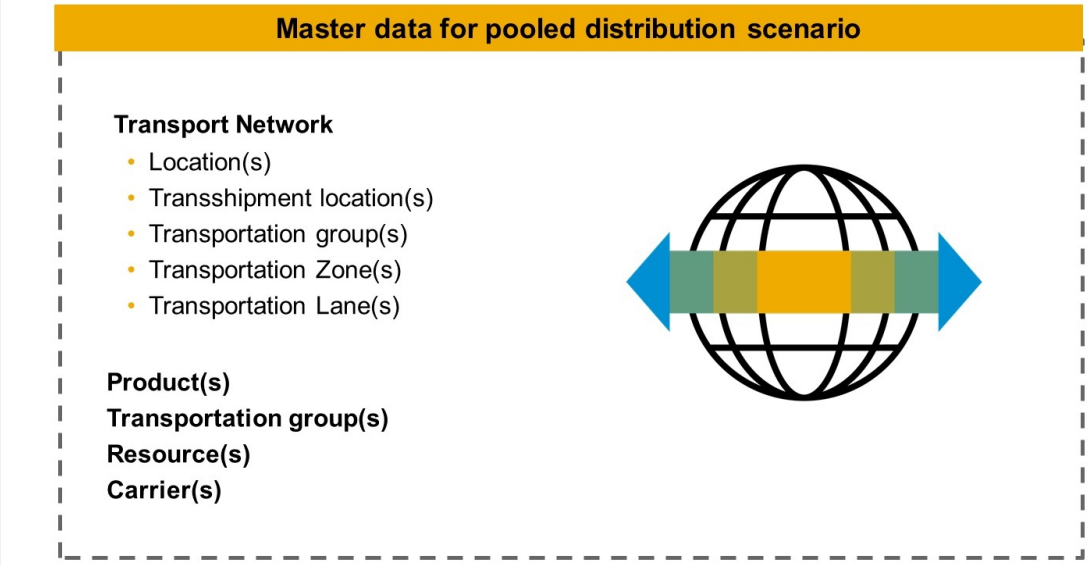

Figure 94: Master Data

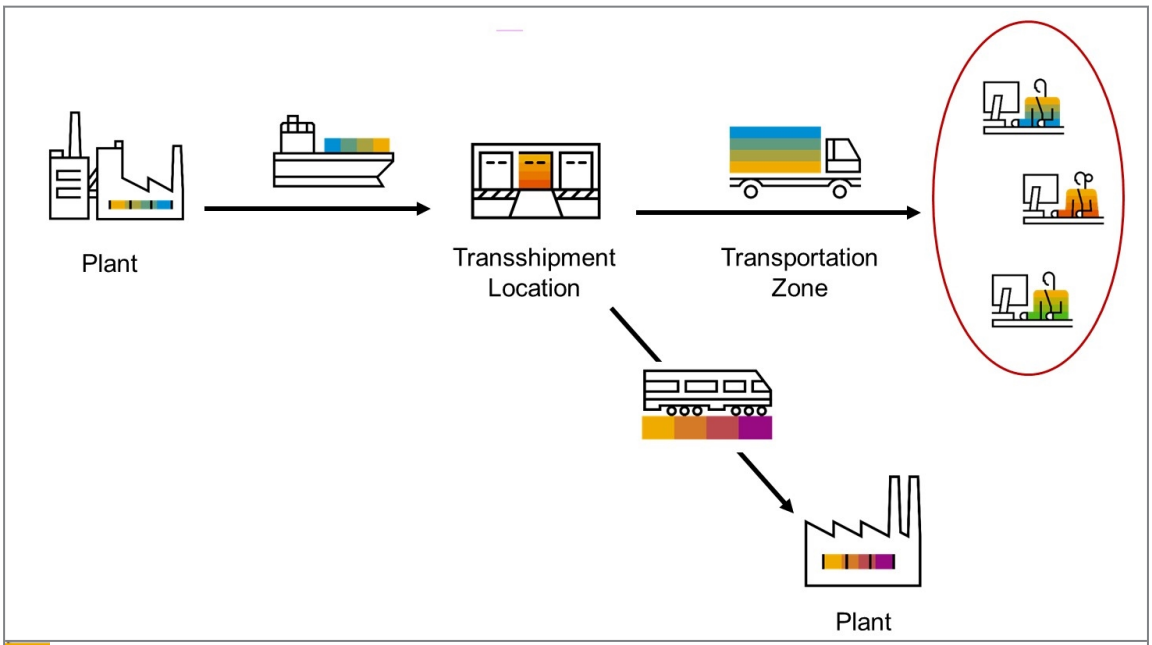

Figure 95: Transshipment Locations

Definition of a Transshipment Location: A transshipment location is defined by assigning a location to either another location or to a transportation zone. When you assign a transshipment location to a transportation zone, it can be used as a transshipment location by all locations that are part of that transportation zone.

A transshipment location is used for unloading goods from one vehicle resource and loading it onto another vehicle resource during the transportation process. Transshipment locations are used when different means of transport or different carriers have to be used in the transportation process. You can also use transshipment locations when consolidating or de-consolidating goods to be transported.

If you define a transshipment location and want to use it in your transportation processes, you must define transportation lanes that take the transshipment location into consideration.

Multi-Stage Transportation

The VSR optimizer evaluates the various possibilities for transporting the selected freight units. It then opts for pooled distribution whenever it is cost-effective to do so. In a standard pooled distribution process, the VSR optimizer creates one freight order to transport the cargo to the transshipment location. It then creates a second freight order to transport the cargo out of the transshipment location.

Other scenarios are also possible. Multiple freight orders allow splitting up of resource assignment, carrier assignment, and other downstream planning and execution activities.

Transportation Proposals

A transportation proposal defines how a freight unit can be transported through a transportation network (which is defined by locations, transshipment locations, transportation zones, transportation lanes, vehicle resources, schedules, and bookings). For a given transportation demand (freight unit), the system determines a set of alternative transportation proposals. The transportation proposal functionality serves the following purposes:

- To help the user identify the different transportation options for a freight unit. In a complex network, in which end-to-end transportation requires several stages, transportation proposals are an easy way to make the different options transparent. Transportation proposals can differ in relation to routing, means of transport, and time required. Each of these variables can increase or reduce costs, and the proposals thus provide the planner responsible with the necessary information to make an appropriate choice.
- To create the stages upfront, for example, to choose the option of ocean transport, because the customer has placed their order well in advance and this is the cheapest choice. In this use case, no freight orders are created based on the proposal result, but only the stage information is stored. This allows the task of planning the different stages to be assigned to different planners and to be completed at different times.

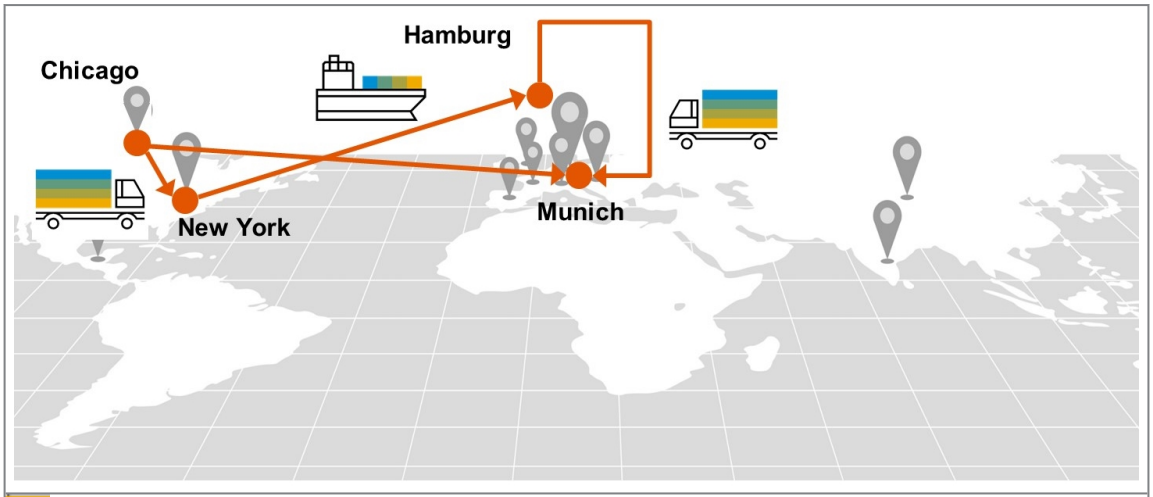

Figure 96: Visualization Of Transportation Proposals

Entry Points for Transportation Proposal Determination

The entry points for transportation proposal determination are as follows:

- *Forwarding Order* → *Stages* → *Actual Route* → *Define Route*

- *Transportation Cockpit → Select Freight Unit(s) → Transportation Proposal*

Layout of the Transportation Proposal Result

The layout of the transportation proposal result screen can be flexibly configured, similar to the transportation cockpit layout. The results can be displayed in a table format or visualized on a map. If the transportation proposal has been carried out for several freight units (because these compete for the same capacity, for example), the solution is always for a valid combination of assignments. In the table-based layout, each stage is shown in a separate line. In complex networks, there could be millions of routing options for a given transport, with only minor differences between them. Depending on the objective of the planner, results can be presented according to defined criteria.

Transportation Proposal: User-Defined Preferences

- Route variation
- Carrier variation
- Departure date variation
- Time relevance
- Cost variance

Preferences can be weighed against each other on the basis of relevance: none, low, medium, or high.

When you use the optimizer to generate a transportation proposal, you can specify whether the system is to accept only the proposed route or the proposed route and associated freight documents. In this field, you have the following options:

- Save Route Only: Only the freight unit stages are saved when the system accepts the route that you have chosen.
- Save Route and Freight Documents: Freight unit stages and freight documents are saved by the system.
- Not Defined: You can specify on a case-by-case basis whether the system is to save only freight unit stages or also the associated freight documents.

Features of the Transportation Proposal

The features of the transportation proposal are as follows:

- Implicit definition of transshipment locations by schedules and freight bookings (simplified definition of transportation network)
- Mode of transport constraints on freight unit and freight unit stage level
- Fast determination of transportation proposals, yielding more alternatives according to predefined variation criteria (for example, route, carrier, and departure date), and trade-off between time and cost (controlled variation according to pre-defined criteria)
- Consideration of preferences for locations, carrier, mode of transport, dates, and times
- Display of multiple solutions on the result map
- Rough planning (detailed planning on the main leg and rough planning for pre leg and subsequent leg, based on rough definition of transportation durations)

LESSON SUMMARY

You should now be able to:

- Configure a planning scenario with hubs
- Configure and execute transportation proposals

Learning Assessment

1. A user parameter needs to be set to activate explanation protocol.

   Determine whether this statement is true or false.

   - ☐ True
   - ☐ False

2. Which of the following items is not a constraint considered by the VSR optimizer?

   Choose the correct answer.

   - ☐ **A** Vehicle capacity
   - ☐ **B** Driver experience
   - ☐ **C** Handling resources
   - ☐ **D** Depot location

3. What information does the explanation tool for VSR optimization display?

   Choose the correct answers.

   - ☐ **A** Input for the VSR optimization run
   - ☐ **B** Solution details
   - ☐ **C** Results of the VSR optimization run
   - ☐ **D** Solution overview

4. A transshipment location allows you to change the means-of-transport.

   Determine whether this statement is true or false.

   - ☐ True
   - ☐ False

5. Which of the following can be expressed as preferences for a transportation proposal?

   Choose the correct answers.

   - [ ] A Route variation
   - [ ] B Departure date variation
   - [ ] C Driver preference
   - [ ] D Incompatibilities

Learning Assessment - Answers

1. A user parameter needs to be set to activate explanation protocol.

   Determine whether this statement is true or false.

   [X] True

   [ ] False

   Correct. A user parameter needs to be set to activate explanation protocol.

2. Which of the following items is not a constraint considered by the VSR optimizer?

   Choose the correct answer.

   [ ] **A** Vehicle capacity

   [X] **B** Driver experience

   [ ] **C** Handling resources

   [ ] **D** Depot location

   Correct. Driver experience is not a constraint considered by the VSR optimizer.

3. What information does the explanation tool for VSR optimization display?

   Choose the correct answers.

   [X] **A** Input for the VSR optimization run

   [ ] **B** Solution details

   [X] **C** Results of the VSR optimization run

   [X] **D** Solution overview

   Correct. The explanation tool for VSR optimization displays the input for the VSR optimization run, results of the VSR optimization run, and the solution overview.

4. A transshipment location allows you to change the means-of-transport.

   Determine whether this statement is true or false.

   [X] True

   [ ] False

   Correct. A transshipment location allows you to change the means-of-transport.

5. Which of the following can be expressed as preferences for a transportation proposal?

   Choose the correct answers.

   [X] A Route variation

   [X] B Departure date variation

   [ ] C Driver preference

   [ ] D Incompatibilities

   Correct. Route variation and departure date variation can be expressed as preferences for a transportation proposal.

UNIT 7 Subcontracting, Load Planning, and Short-Cut-Process

UNIT OBJECTIVES

- Define transportation allocations and business shares
- Subcontract freight orders
- Configure the load planning process
- Understand, configure, and execute the short-cut process

Carrier Selection

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Define transportation allocations and business shares
- Subcontract freight orders

Carrier Selection

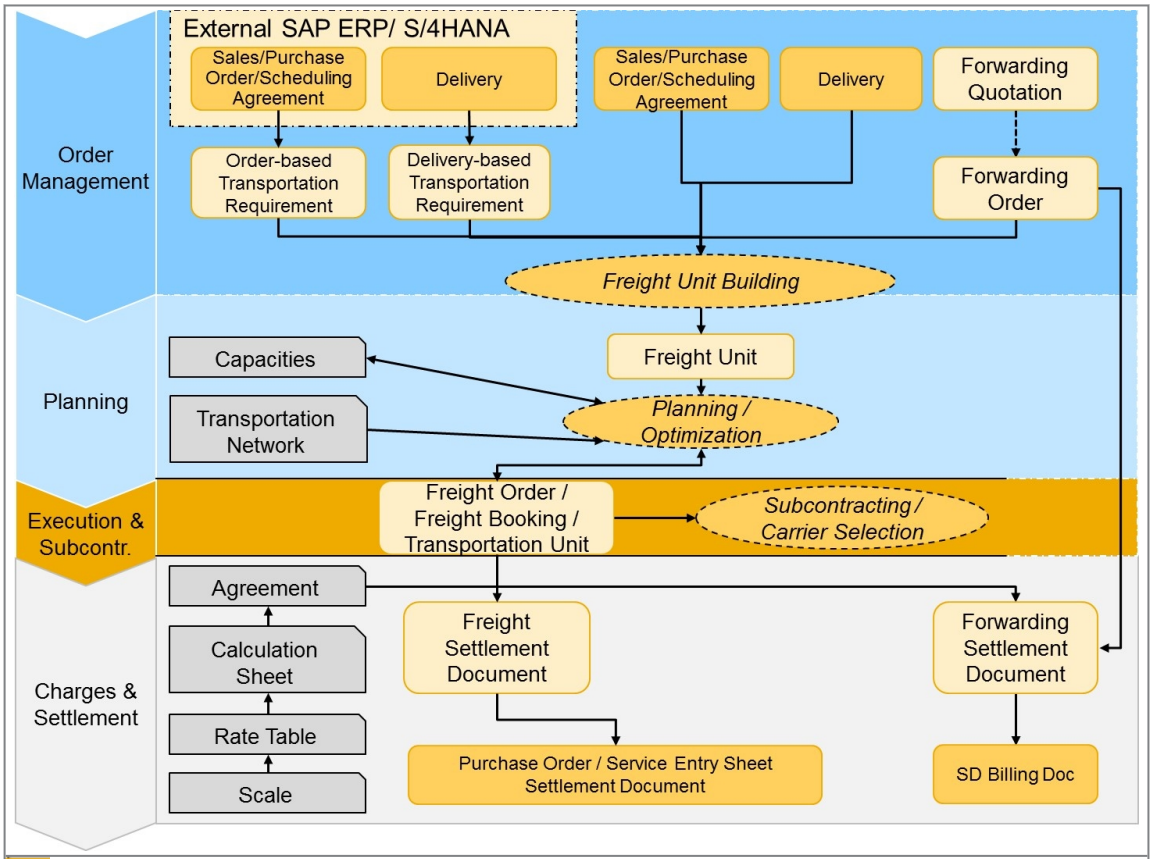

Figure 97: Overview Document Flow

Once a freight order has been built, a shipper needs to choose (and communicate with) the business partner responsible for moving the product. We will refer to this as carrier selection.

The carrier is the business partner that you subcontract the freight order to. The carrier can be different from the executing carrier, which is another business partner role that you can assign to your freight order, if the carrier itself subcontracts the execution of the freight order to a third party. That way, you have the option to differentiate between the party you contracted with and the party actually executing the freight move.

Carrier Selection

Carrier selection is used to assign a suitable carrier to your sub-contractable business documents (for example, freight orders), either manually or automatically. Carrier selection can be done for freight bookings and also via report /SCMTMS/PLN_OPT. The aim is to find a carrier with the lowest costs under consideration of the defined constraints.

In manual carrier selection, you manually assign the required carrier to your business documents. If you have configured a check against transportation allocations, the system takes this into account and checks transportation capacities (transportation allocations) that you have defined for the individual carriers. If, during the allocation, the system finds relevant transportation allocations without capacity or that certain rules are violated by the allocation, warning messages appear. When you want to take business shares into account for carrier selection that you have to define this in the transportation lane and carrier selection settings.

A separate optimization is available for automatic carrier selection. It takes selected optimization options into account when determining the most cost-effective carrier for all business documents that you have selected. If none of the carriers are available, the system does not assign any carrier to the relevant business documents.

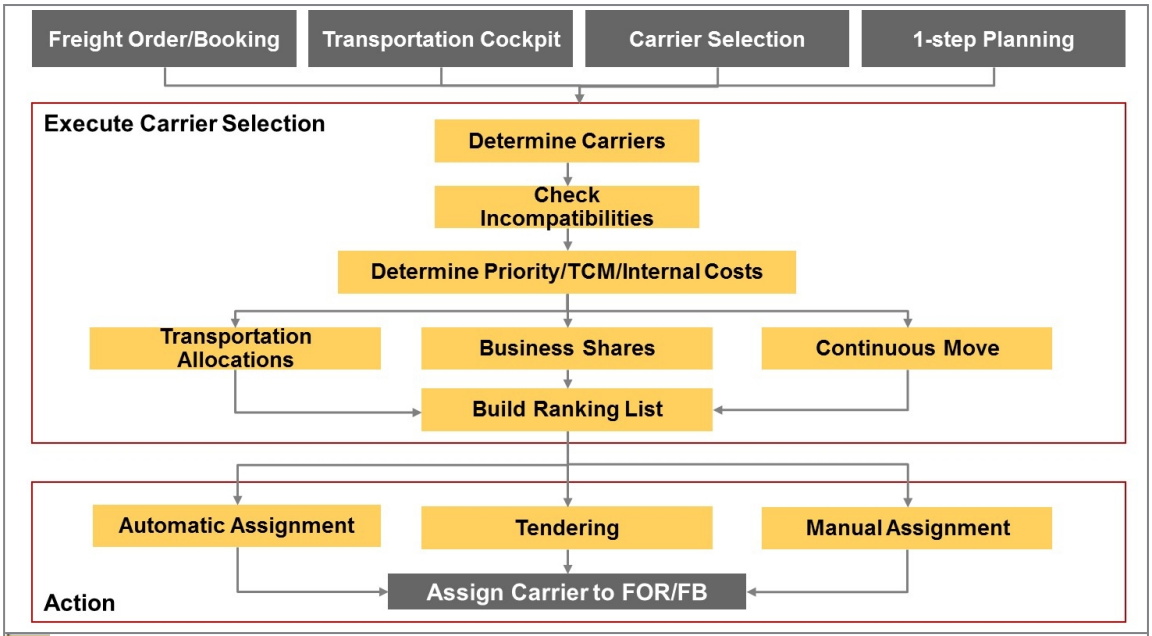

Figure 98: Carrier Selection Process Flow

Status Management in Subcontracting

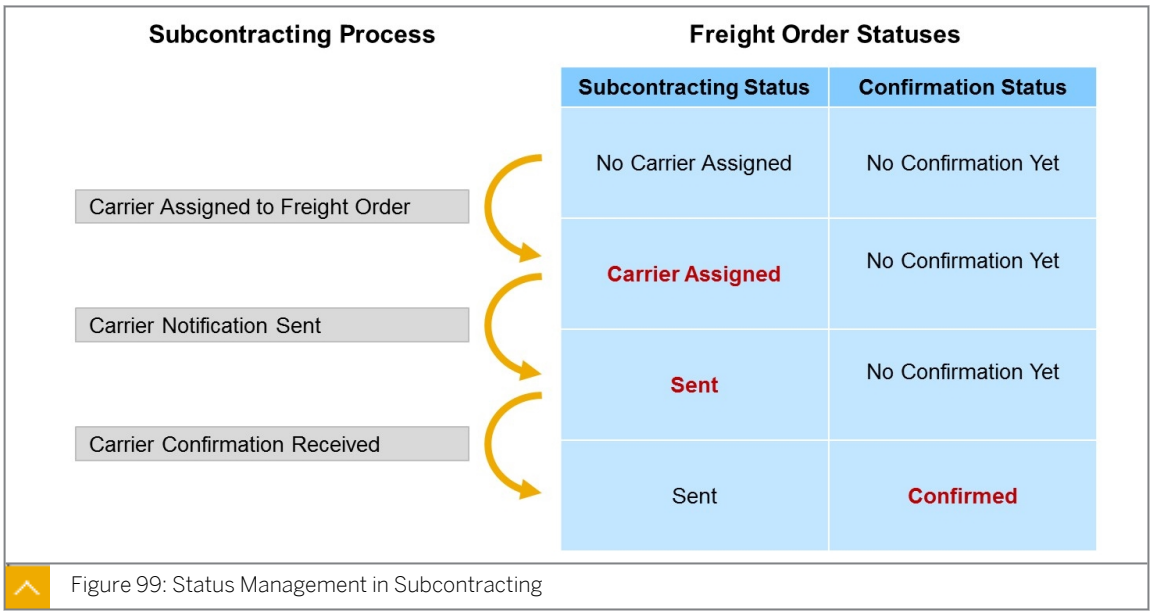

Figure 99: Status Management in Subcontracting

The figure shows which statuses change during the subcontracting process.

Strategy Options

During planning in SAP TM, strategies are defined which are optimization options for carrier selection. The system takes these strategies into account during the automatic carrier selection process.

You define strategies either in the transportation lane or in carrier selection settings. Initially, the system considers the appropriate transportation lane for each freight order. This allows it to consider different settings in one run. Taking strategies and settings into consideration, the optimizer then creates a carrier ranking list containing the different carrier options. The strategy options supported are as follows:

- Cost and Priority
- Business Share
- Transportation Allocation
- Continuous Move

Costs and Priorities in Carrier Selection

In carrying out carrier selection, the system can put more weight on priorities or costs. Penalty costs can influence business shares and continuous moves.

In terms of priority, the system can determine the most favorable carrier based on the priorities you have defined. In effect, this means that the system chooses the carrier with the highest priority, while taking into account the various restrictions that may be in place.

Alternatively, the system can determine the carrier on the basis of lowest total cost. Costs in this case can refer to internal costs or to charges calculated in charge management. carrier reliability can be taken into account e.g. by using the BCV to review the reliability manually in a manual process or by using the “cost+priority” selection and model as bonus in automatic process.

Note:
When we speak of internal costs here, we are not speaking of real-world costs. Internal costs are used for weighting only, as part of the carrier selection process.

Transportation Allocations

Transportation allocations allow companies to assign defined quantities of capacity to certain business partners. This includes set minimum or maximum capacity restrictions that regulate how much business is allowed with a certain carrier in a certain region for a certain means of transport. A separate business object is used to model these allocations.

Often, firm relationships exist with carriers in the form of contracts. These contracts can guarantee that an amount of business is allocated to a carrier, which if not met, results in penalties. SAP TM has the tools to track these relationships or, alternatively, divide up business between different carriers.

An allocation represents the planned capacities for a carrier and a trade lane during a validity period. The capacities can be defined for multiple dimensions, such as volume, weight, and 20-foot equivalent units, as well as a sequence of time periods of the same granularity, which are frequently called (time) buckets. For each dimension and time period, the allocation captures the already-consumed portion of the maintained capacity. All freight documents matching the carrier, trade lane, and validity period consume the corresponding buckets of the allocation. As soon as a freight document is created, the matching allocations are determined asynchronously and updated according to the freight document's capacity. The consumed quantities are visible in the allocations and allow tracking of the capacities and their utilizations.

The following are examples of transport allocations:

- A carrier commits to at least 25 shipments or truckloads from Nashville each day. However, for business reasons, the availability changes each day.
- A carrier normally provides two trucks per day from Dayton, Ohio. For business reasons, the carrier is able to offer, on Tuesday and Friday only, five trucks to the shipper.
- A carrier can include additional capacity to the existing number of shipments by truck. For example, a carrier could add five additional trucks during the week between Tuesday and Thursday.

Carrier capacity can be defined for any geographical level in arbitrary dimension. When defining the allocation, the trade lane can be specified as follows:

- Along: Both source location/zone and destination location/zone can be specified
- From: Source location/zone only
- Within: Using zone hierarchy
- To: Destination location/zone only
- Inbound: Destination zone is specified
- Outbound: Source zone is specified

Extended carrier selection optimizer interface

- During carrier selection either using optimizer or manual planning, the allocation can be checked
- During tendering, the allocation can be checked

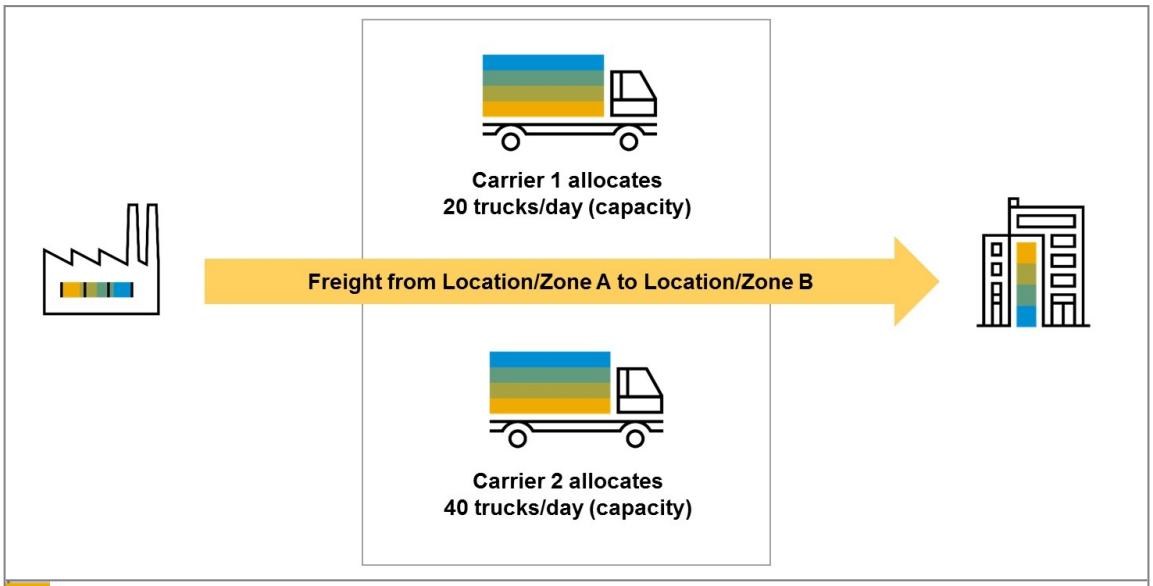

Figure 100: Transportation Allocation

Creation of Transportation Allocations:

When you create a transportation allocation, you define the following:

Creation options: You can specify, for example, whether a transportation allocation is to refer to a transportation lane and whether time buckets may be overwritten.

Scope of transportation allocation: Here you enter, for example, the planning period (yearly, weekly, and so on). You are free to choose the start of the planning period. For example, you can define a bucket from Monday 14:00 until Tuesday 14:00.

Buckets: Here you can define, for example, a sub-bucket distribution. If a carrier can only deliver, for example, in the morning, you can define two sub-buckets (Morning and Afternoon) for the bucket Daily. As the percentage of the assigned business documents (for example, freight orders), you define 100% for Morning and 0% for Afternoon. In addition, you can specify the minimum and maximum product allocation quantity.

SAP Transportation Management distinguishes between the following three transportation allocation types:

- Air freight agreement allocation

  Stores information about transportation allocations of carriers that act as constraints for air freight agreements. You can create air freight agreement allocations directly from an air freight agreement.

- Carrier selection allocation

  Stores information about transportation allocations of carriers in a specific trade lane. The system uses carrier selection allocations when optimizing the carrier selection.

- Flight schedule-based allocation

Stores information about transportation allocations of carriers at schedule departure level in a master flight schedule. You can create flight schedule-based allocations directly from a master flight schedule.

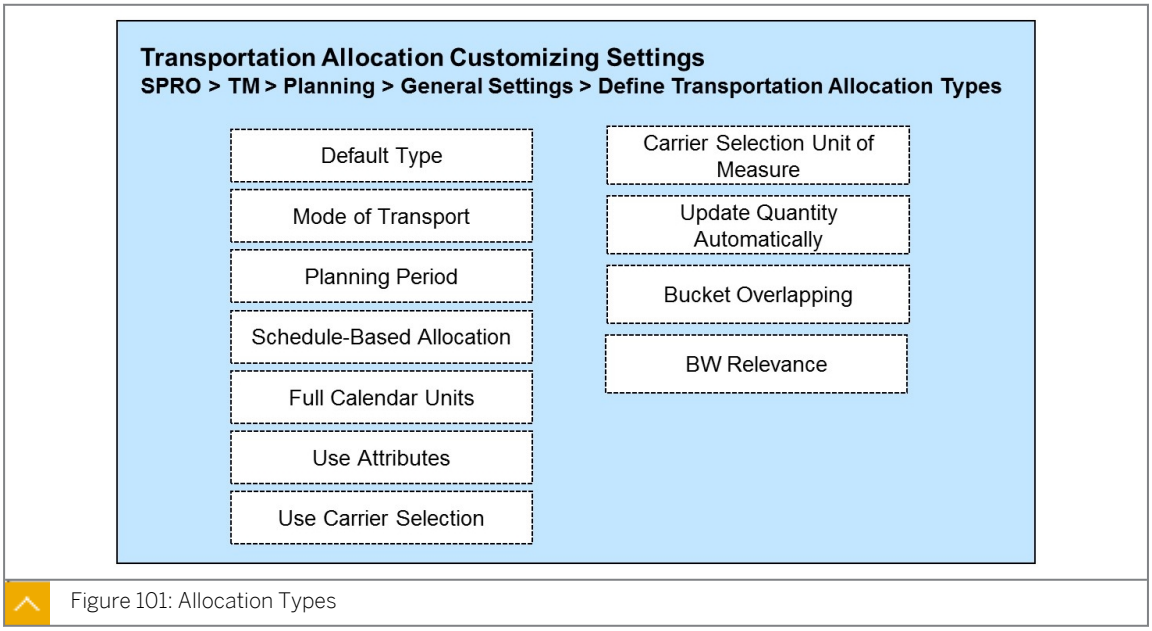

Figure 101: Allocation Types

In Customizing, you can follow the menu path *Transportation Management → Planning → General Settings → Define Transportation Allocation Types* and define allocation types by specifying the following parameters:

- Default Type: If you created an allocation from scratch and did not choose an allocation type, the default allocation type is chosen; it's set by this parameter.
- Mode of Transport: You can define the mode of transport or omit this field.
- Planning Period: You can choose among daily, weekly, monthly, quarterly, yearly, and schedule departure. Whereas the first considers all freight documents in the specified time period, the last option refers to departures of an underlying schedule. This means that all freight documents created for that departure are covered by the bucket.
- Schedule-Based Allocation: This specifies that the allocation depends on a schedule – that is, you can create the allocation only out of a schedule.
- Full Calendar Units:You can define whether the bucket fully covers a calendar unit or if it can start at any time but has a duration according to the planning period. If you use a daily planning period and do not use full calendar units, you can have a planning period from Monday at 8:00 until Tuesday at 8:00. If you use a monthly planning period and full calendar units, the bucket starts at 0:00 on the first day of the month and lasts until 0:00 on the first day of the next month.
- Use Attributes: This allows you to create multiple buckets for the same period of time. The buckets consider different attribute combinations based on shipping type, contract basis, or handling code. Using handling codes for the upper deck and lower deck of an airplane, you can define two buckets with individual capacities, one for the upper deck and one for the lower deck.
- Use Carrier Selection: This defines whether allocations of this type are considered by carrier selection.

- Carrier Selection Unit of Measure: If carrier selection is activated, you can specify the allocation's unit of measure that is considered for carrier selection. You may define allocations with volume, weight, and TEU quantities and choose carrier selection considering the TEU capacities.
- Update Quantity Automatically: This defines whether a newly created allocation or bucket gets an automatic update of its consumed quantities.
- Bucket Overlapping: A freight document may cover multiple buckets of the allocation. Using this parameter, you can define whether all covered buckets get consumed by the freight document or only the first covered bucket gets consumed. This parameter should not be changed if allocations already exist in your productive system because the buckets will contain data according to both consumption modes, which makes the quantities hard to interpret.
- BW Relevance: This specifies whether the allocation type is relevant for analytics based on SAP Business Warehouse (SAP BW).

Business Shares

Selecting Carriers Based on Business Share

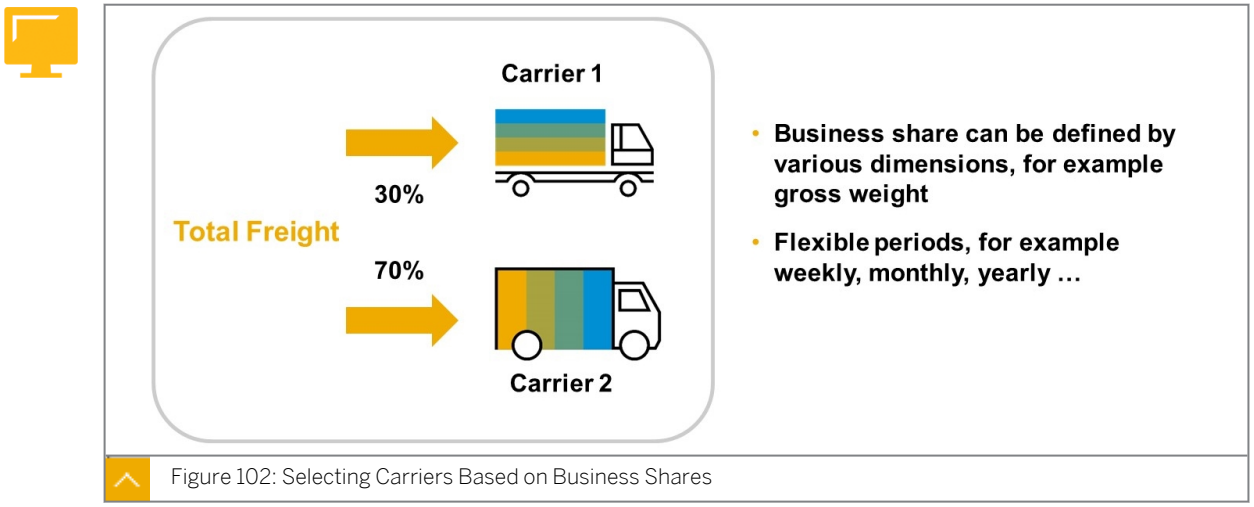

Figure 102: Selecting Carriers Based on Business Shares

The objectives of business shares are as follows:

- Assign defined percentages to certain business partners
- Support negotiation of freight agreements
- Avoid dependency on a single vendor
- Consider the capacity of a carrier for a certain relation/route/geography

Like transportation allocations, business shares make use of trade lanes. With SAP TM, you can define such target shares per carrier as a business share for a trade lane and means of transport or mode of transport on a daily, weekly, monthly,quarterly, or yearly basis.

Business Share (Example)

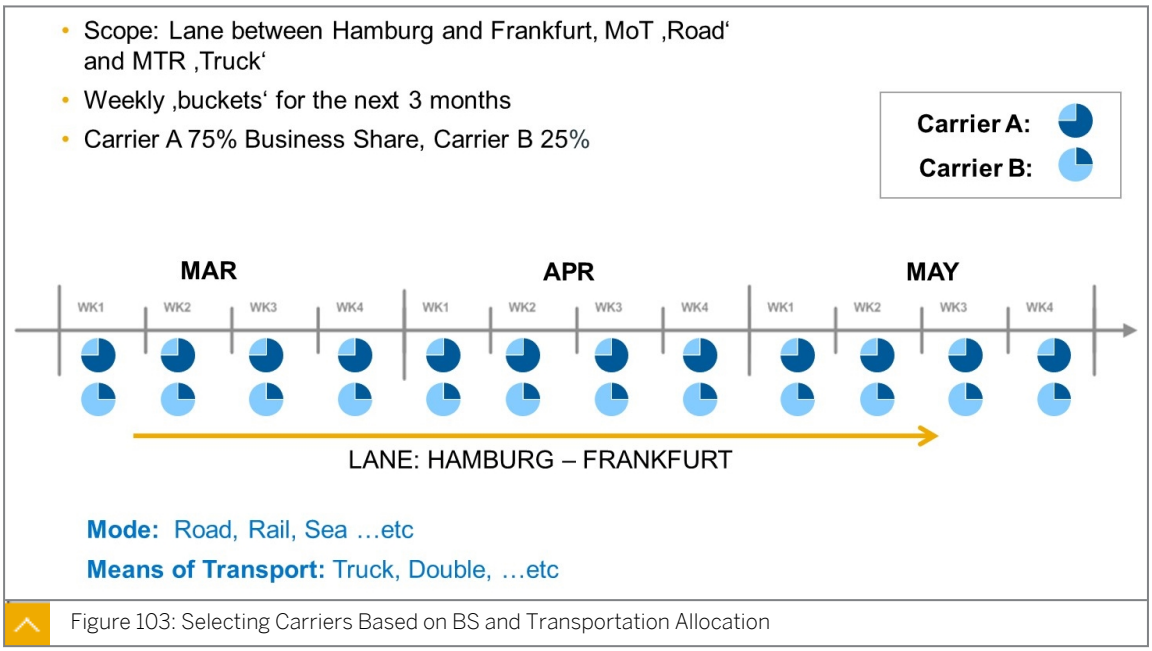

Figure 103: Selecting Carriers Based on BS and Transportation Allocation

When defining the business share context, you create the business share buckets. The percentage of business share a carrier can have for these individual buckets is the actual business share a carrier is allowed to have. There are different types of bucket available during business share creation. They are yearly, quarterly, monthly, weekly, and daily.

Example One

Carrier A can have a weekly bucket of 75% of the business share on the lane between Hamburg and Frankfurt between the validity periods March 1 2015 to 31 May 2015. In the same context, Carrier B can have a weekly bucket of 25% defined.

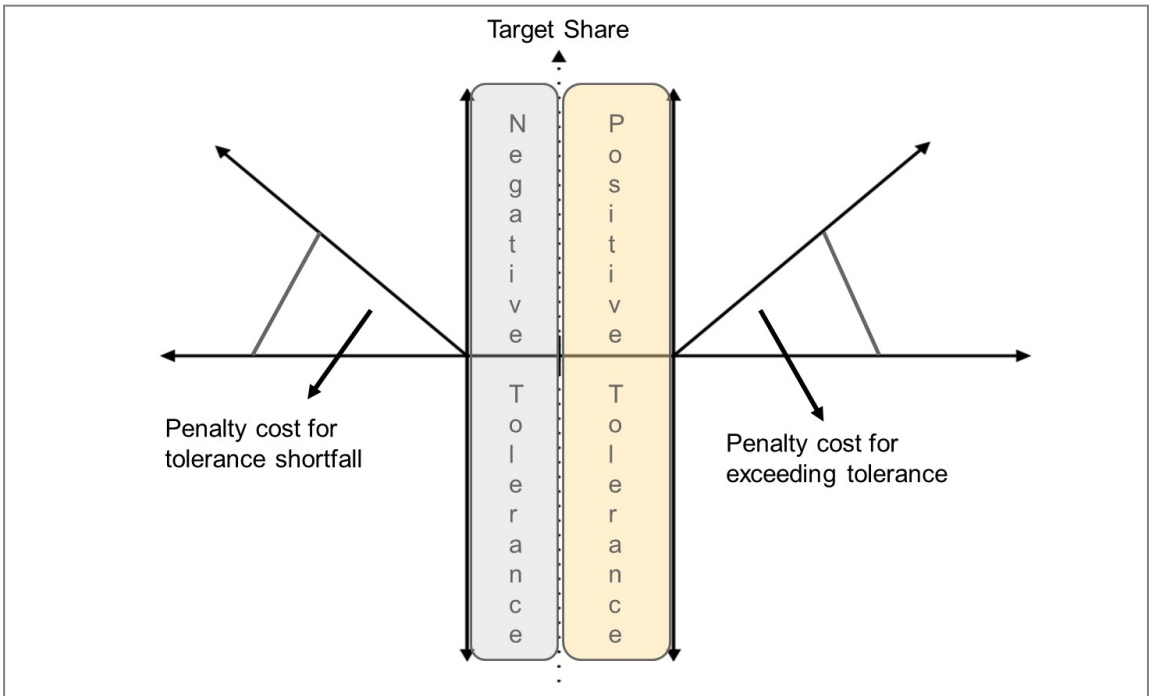

Figure 104: Business Share Tolerances and Penalty Costs

Tolerances and penalty costs can be defined for business shares. As long as business shares are within the tolerance limits, the cost calculations during carrier ranking are not affected. Tolerances are always defined in percentages (%). If the total business share of the carrier exceeds the defined tolerances, either shortfall or over, a penalty applies.

The shortage penalty costs are added to all carriers, other than the one selected. The excess penalty costs are added to the carrier under consideration. Penalties are maintained as numeric values in the business share. This number is multiplied by the deviation percentage to arrive at the penalty cost.

It only makes sense to use business shares if you have defined penalty costs. It is recommended to also always define tolerances to give the optimizer a certain amount of leeway.

Example Two

There is a penalty of 1000 defined in the business share. An excess tolerance of 10% is also defined. During business share calculation, if the excess is 12%, the excess liable for penalty is 2%. This 2 is multiplied by 1000 to arrive at the total excess penalty costs of 2000.

Note:
When calculating the total costs for a carrier, if you are working with TCM costs, there will be a currency assigned to the costs. To assign a currency to business share penalty costs, go to *Carrier Selection Settings* → *Advanced Settings* → *Common Currency*.

For example, if you are working with carriers from multiple geographic locations with multiple currencies to arrive at the correct ranking, the system uses the common currency (maintained in the *Carrier Selection Settings*) for all its calculations. The currency displayed in the carrier ranking list is always the local currency of the carrier (maintained in the freight agreement).

All FORs in the business share context are selected for the business share penalty calculations, though these FORs are not selected during the planning run.

For example, assume in a business share context there are two carriers, A and B. There are no tolerances defined. Carrier A is awarded a 60% business share and Carrier B a 40% business share. There are already 10 freight orders awarded, of which Carrier A is assigned six and Carrier B is assigned four.

Now let us perform carrier selection for the eleventh FOR. If Carrier B is assigned this FOR, Carrier A will have a shortfall of business share, and the penalty cost for the shortfall will be charged to Carrier B, on top of the usual costs determined during carrier selection.

If Carrier A is assigned the eleventh FOR, Carrier B will have a shortfall of business share, and the penalty cost will be charged to carrier A, on top of the usual costs determined during carrier selection. Both options are evaluated by the system and the ranking is done accordingly.

Carrier Selection Settings

The objective of carrier selection is to provide a ranking list of carriers that are available to execute a planned freight order. You can perform carrier selection manually, by using an optimization algorithm, or by using an auctioning mechanism as part of the tendering process.

The primary objective of carrier selection is to assign a reliable and cost-efficient carrier to a freight order. This can be done in the background, interactively using manual steps, or by using an automated optimization procedure.

Carrier selection can be started directly from the freight order user interface (UI) or from any work list that displays freight orders. It can also be started for freight orders inside the transportation cockpit.

Carrier selection can be executed as part of a planning strategy (for example, by including method VSR_TSPS as in planning strategy VSR_1STEP, which is delivered as a standard planning strategy that combines vehicle scheduling and routing (VSR) optimization and carrier selection.

In the background, the carrier selection process can be initiated in the following ways:

- As part of the transportation planning process with background report /SCMTMS/PLN_OPT and using a planning strategy that includes carrier selection (for example, VSR_1STEP)
- By scheduling report /SCMTMS/TSPS_OPT_BGD
- By assigning strategy Carr_Sel as a creation strategy in the freight order type Customizing

The carrier selection process is predominantly used in land transportation. However, the carrier selection process can also be triggered for freight bookings using the background report or from the freight booking UI. In contrast to carrier selection for freight orders, carrier selection for freight bookings will only consider transportation allocations – no business shares or continuous moves.

The input data for carrier selection is one or more freight orders (selected interactively in a work-list) or a selection profile by which the freight orders that need to have a carrier assigned are determined. In addition, carrier selection settings are required to specify exactly how carrier selection should be carried out. These settings control the carrier selection process and determine which constraints are used and how. Therefore, configuring carrier selection settings for automatic carrier selection is mandatory.

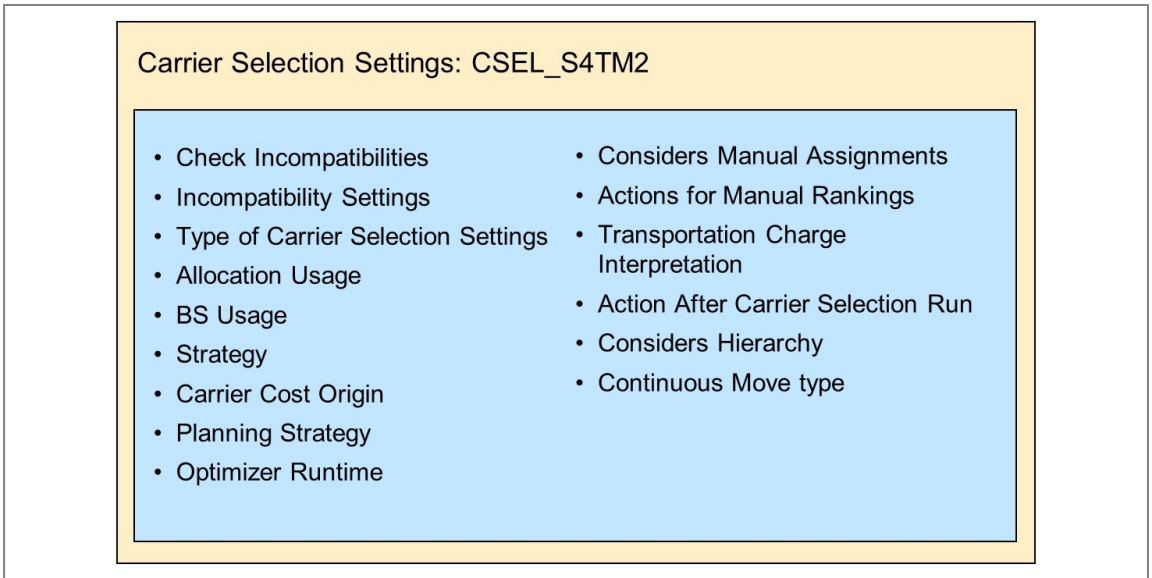

Figure 105: Carrier Selection Settings

The following fields are the most important to influence the carrier selection process:

- Check Incompatibilities: Incompatibilities are checked only if this checkbox has been selected.
- Incompatibility Settings: If the *Check Incompatibilities* checkbox is selected, incompatibility settings define which incompatibility definitions need to be adhered to.
- Type of Carrier Selection Settings: This parameter defines the purpose of carrier selection. Available options are General Carrier Selection, Carrier Selection for Tendering, and Carrier Selection for Direct Shipment.
- Allocation Usage: This parameter determines the consideration of transportation allocations. Available options are to use transportation allocations, not to use them, or to decide on the transportation lane level.
- BS Usage: This business share usage parameter determines the consideration of business shares. Available options are to use business shares, not to use them, or to decide on the transportation lane level.
- Strategy: The strategy determines how the objective of carrier selection is calculated in optimization. The objective can be based on cost, priority, the sum of cost plus priority, or the product of cost times priority. In addition, the *Use Transportation Lane Settings* option can delegate this decision by geography to the individual transportation lanes, so that in different geographical areas, different objectives can be pursued (for example, priority in one transportation lane and costs in another transportation lane).
- Carrier Cost Origin: Carrier cost origin defines how costs are calculated. Transportation charges from Transportation Charge Management or internal costs can be used. The No Cost Determination strategy may be used if carrier selection for tendering searches for the available carriers in a broadcast tendering process. Like the settings for strategy with the *Use Transportation Lane Settings*, you can delegate this decision by geography to the individual transportation lanes.
- Planning Strategy: The default planning strategy for carrier selection is TSPS_DEF.
- Optimizer Runtime: This parameter specifies the maximum runtime for the optimizer (in seconds).
- Consider Manual Assignments as Fixed: Dealing with manual assignments in automatic carrier selection is an important topic because there is likely a reason for manual assignments, and they should not simply be overridden. Therefore, manual assignments can be considered as fixed when this checkbox is selected.
- Action for Manual Rankings: A similar question is how to deal with manual rankings. Available options for manual rankings are to keep them, remove them, or keep the carrier only when it is considered available.
- Transportation Charge Interpretation: If, for any reason, the transportation charges for a carrier for a freight order are evaluated as zero, this parameter determines how to deal with it. Available options are to either ignore the carrier availability for this freight order or accept the carrier for this freight order as either the cheapest available carrier or the most expensive one.
- Action after Carrier Selection Run: Available actions after the carrier selection run are the automatic assignment of the highest ranking carrier to the freight order or doing nothing (that is, leaving this decision to a manual process/user, based on the created carrier ranking).

- Consider Hierarchy: This parameter chooses the available carriers. Options include considering only those carriers defined on the most specific transportation lane or considering all transportation lanes to retrieve available carriers.
- Continuous Move Type: With this parameter, you decide whether only simple continuous moves are allowed, only round-trips are allowed, continuous moves are not considered at all, or this decision is made on the transportation lane level.

LESSON SUMMARY

You should now be able to:

- Define transportation allocations and business shares
- Subcontract freight orders

Unit 7
Lesson 2

Load Planning

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Configure the load planning process

Load Planning

During truck planning, rules are applied to fulfill legal restrictions. For example, certain axle loads may not be exceeded. In addition, a certain loading sequence of the goods to be transported optimizes the transportation plan. Load planning concerns the loading of goods to be transported in an optimized manner into a transportation unit, be it be a truck, trailer, or container resource.

You can plan the loading space of box trucks, trailers, semi-trailers, and containers in the transportation cockpit or directly in one of the following business documents:

- Road freight order
- Trailer unit
- Container unit

Planning is carried out at the level of business document items. Load planning returns an approximate calculation of how the available loading space can be optimally used, taking into account the maximum axle loads and the maximum weight of a vehicle resource. The calculation is based on the master data that you enter for the resource.

In automatic load planning, also known as load optimization, the load optimizer creates a load plan for your business document. It considers capacity restrictions in terms of the height, width, weight, and length of the loading space. For vehicle resources with two axle groups, it also considers the maximum axle load.

Vehicle Capacity Attributes

- VSR:
  - One-dimensional, for example, volume or mass: Up to eight dimensions.
- VSO:
  - Three-dimensional, for example, pallet or box size: Visual representation.
- Vehicle capacity is maintained in vehicle resource master data.

In vehicle scheduling and routing (VSR) planning, SAP TM considers the resource capacities of weight and volume. However, the new load planning function requires much more information on master data level. Not only are weight and volume limitations considered more precisely, but weight distribution of axles is also planned. This is required to fulfill legal restrictions when creating a load plan.

Within the resource master data, on the *Physical Properties* tab, there are additional capacity and resource configuration fields to maintain. You can specify attributes regarding dimension, weight, and type of resource. One specific attribute is the definition of axle groups.

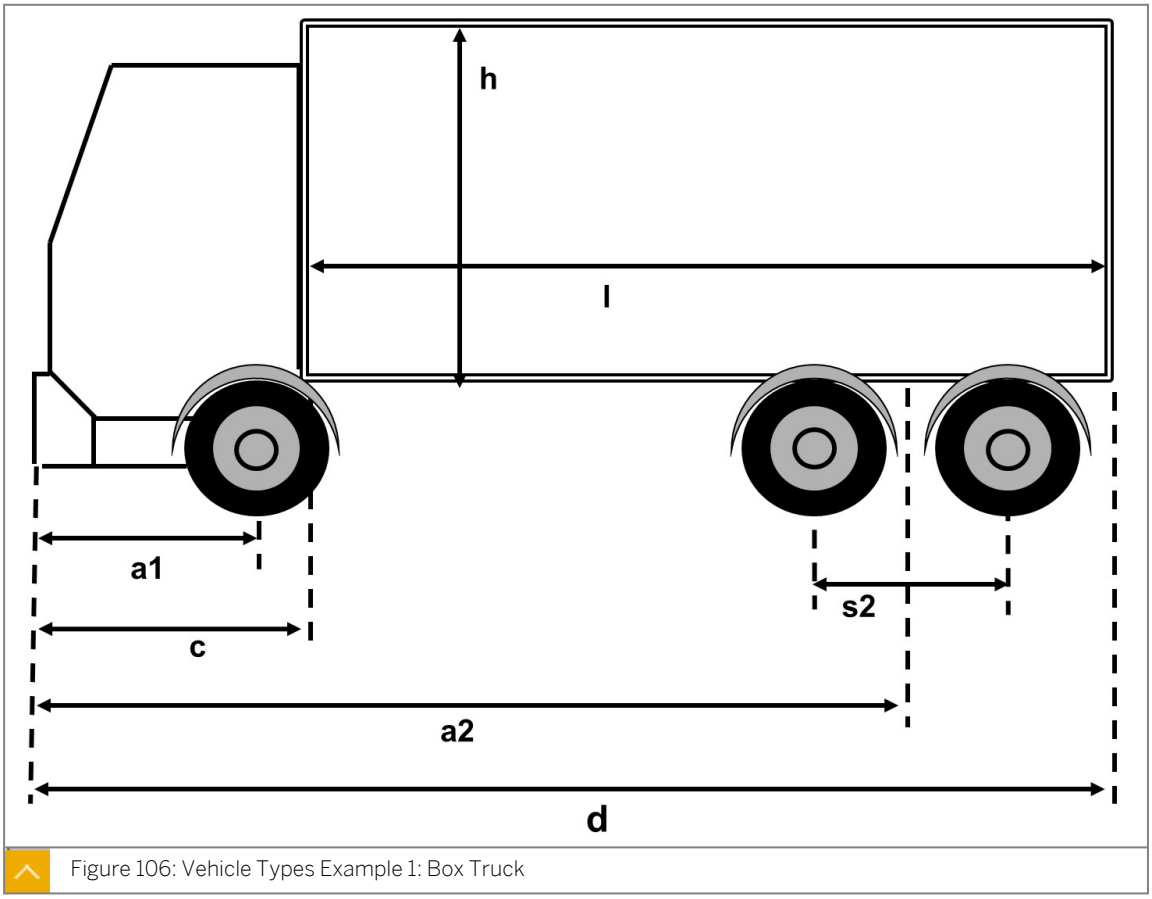

Figure 106: Vehicle Types Example 1: Box Truck

The table, Box Truck, provides a detailed explanation of the elements of the figure, Vehicle Types Example 1: Box Truck.

Table 1: Box Truck

Measurement in Figure	Name in the Master Data	Description
a1	Axle Group Distance 1	Distance between axle group 1 and the front of the box truck
c	Cargo body distance	Distance between the start of the loading space and the front of the box truck
a2	Axle Group Distance 2	Distance between axle group 2 and the front of the box truck
d	Connector Distance	Distance between the trailer coupling of the box truck and the front of the vehicle
s2	Distance Between Axles	Distance within axle group 2
h	Interior Height	Height of the loading space

Measurement in Figure	Name in the Master Data	Description
l	Interior Length	Length of the loading space

Vehicle Types Example 2: Semi-Trailer

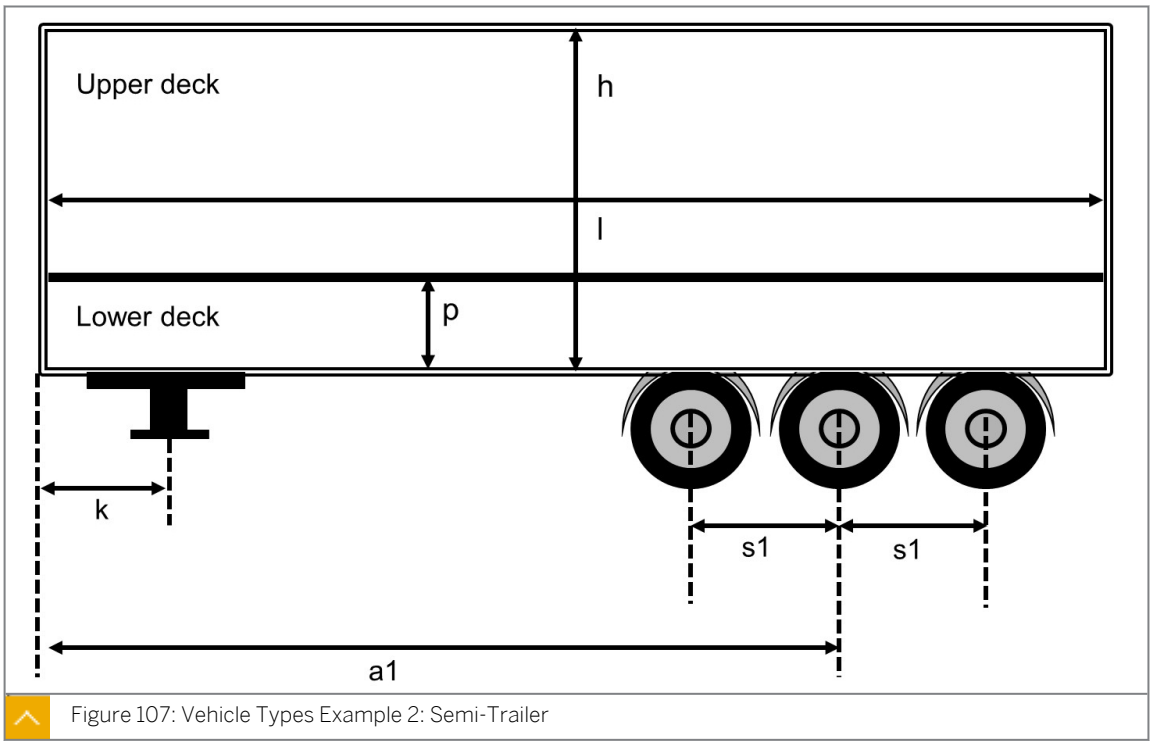

Figure 107: Vehicle Types Example 2: Semi-Trailer

The table, Semi-Trailer, provides a detailed explanation of the elements of the figure, Vehicle Types Example 2: Semi-Trailer.

Table 2: Semi-Trailer

Measurement in Figure	Name in the Master Data	Description
a1	Axle Group Distance 1	Distance between axle group 1 and the front of the trailer
s1	Distance Between Axles	Distance within axle group 1
k	King Pin Distance	Distance between the king pin and the front of the trailer
h	Interior Height	Height of the loading space
l	Interior Length	Length of the loading space
p	Split Deck Position	Position in the trailer at which you have added the split deck

Freight Unit Dimensions

Dimensions of individual packages are determined from the business document items; that is, freight unit items are the basis for load planning and load optimization in the transportation cockpit. The following are relevant dimensions:

- Length
- Height
- Width
- Gross Weight

Load Plan Settings

Load planning settings define a process controller strategy. This strategy defines a sequence of methods to be executed for the load planning and enables a flexible combination of standard and custom logic. With the strategy, it is possible to define a set of rules to be applied when optimizing the load. The rules can be given a priority, deactivated to test the planning with a different rule set, and adjusted with certain attributes.

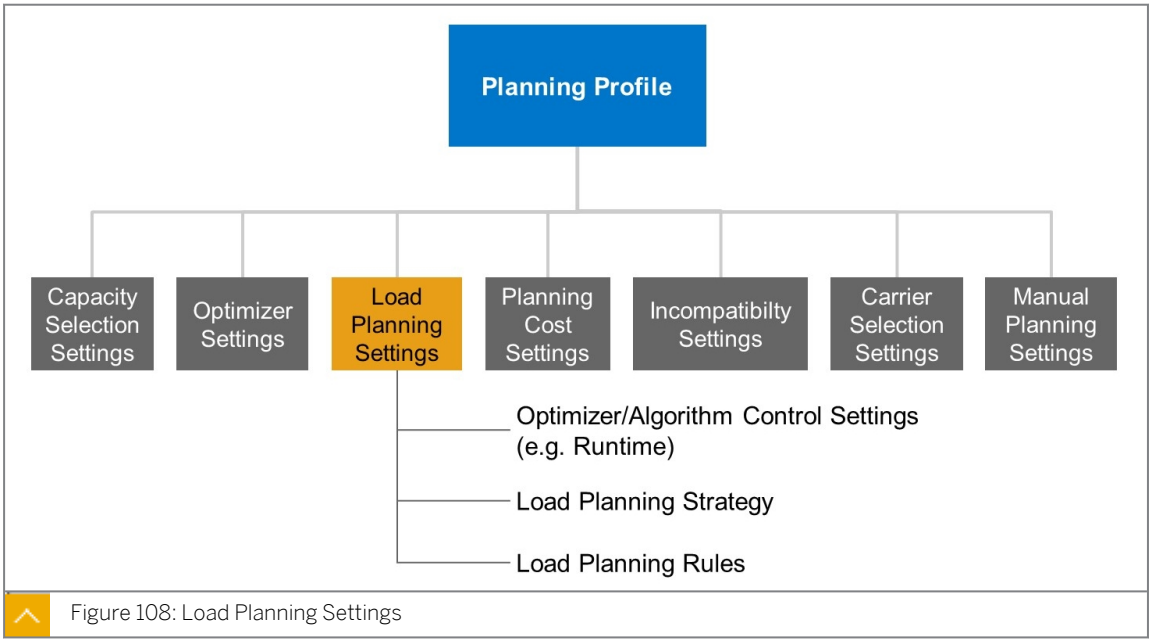

Figure 108: Load Planning Settings

Load Planning Settings Definition

- Load planning strategy
- Load optimization runtime
- Load planning rules (including their priorities and parameters)

Load planning settings are assigned in the planning profile. By assigning a planning profile in the freight order type, different load planning settings can be used for different freight order types.

Load Planning Rules

In automatic load planning, you can define rules to be considered by the system during a load optimization run. You can choose between the following types of rules:

- Rules that apply to automatic planning for all resource types
- Rules that apply only to the automatic load planning of box trucks
- Rules that apply only to the automatic planning of trailers and semi-trailers

- Rules that apply only to the automatic load planning of the upper decks of double-deck trailers

You can define different rules for the lower and upper deck of double-deck trailers.

The combination of stack, row, and line indicates the exact position of each package loaded onto the resource. Packages loaded on top of each other form a stack. Packages loaded next to each other from left to right form a row. The first row of a deck is always placed towards the start of the loading space. Packages loaded one behind the other from front to back form a line. The first line of a deck is always on the left side of the deck in the direction of travel.

Rules for Load Planning

- Stack height ascending in driving direction
- Stack height descending in driving direction
- Maximum height difference of adjacent stacks
- Maximum height difference of stacks within a row
- Maximum height difference of stacks within a line
- Penalty for packages that cannot be loaded based on weight
- Penalty for packages that cannot be loaded based on weight multiplied by volume
- Packages with high density must be at the bottom of the stack
- Packages can be positioned anywhere in the stack regardless of weight and density

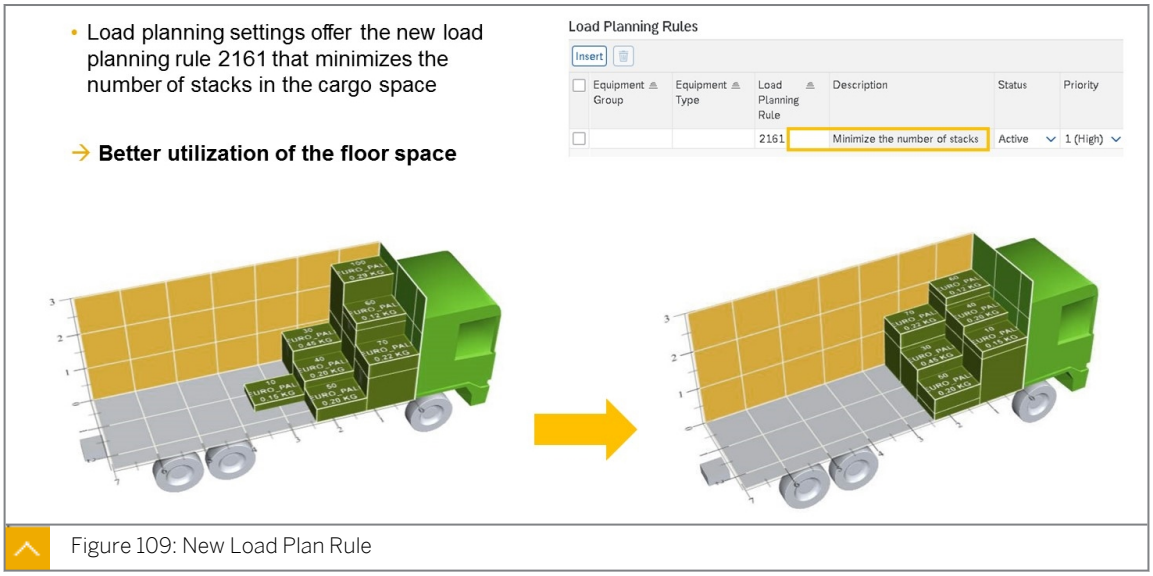

Figure 109: New Load Plan Rule

Load Planning

The load plan is the result of load planning. It provides you with an overview of how the loading space available for transporting a business document is used currently.

In both the transportation cockpit and in the business document, you can display the complete load plan as a 3D load plan or a table load plan of business document items. In the 3D load plan, you can show or hide individual objects as well as entire rows, columns, or stacks and fill them with different colors. Furthermore, you can show and hide gridlines in your decks in the 3D load plan.

If items cannot be loaded, the load plan includes information on the loading sequence and the exact position on the vehicle. In addition to the load plan, a load distribution is available for each axle and the complete vehicle. This document proves that the load plan fulfills legal requirements. An additional tab holds statistical indicators such as the used volume and area.

The Load Plan

The load plan contains the following information about the business document item:

- Resource
- Item in the resource
- Loading sequence
- Row, stack, and level in the loading space
- Gross weight
- Height, width, and length
- Stackability

Load Plan Analysis

The following is the load distribution and statistical data based on the current load plan:

- Number of loaded business document items
- Used area on the lower deck of your double-deck trailer
- Utilization of the loading volume in percent
- Used area on the upper deck of your double-deck trailer
- Maximum weight for each axle group compared to the current weight for each axle group
- Maximum trailing load compared to the current trailing load

LESSON SUMMARY

You should now be able to:

- Configure the load planning process

Short-Cut Process

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Understand, configure, and execute the short-cut process

Short-Cut Process

Creating a freight order directly from the FUBR is called the short-cut planning process because, in this case, freight units as separate business documents are omitted, and additional planning steps are not required because the freight order is created right away.

The purpose of the short-cut process is to skip any planning activities, because these may not be required in certain scenarios. For example, if the sales orders that are received by a company already state the required truck size, the freight order could be created directly from the transportation demand (in this example, a sale order). Technically, this is done during freight unit building by selecting a freight order type instead of a freight unit type. Thus, freight units are omitted in the scenarios where transportation demand/requirement exactly matches the to-be-created transportation document.

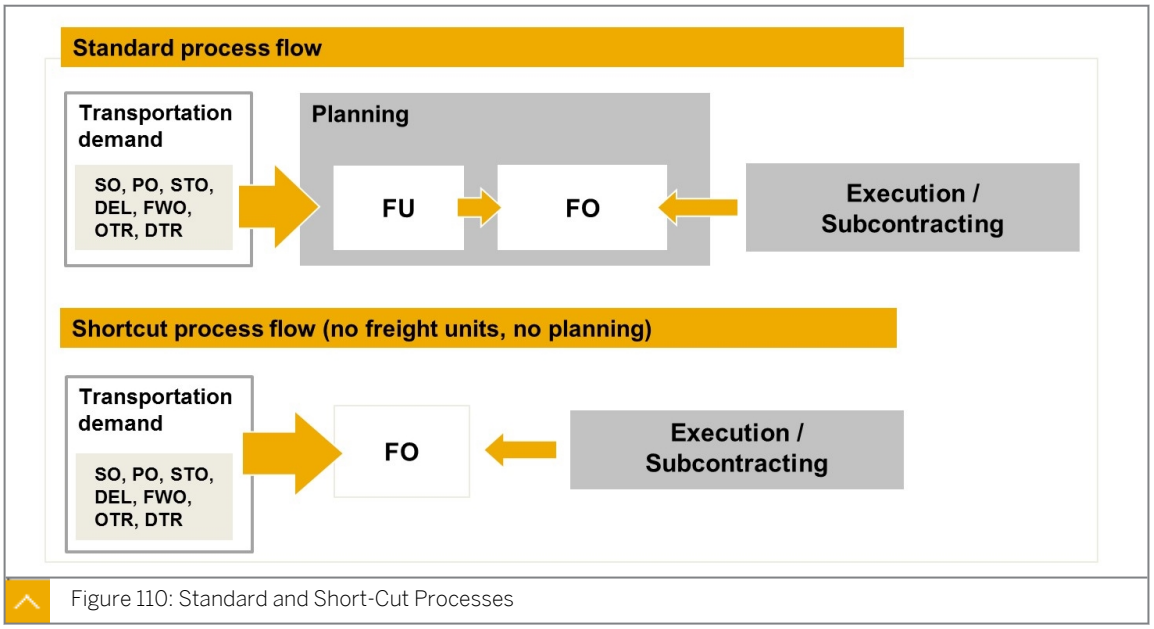

Figure 110: Standard and Short-Cut Processes

LESSON SUMMARY
You should now be able to:

- Understand, configure, and execute the short-cut process

Learning Assessment

1. Based on what you have learned about business share in transportation planning, which of the following statements is true?

   Choose the correct answer.

   ☐ **A** Business share is an in-built mechanism in SAP TM for ensuring all carriers in a region have sufficient business.

   ☐ **B** Business share buckets provide a means of numerous shippers pooling together to create merged (shared) freight orders.

   ☐ **C** Business share settings define the percentage of business to be allocated to various carriers. Costs are incurred for non-adherence and the system takes these into account during optimization.

   ☐ **D** A company may have working formalised relationships with a number of carriers. Business share allocation ensures that all carriers receive the same amount of business from the company.

2. Incompatibilities between order and carrier, or customer and carrier, can also be maintained in the carrier selection settings.

   Determine whether this statement is true or false.

   ☐ True

   ☐ False

3. Load optimization can consider only one planning rule.

   Determine whether this statement is true or false.

   ☐ True

   ☐ False

4. Which of the following statements are correct?

   Choose the correct answers.

   - [ ] A A freight order is created from sales order directly.
   - [ ] B Planning activities are omitted during short-cut planning.
   - [ ] C Short-cut planning is not possible in SAP S/4HANA.

Learning Assessment - Answers

1. Based on what you have learned about business share in transportation planning, which of the following statements is true?

   Choose the correct answer.

   ☐ A Business share is an in-built mechanism in SAP TM for ensuring all carriers in a region have sufficient business.

   ☐ B Business share buckets provide a means of numerous shippers pooling together to create merged (shared) freight orders.

   ☒ C Business share settings define the percentage of business to be allocated to various carriers. Costs are incurred for non-adherence and the system takes these into account during optimization.

   ☐ D A company may have working formalised relationships with a number of carriers. Business share allocation ensures that all carriers receive the same amount of business from the company.

   Correct. This is the true statement about business share in transportation planning: Business share settings define the percentage of business to be allocated to various carriers. Costs are incurred for non-adherence and the system takes these into account during optimization.

2. Incompatibilities between order and carrier, or customer and carrier, can also be maintained in the carrier selection settings.

   Determine whether this statement is true or false.

   ☒ True

   ☐ False

   Correct. Incompatibilities between order and carrier, or customer and carrier, can also be maintained in the carrier selection settings.

3. Load optimization can consider only one planning rule.

   Determine whether this statement is true or false.

   ☐ True

   ☒ False

   Correct. Load optimization can consider multiple planning rules.

4. Which of the following statements are correct?

   Choose the correct answers.

   [X] A A freight order is created from sales order directly.

   [X] B Planning activities are omitted during short-cut planning.

   [ ] C Short-cut planning is not possible in SAP S/4HANA.

   Correct. Creating a freight order directly from the FUBR is called the short-cut planning process because, in this case, freight units as separate business documents are omitted, and additional planning steps are not required because the freight order is created right away.

UNIT 8 Transportation Execution

UNIT OBJECTIVES

- Understand transportation units
- Understand service orders
- Understand warehouse integration
- Understand Advance Shipping and Receiving
- Explore the configuration of output management
- Monitoring Events
- Configure discrepancy management

Unit 8
Lesson 1

Transportation Units and Service Orders

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Understand transportation units
- Understand service orders

Transportation Unit

TUs can represent both demand and capacity. They share some similarities with freight units and others with freight orders, but they also differ from both freight units and freight orders.

Scenarios involving trailers, railcars, containers, and packages can be modeled by TUs, abstracting from the specific documents called trailer units, railcar units, container units, and package units. For these scenarios you have to configure freight order types and transportation unit types.

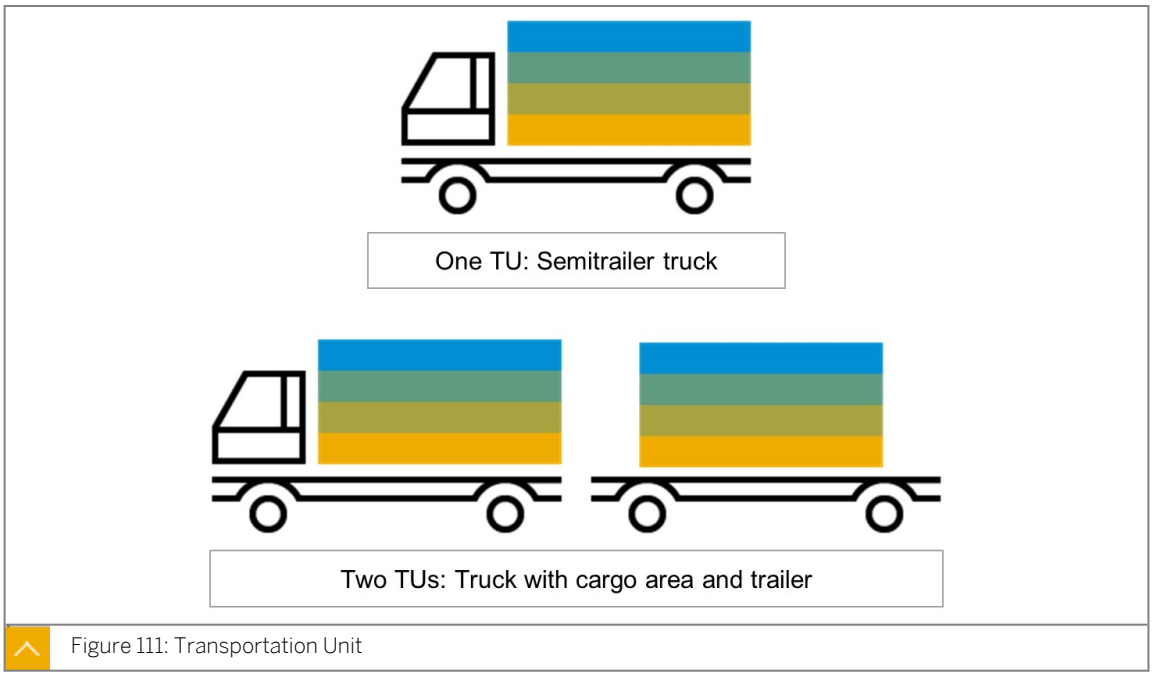

Figure 111: Transportation Unit

Like freight documents, TUs have stages defining their paths through the network. While trailer, railcar, and container resources can be assigned to the corresponding TUs, package units represent one or multiple packages, each having an assigned packaging material. On the one hand, TUs cannot move themselves; instead, they require being moved by a truck, locomotive, vessel, or airplane and thus need to be assigned to a freight document. Therefore, they represent a demand for transportation, like freight units.

The assignment of a TU to a freight document can be done directly – for example, trailer unit to road freight order – or indirectly, such as container unit to trailer unit, which is then assigned to a road freight order.

While a freight document cannot be assigned to another freight document, TUs allow nested assignments within this document category. For example, consider the following assignment chain: freight unit → package unit → container unit → trailer unit → road freight order. In this case, the TUs represent three consolidation levels between freight unit and road freight order. It is not possible to consolidate a trailer unit into another trailer unit, and this holds true analogously for railcar units, container units, and package units.

On the other hand, TUs can consolidate other demands. Therefore, they also represent a capacity for transportation, like freight documents. While a freight unit represents a single transportation demand, the TU can represent a set of transportation demands that may even have different source and destination locations. For example, a trailer is moved from location A to B to C, delivering three freight units: the first from A to B, the second from A to C, and the third from B to C. In general, TUs provide a lot of modeling capabilities but that requires additional planning decisions and adds planning complexity. Therefore, we recommend avoiding using TUs if your business can be modeled without them. Of course, for many transportation scenarios, using TUs is mandatory because it is the only feasible way to model your business.

Ways to Create TUs

There are many ways to create TUs:

- Manual planning can be done in the transportation cockpit, as described in Section.
- The VSR optimizer can create trailer units and railcar units based on freight units, container units, and package units.
- Load consolidation can create trailer units and container units based on freight units and package units.
- Package units of linear distribution type can be extracted out of road freight orders.
- FUB can create trailer units, railcar units, container units, and package units, but these TUs represent pure demand documents and do not allow consolidation.

Configuring TUs

Each TU has a specific type, which you can maintain in Customizing by following the menu path *Transportation Management → Planning → Transportation Unit → Define Transportation Unit*.

Within the transportation unit type, you configure the most important settings for the transportation unit. For example, you use the transportation unit category to indicate whether you want to create the transportation unit type for a trailer, a railcar, a container, or a package. When you then create the related business document (for example, a trailer unit), the system offers you only the relevant transportation units.

Document Structure with Transportation Units

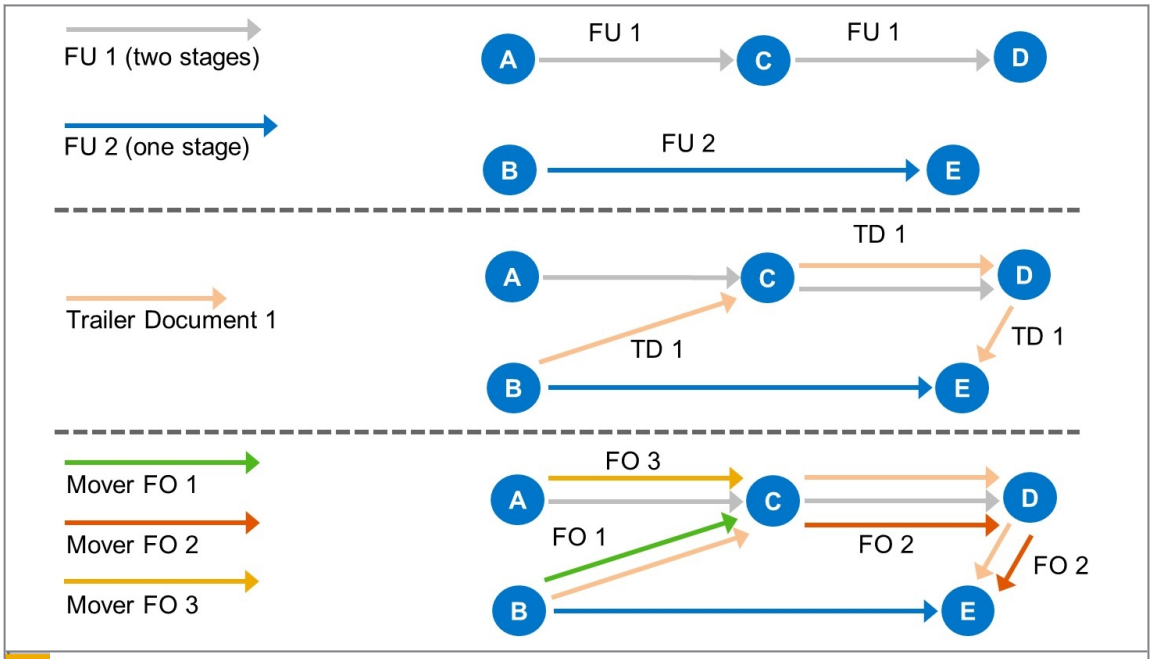

Figure 112: Document Structure with Transportation Units

Table 3: Document Structure with Transportation Units: An Explanation

The following table provides explanatory information about the figure, Document Structure with Transportation Units.

Transportation Order	Structure
Trailer TU 1	• Contains FU 1 and FU 2 • Defines own stages
Mover FO 1	• Covers 1 TU stage
Mover FO 2	• Covers 2 TU stages

For truck and tailer scenarios you have to configure freight order types and transportation unit types.

Service Order

Cleaning containers, fumigating, and performing security services or documentation are typical examples of services that can occur for items of a freight order or freight booking. The service order is used to account for and track services, calculate charges,and enable settlement of the charges for services that have been provided for individual items in a freight order/booking or for the entire freight order/booking.

You can create service orders in the following two ways:

- Create service orders from freight bookings, freight orders, freight booking items, or freight order items. With such a service order, you can:

  - Enter service items related to the freight booking, freight order, freight booking item, or freight order item.
  - Add service items that are not related to the freight booking, freight order, freight booking item, or freight order item. You can do this using the *Add Service* action without marking another item.
- Create stand-alone service orders without reference to any freight booking, freight order, freight booking item, or freight order item. You can use the *Create Service Order* function to create a service order by entering the service order type.

Structure of Service Order

A service order contains the following information:

- General data including the service provider, service order type, and status of the service order
- An item overview that contains the following information:
  - Link to the freight booking or freight order for which the service order was created. (Applies only for service orders created from freight bookings, freight orders, freight booking items, or freight order items).
  - IDs of the original freight booking items or freight order items for which services are to be carried out, for example, containers or products. (Applies only for service orders created from freight bookings, freight orders, freight booking items, or freight order items).
  - Services to be carried out.
  - Location at which the services are to be executed and time period in which they are to be executed.
- Transportation charges
- Document dependencies as well as predecessor and successor documents (document flow)
- Other information such as the following:
  - Notes
  - Attachments
  - Change documents
  - Administrative data
  - Output management information

Customizing Service Order

You make the required settings for service orders in Customizing for Transportation Management under:

- *Freight Order Management → Define Item Types for Freight Order Management*
- *Freight Order Management → Service Order → Define Service Order Types*
- *Basic Functions → General Settings → Define Service Types*.

You can use the change controller to define how the system reacts to changes.

Service Order Types, Service Item Types, and Service Types:

In Customizing, when defining service order types, you can specify the allowed service item types (these must be item types of the category Service). You make the required settings for service order types in Customizing for Transportation Management under *Freight Order Management → Service Order → Define Service Order Types*.

For each service item type, you can specify the allowed service types. For more information, see Customizing for Transportation Management under *Freight Order Management → Define Item Types for Freight Order Management*.

Then, you can use the service order type you defined to create a service order. You can specify one of the allowed item types for the order and the system proposes the default service type for that item type. You can specify a different service type. If you change this service type to a type that you have not specified in Customizing as allowed for this item type, the system returns a warning message.

LESSON SUMMARY

You should now be able to:

- Understand transportation units
- Understand service orders

Unit 8
Lesson 2

Warehouse Integration

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Understand warehouse integration

Direct SAP TM and SAP EWM Integration

Since the days of SAP TM 9.0, the integration of SAP TM with SAP EWM ran via SAP ERP using SAP ERP shipments as an intermediate step. Data was not sent directly between SAP TM and SAP EWM. Since release 9.1, SAP TM supports direct integration between SAP TM and SAP EWM without creating shipments in SAP ERP.

The next step in the evolution is the current scenario, where both SAP EWM and SAP TM run as part of the SAP S/4HANA system since release 1709. The SAP EWM for SAP S/4HANA design was adapted to reflect the principle of one design idea, which was the basic guideline for the development of the new system. For SAP EWM for SAP S/4HANA, this meant both direct access to master data without the need for replication and also structural changes in its architecture.

As part of its first release in SAP S/4HANA 1610, the inbound delivery notification and the ODR were removed. The purpose of these objects was to reflect the information of the delivery and form the basis for further warehouse execution. With the introduction of SAP EWM for SAP S/4HANA, this intermediate step was no longer necessary to be part of the overall design and thus was removed.

In this unit, we explain the current, direct integration in SAP S/4HANA within an SAP EWM for SAP S/4HANA. The integration scenarios are still based on orders and deliveries.

Standard Integration Scenarios

To optimize transportation costs and efforts in a flexible and optimized way, SAP TM supports transportation planning based on either SO requirements or outbound deliveries. As part of transportation planning, the results influence warehouse-internal processes such as staging. The integration of the SAP TM transportation planning results into SAP EWM warehouse management processes is beneficial because it enables smooth outbound processing with an optimized warehouse-internal process according to the transportation planning result.

- Order-based integration
- Delivery-based integration

Integration type	Outbound	Inbound
Order based	Sales orders	Purchase Orders

Integration type	Outbound	Inbound
Delivery based	Outbound deliveries	Inbound Deliveries

SAP Note 1984252 describes the known supported functional scope and limitations of the direct integration.

Delivery-Based Transportation and Warehouse Integration

The delivery-based integration scenario is an integrated warehousing and transportation process that sends ordered goods via an external carrier to external customers from a warehouse managed with SAP EWM. Transportation is planned in SAP TM, while warehouse activities are planned and executed in SAP EWM. This process is based on SAP S/4HANA sales orders and transportation requirements are based on SAP S/4HANA outbound deliveries.

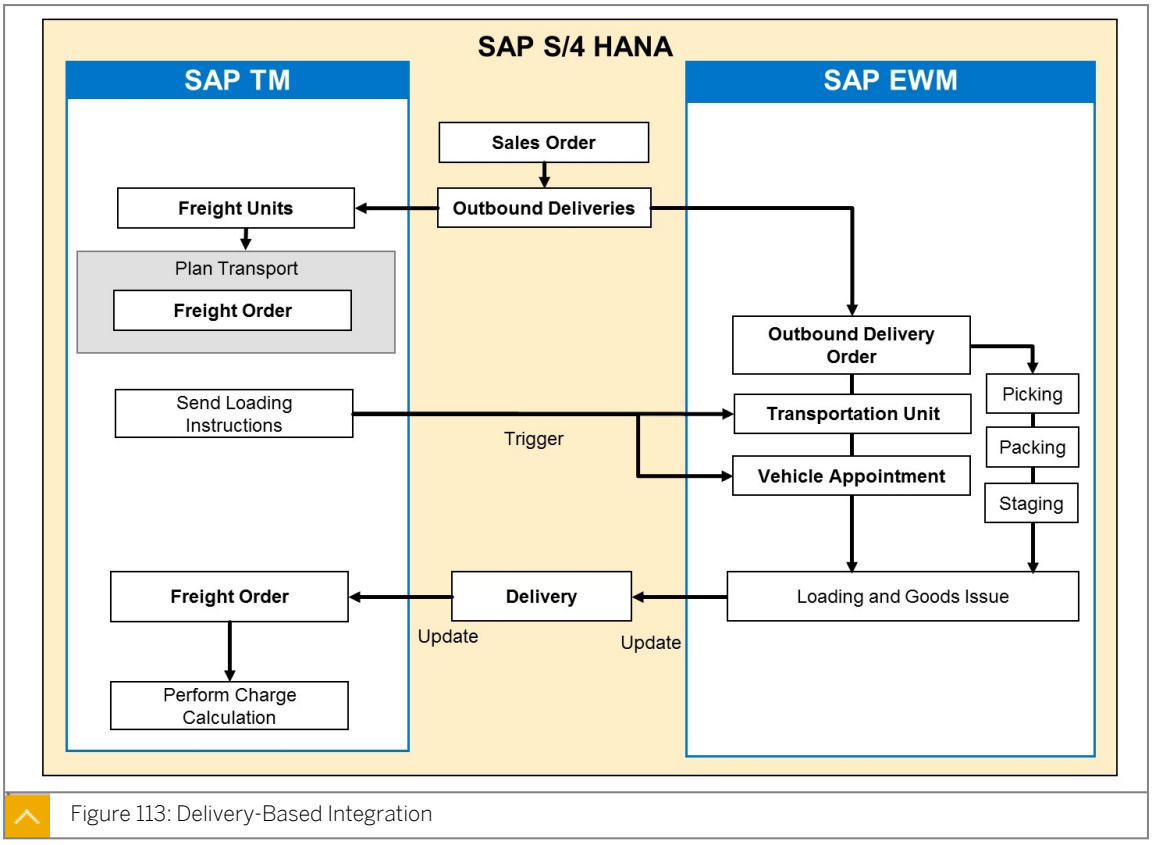

Figure 113: Delivery-Based Integration

Delivery processing in SAP S/4HANA involves grouping deliveries to pick, pack, and ship and then performing all the functions associated with the delivery process. Based on split criteria or combination indicators, you can group together entire orders or individual items or split orders into partial deliveries. Outbound deliveries are created and scheduled in SAP S/4HANA and are the basis for transportation planning in SAP TM.

Because of the transportation planning in SAP TM, a freight order is created in SAP TM, which, as soon as the freight order is ready for loading, results in the creation of a transportation unit in SAP EWM.

One or more delivery positions can create one or more freight units. At all times, the documents created in SAP TM can be seen in the delivery via the document flow in the *TM Status* tab of the delivery.

The deliveries are visible both in SAP TM for transportation planning and execution and in SAP EWM for warehouse planning and execution. In SAP EWM, the delivery creates an outbound delivery order, which acts as the actual warehouse request and initiates the GI process in SAP EWM.

The outbound delivery contains data assumed from the preceding document and all necessary information to trigger the GI process and monitor it accordingly. From the perspective of warehouse management, the outbound delivery order represents a work list that is completed only when the picked materials have been loaded and shipped.

The outbound delivery order in SAP EWM is still blocked for processing. It is released as soon as the transportation planning process in SAP TM is completed, and SAP EWM is updated with the final planning results. Sending the loading instructions to SAP EWM creates a TU and automatically assigns the outbound delivery orders. With this assignment, the outbound delivery orders are unlocked and updated with the related carrier information from SAP TM.

Unlocked outbound delivery order with transportation units are now the basis for warehouse execution in SAP EWM. The SAP TM freight order now exists as a transportation unit in SAP EWM. To easily identify the same object across all three systems, they all share the same document number.

As soon as the materials have been picked, staged, and loaded,GI can be posted. During the outbound process execution, SAP TM is updated with all execution-relevant information and events.

Order-Based Transportation and Warehouse Integration

In addition to delivery-based integration, SAP EWM and SAP TM can also work together in an order-based process. In contrast to the previous scenario, the outbound delivery is now created because of freight unit–based delivery proposals and transportation planning in SAP TM. In the delivery-based scenario, inventory planning and logistics execution had priority over the transportation planning process in SAP TM, and deliveries were already created.

In the order-based scenario, SAP TM plans transportation based on SAP S/4HANA sales orders and as a result proposes and creates deliveries based on the determined dates and quantities. Transportation planning results in the creation of freight orders, which are the basis for the delivery creation in SAP S/4HANA. In this context, SAP TM considers transportation constraints, such as resource availability and transportation durations. The created deliveries are usable by SAP EWM. In SAP TM, the freight order can be the basis for tendering and carrier selection.

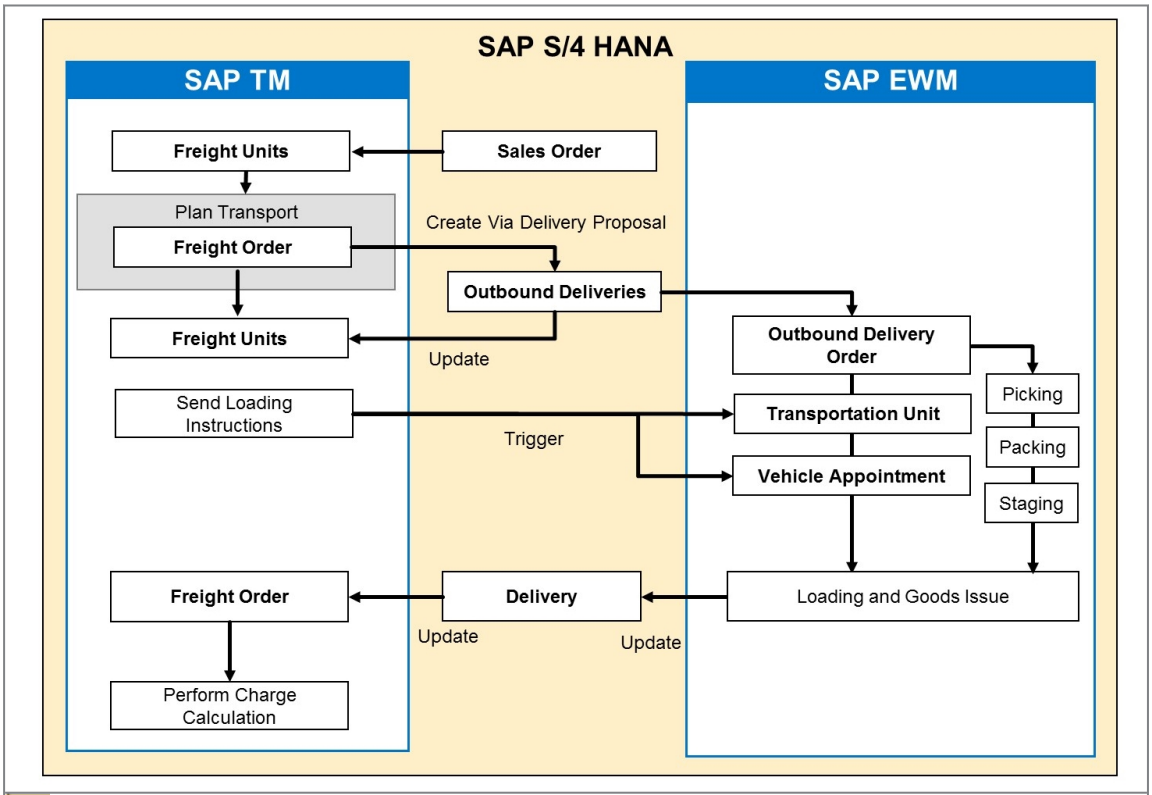

Figure 114: Order-Based Integration

The process starts with a sales order and a planned delivery date. This automatically creates freight units. These are then the basis for transportation planning and optimization in SAP TM.

The transportation planning in SAP TM is completed as soon as the transportation capacity of the freight orders has been fully planned and all relevant transportation requirements have been assigned. After the carrier has been assigned, SAP TM can trigger the creation of a SAP S/4HANA outbound delivery and communicate the freight order number to the selected carrier. These deliveries are based on the transportation planning results and therefore consider planning constraints, such as resource availability, distances, durations, and consolidation and dates. This step can be executed manually or automatically as a background job. As soon as the delivery has been created, the document flow in SAP TM is updated to show all related documents to a freight unit and freight order.

When the deliveries have been created, they are visible in the SAP EWM environment for further processing as outbound delivery orders. The SAP S/4HANA delivery is created with the proposed delivery date from SAP TM. If the SAP EWM outbound delivery orders haven't been assigned to a TU, these orders are locked for execution. When the transportation planning activities are finished, and the freight order status has been set to *Cargo Ready for Loading*, SAP TM sends a loading instruction to SAP EWM. This triggers the creation of a TU in SAP EWM. In SAP EWM, the transportation units are automatically assigned to the (locked) outbound delivery orders . With this assignment, the outbound delivery orders are unlocked and updated with the related carrier information from SAP TM. Unlocked outbound delivery orders, assigned to a Transportation units, are now the basis for warehouse execution in SAP EWM.

Goods are picked, staged, and loaded on a truck. Posting GI in SAP EWM immediately adjusts the inventory in SAP S/4HANA, updating the outbound deliveries and the freight order in SAP TM for a later freight cost settlement.

LESSON SUMMARY

You should now be able to:

- Understand warehouse integration

Unit 8
Lesson 3

Advance Shipping and Receiving

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Understand Advance Shipping and Receiving

Advance Shipping and Receiving

Advanced Shipping and Receiving is an integrated, end-to-end process that allows users to send, receive, and transport products. It supports mixed and multi-warehouse scenarios within one freight order. It helps you, to coordinate the process steps from arrival of trucks at the gate to the final goods receipt in the warehouse. A truck that has posted arrival at a checkpoint can carry out both loading and unloading activities at a location, or it can deliver goods at several warehouses at the same location.

Advanced Shipping and Receiving simplifies communication between the Transportation Management (TM), Extended Warehouse Management (EWM), Stock Room Management (STRM), Inventory Management and Physical Inventory (MM-IM), and Logistics Execution (LE) application components embedded in SAP S/4HANA. You need Materials Management (MM) and Sales and Distribution (SD) to create transportation requirements.

The Advanced Shipping and Receiving process is based on the freight order and does not use the EWM transportation unit (TU) or the EWM vehicle. Both integration processes, integration based on the freight order or integration based on the EWM transportation unit, can run in parallel. For warehouse-driven outbound processes, you start in EWM.

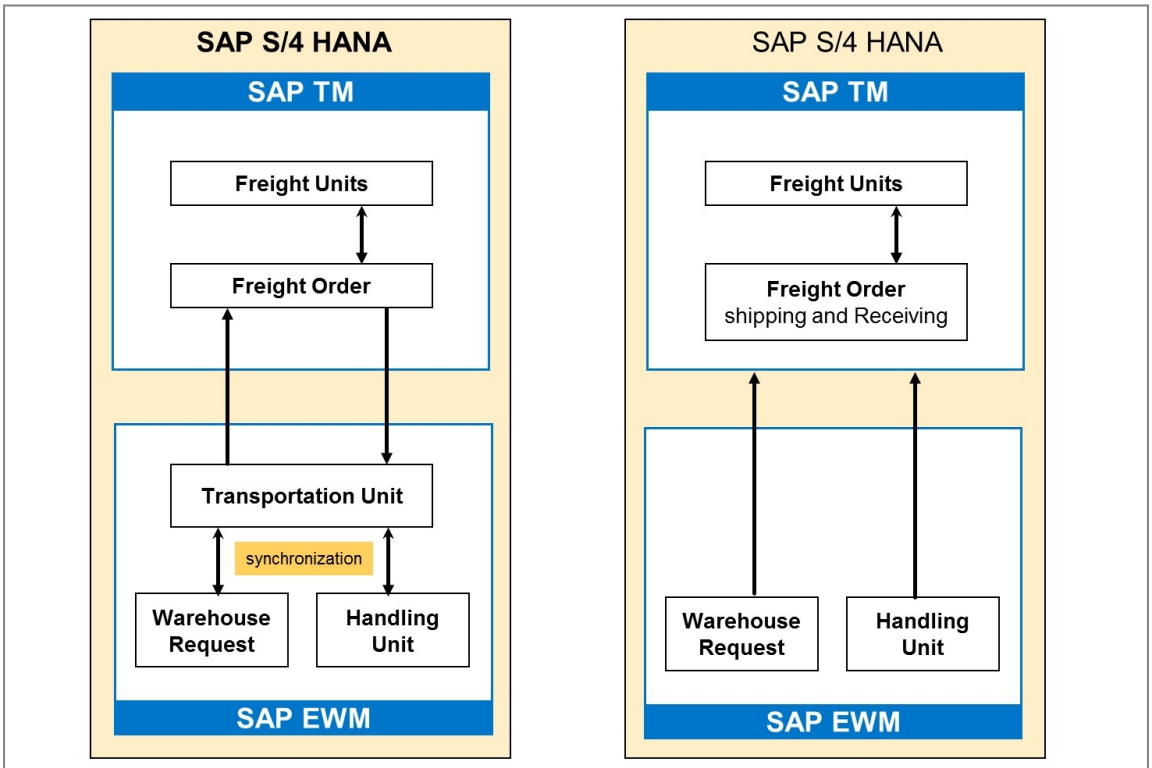

Figure 115: Advance Shipping and Receiving

https://youtu.be/jLZM5S84AWM

Storage Location

The freight order can contain both EWM managed and IM managed storage locations, for example at a production location, and the two storage locations can share a loading point.

In Advanced Shipping and Receiving you can integrate TM in S/4HANA with the following warehouse management applications located in the same SAP S/4HANA system:

- Lean Warehouse Management in SAP S/4HANA:

  You can use a very simple warehouse where inventory management takes place solely at storage location level. You need to create a place holder warehouse that ensures the document flow in TM.

- Stock Room Management in SAP S/4HANA:

  You can use Stock Room Management for small warehouse operations and for warehouse operations with low complexity. Stock Room Management contains SAP S/4HANA functionality from the former Warehouse Management in Logistics Execution (LE-WM).

- Extended Warehouse Management in SAP S/4HANA:

  You can use EWM for a flexible, automated support for processing various goods movements and for managing stocks in your warehouse complex.

Prerequisites for Advanced Shipping and Receiving

Master Data:

You have made the following settings in the location master data on the SAP Easy Access screen under Logistics Transportation Management Master Data Transportation Network Location:

- You have activated Advanced Shipping and Receiving.

  You do this, by indicating in the master data for your source or destination location. Location type 1003, shipping point & location type 1200, loading points, is relevant for Advanced Shipping and Receiving. This setting is mandatory.

- You have defined a location with location type 1200 (loading point). The setting is mandatory.

Assignment of Doors:

Assign Stock Room Management (STRM) doors or Lean Warehouse Management (Lean WM) doors to Extended Warehouse Management (EWM) doors or loading points. This setting is mandatory for all scenarios using shared doors and multiple warehousing components. The setting is not required for a scenario that only uses EWM.

Consignment order

A consignment order serves as an important basis for the communication between the partners that are involved in a business process. For example, as a supplier you can communicate to your ordering party which products you will deliver to a certain destination on a specific delivery date. The consignment order receives an ID that serves as a reference for the business partners. Consignment order can be assigned to one freight order.

Based on a consignment order, you can also perform subcontracting, charge calculation, settlement with the carrier, and shipment tracking. It is not, however, possible to perform tendering based on a consignment order.

You can then assign the consignment order to a road freight order and in doing so stipulate on which truck the products contained in the consignment order are to be transported. A consignment order can be assigned to only one freight order at a time and must be completely assigned. A freight order can, however, contain several consignment orders. The transportation is then planned and executed based on the freight order.

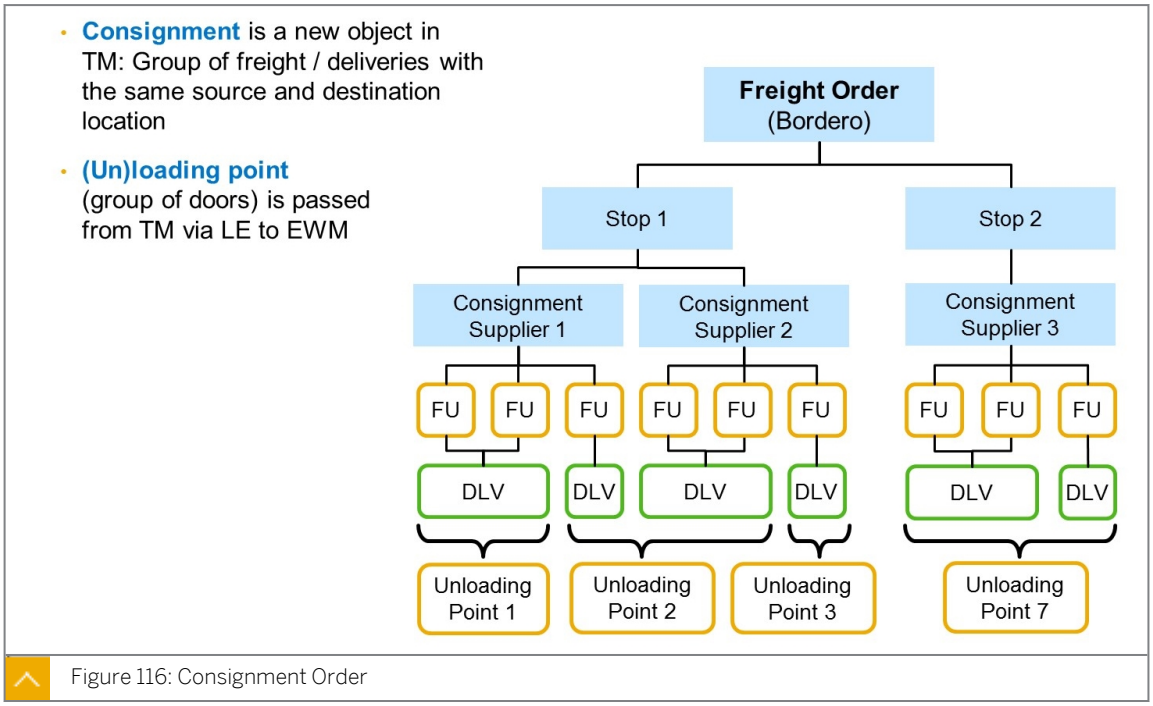

Figure 116: Consignment Order

End to End Process Flow

The following processes are available:

- Inbound delivery process starting in TM/LE
- Outbound delivery process starting in LE or SD

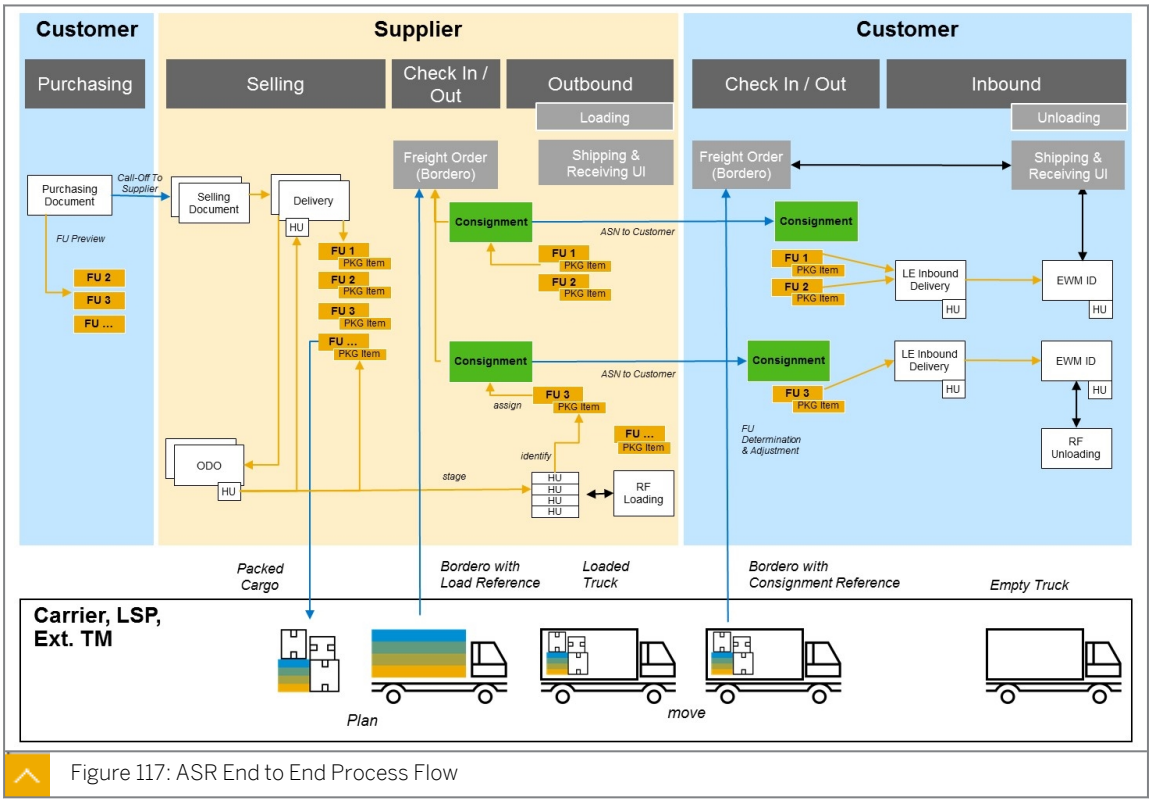

Figure 117: ASR End to End Process Flow

LESSON SUMMARY

You should now be able to:

- Understand Advance Shipping and Receiving

Unit 8
Lesson 4

Output Management

LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Explore the configuration of output management

Output Management

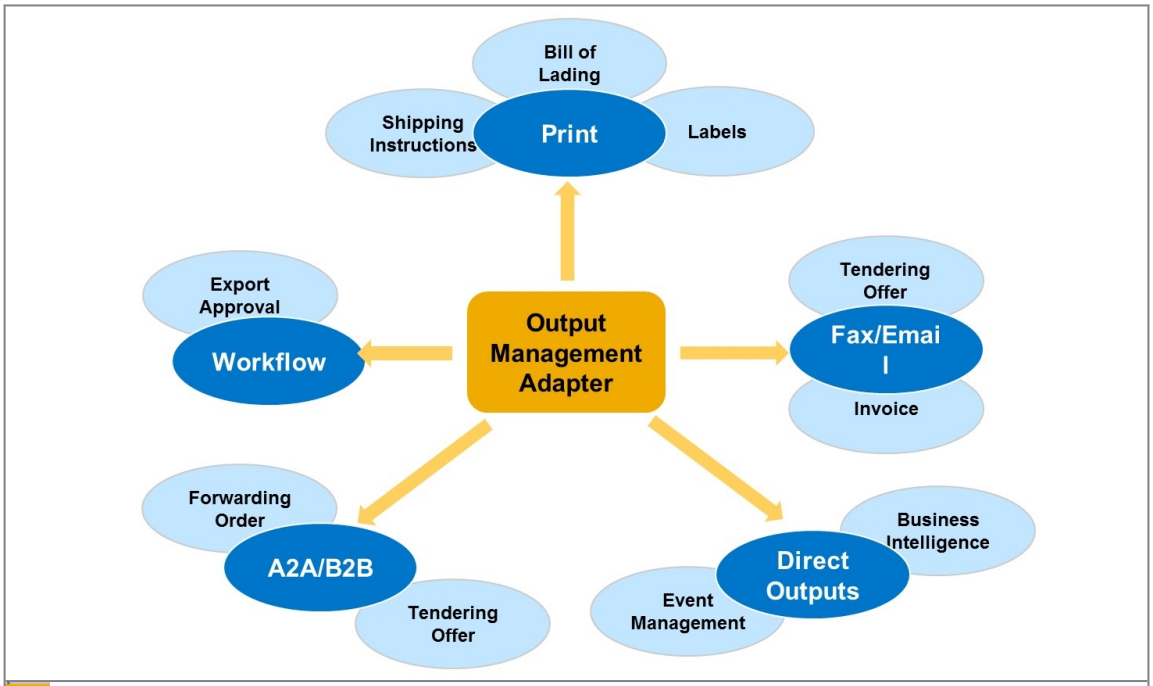

Figure 118: Output Management

You can use output management to print, fax, and email documents such as order, delivery, and billing information. You can also execute application-to-application or business-to-business actions. The Post Processing Framework (PPF) is a tool in SAP TM used to execute program logic that is considered a follow-up action to a certain business process step. The PPF is used for the following tasks or actions (to name a few):

- Document printing
- Ending messages, such as email, fax, or electronic data interchange (EDI)
- Work-flow triggers

All actions are defined in the PPF with a schedule condition that defines whether the action needs to be executed and a processing time that defines when to execute the action.

An action profile bundles all actions concerning a specific business process area (for example, the action profile /SCMTMS/TOR bundles all actions important for the freight order). You can see in the *Action Settings* area where we can define the processing time of the action and whether the action should be scheduled automatically or by a batch job.

The processing type of the action can be one of the following:

- Trigger alert
- Method call
- Work-flow
- Smart Forms actions
- External communication

To trigger PPF actions, start and schedule conditions need to be configured according to business needs or rules, as follows:

- Schedule condition:

  The schedule condition decides whether an action should be scheduled for processing. An action is therefore only generated if the schedule condition is met.

  The filter value is specified in the Schedule condition field. The standard value /BOFU/EVAL_SCHEDULE_CONDITION ensures that the method in the agent class is invoked.

- Start condition:

  The start condition is checked before the action is executed. The action is only executed when the start condition has been fulfilled.

  The filter value is specified in the Start condition field. The standard value /BOFU/EVAL_START_CONDITION ensures that the method in the agent class is invoked.

Adapter Settings

Output management automates the output of business documents such as printouts, in response to certain business events. This output management adapter helps you to integrate output management functionality with application business objects (BOs) that are implemented in a business object processing framework (BOPF).

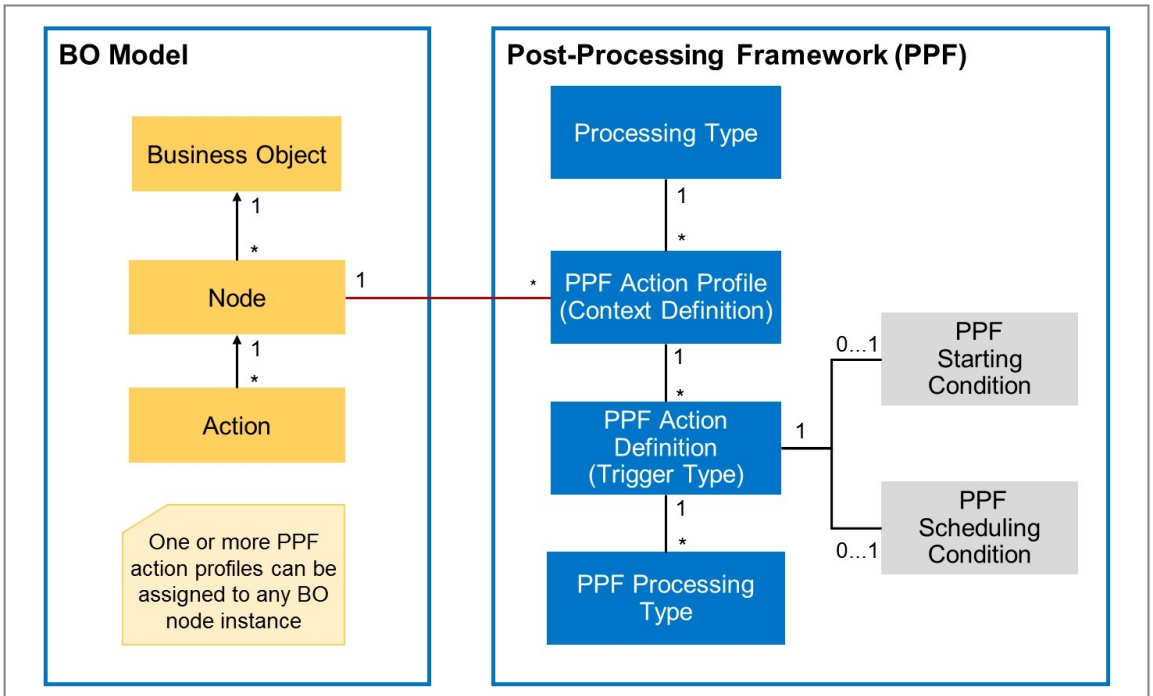

Figure 119: Output Management Logic

LESSON SUMMARY

You should now be able to:

- Explore the configuration of output management

Unit 8
Lesson 5

Track & Trace

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Monitoring Events

Execution Tracking

You use this function to determine whether the end user can manually report the execution of transportation processes managed by TM, or not. For example, the end user reports that an event has happened such as a freight order has arrived at a destination.

Execution Tracking reports the tracking of the following TM business documents:

- Freight Units
- Freight Orders and Freight Bookings
- Transportation Units

Features:

- No Execution Tracking: With this option selected, there is no tracking of executions. This is the default option.
- Execution Tracking: With this option you allow execution tracking without an external event management system. That is, the system automatically starts the tracking of executions reported manually from transportation processes managed by TM. The data this creates is stored in the TM database.
- Execution Tracking with External Event Management; With this option you allow execution tracking with an external event management system. The system stores the data from the tracking of executions in the TM database, but it can also send it to an external event management system. This option requires the connection of an external event management system, such as SAP Event Management. The use of SAP Event Management means that an end user can use its simple in-built interfaces to report actual events, such as a freight order has arrived. Further, the time that those actual events occurred can be compared with the time they were expected to occur. In addition, SAP Event Management allows events that are related but unexpected to be reported. Together this means that for any tracked item a database record is always available including its last known event. From that you can know whether that item is on track, late or whether an unexpected has happened to it. You can also use rule-based processing in-built into SAP Event Management to trigger automatic follow up activities.

You can see and change the current settings for execution tracking in Customizing. The path in Customizing depends on the type of TM business document as follows:

- For freight orders, make the settings in Customizing for Transportation Management under Freight Order Management Freight Order Define Freight Orders Types. Then you select the Details button and under Execution Settings, select an option from the field Execution Tracking Relevance.
- For freight bookings, make the settings in Customizing for Transportation Management under Freight Order Management Freight Booking Define Freight Booking Types. Then you select the Details button and under Execution Settings, select an option from the field Execution Tracking Relevance.
- For transportation units, make the settings in Customizing for Transportation Management under Freight Order Management Transportation Unit Define Transportation Unit Types. Then you select the Details button and under Execution Settings, select an option from the field Execution Tracking Relevance.
- For freight units, make the settings in Customizing for Transportation Management under Freight Order Management Planning Freight Unit Define Freight Unit Types. Then you select the Details button and under Execution Settings, select an option from the field Execution Tracking Relevance.

Event Management

Event Management

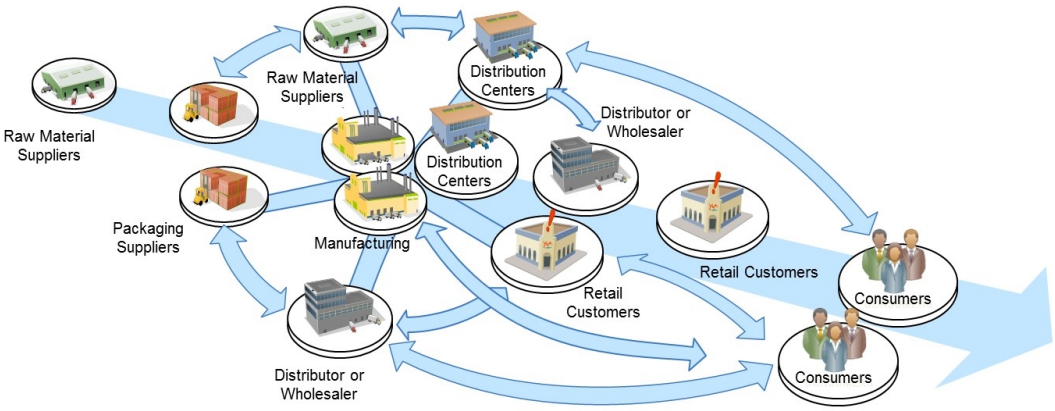

Figure 120: Visibility Across Business Partners And IT Environments

Nowadays, supply chains are global and complex. End-to-end supply chain visibility is one of the key factors in efficient supply chain operation and control. SAP Event Management is the only application needed to provide this visibility, since it is available to all partners, including customers. SAP Event Management can also work with multiple SAP and non-SAP applications.

As companies expand their suite of IT products to handle more complex scenarios, they often have to add systems to their ERP environment. This makes it difficult for business users and management to gain a complete view of end-to-end processes and monitor potential service issues. Therefore, it is imperative to have a tool that can incorporate information from several systems and provide insight into how order fulfillment is progressing.

SAP Event Management makes processes, assets, and performance visible across the entire supply chain. Extensive tracking and tracing functions allow process monitoring, automated exception resolution, proactive alerting, as well as extensive reporting in a single solution.

The event management system is designed to work with several SAP ERP & S4 HANA instances, if necessary. It can communicate with SAP CRM, where sales orders may be received, and this communication is processed back to the customer to support order fulfillment. SAP IBP may be responsible for creating the replenishment plan. SAP ERP or SAP Manufacturing Execution may be responsible for communication and tracking progress on the shop floor. SAP EWM (Extended Warehouse Management) may be responsible for the picking and packing as part of the logistics execution.

Event Management in SAP TM

SAP Event Management offers visibility processes to monitor transportation execution in connection with SAP TM. The transportation execution visibility processes enable users in roles such as transportation dispatcher, shipper, or ordering party, to track and monitor planned events or to report an actual event.

Tracking and tracing is provided for the following business document types in SAP TM:

- Freight unit
- Freight order
- Freight booking
- Transportation unit
- Resource
- Instruction execution for standard operating procedures

In each case, the goal is to manage by exception, reduce time to action, and spend less time fire-fighting.

Event Management Process

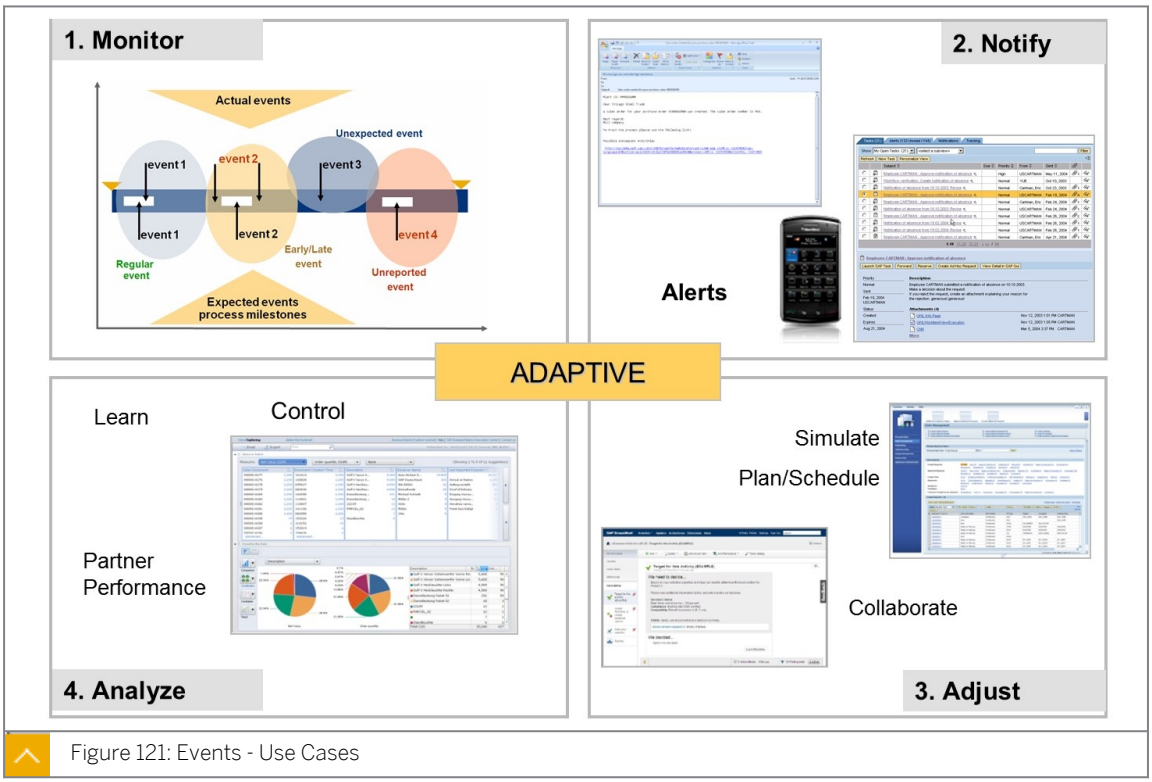

Figure 121: Events - Use Cases

Monitor, notify, analyze, and adjust - these are the four cornerstones of SAP Event Management, and they contribute in providing an adaptive solution. The monitoring process collects data from the various source systems. Notifications can be set up to be triggered, with alerts sent to the parties responsible if a process deviates from its anticipated course. Based on the alerts, the appropriate parties can then simulate adjustments and make any necessary changes. Finally, in relation to analytics, SAP Event Management can be tied into the SAP BW environment to support transportation management reviews.

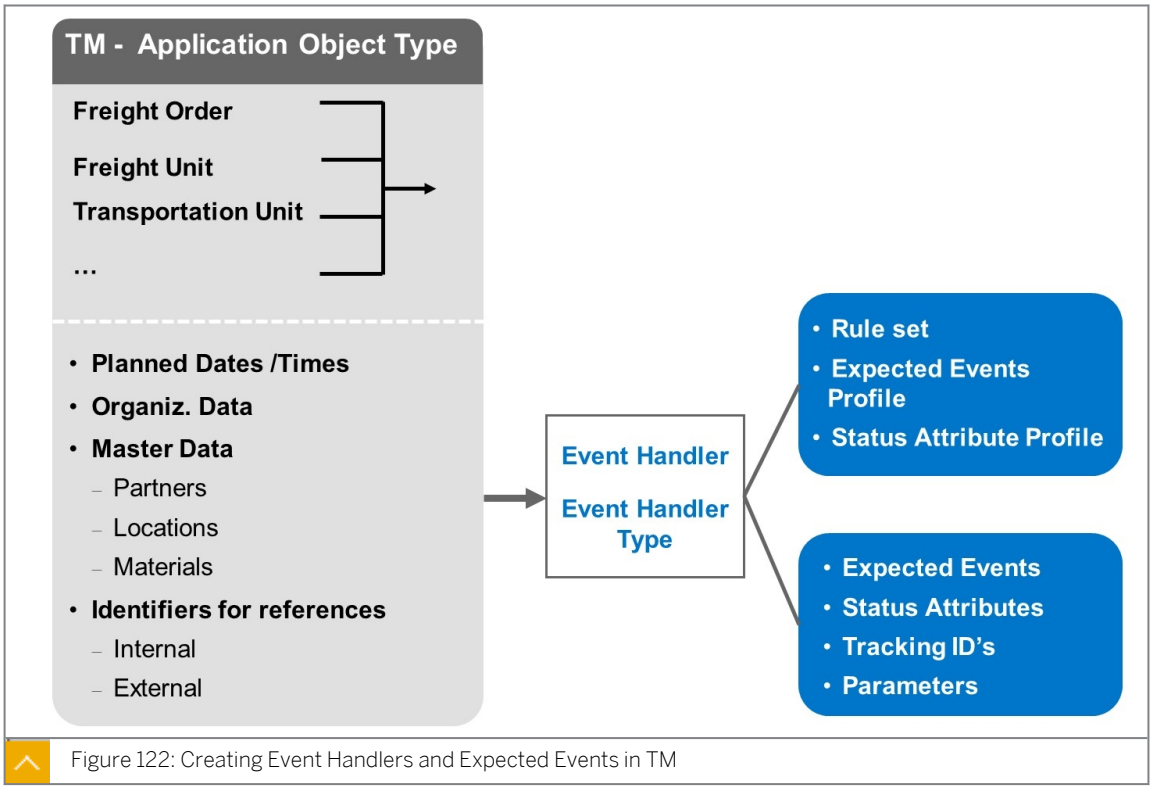

Figure 122: Creating Event Handlers and Expected Events in TM

In the integration between SAP TM and SAP EM, two different interfaces and functions are used, as follows:

1. Creation and update of the Event Handler with all expected events and other critical fields such as parameter and tracking IDs.
2. Sending or reporting of events from the SAP TM system, for example, loading or unloading events from freight unit or freight order.

To be able to create event handlers in SAP TM, you must configure the application object types (AOTs). From the AOTs, the extractors are created. These extractors send the data to SAP EM and create SAP EM event handlers.

Content of Application Object Types

Application Object Types contain the following:

- Expected events, with planned dates and times
- Tracking IDs that uniquely identify the trackable object or business document, for example, a freight order
- Information and system parameters that contain information about the object

Content of Extractors

The extractors contain the following:

- A freight order
- A freight booking
- A freight unit

- A transportation unit
- Other objects

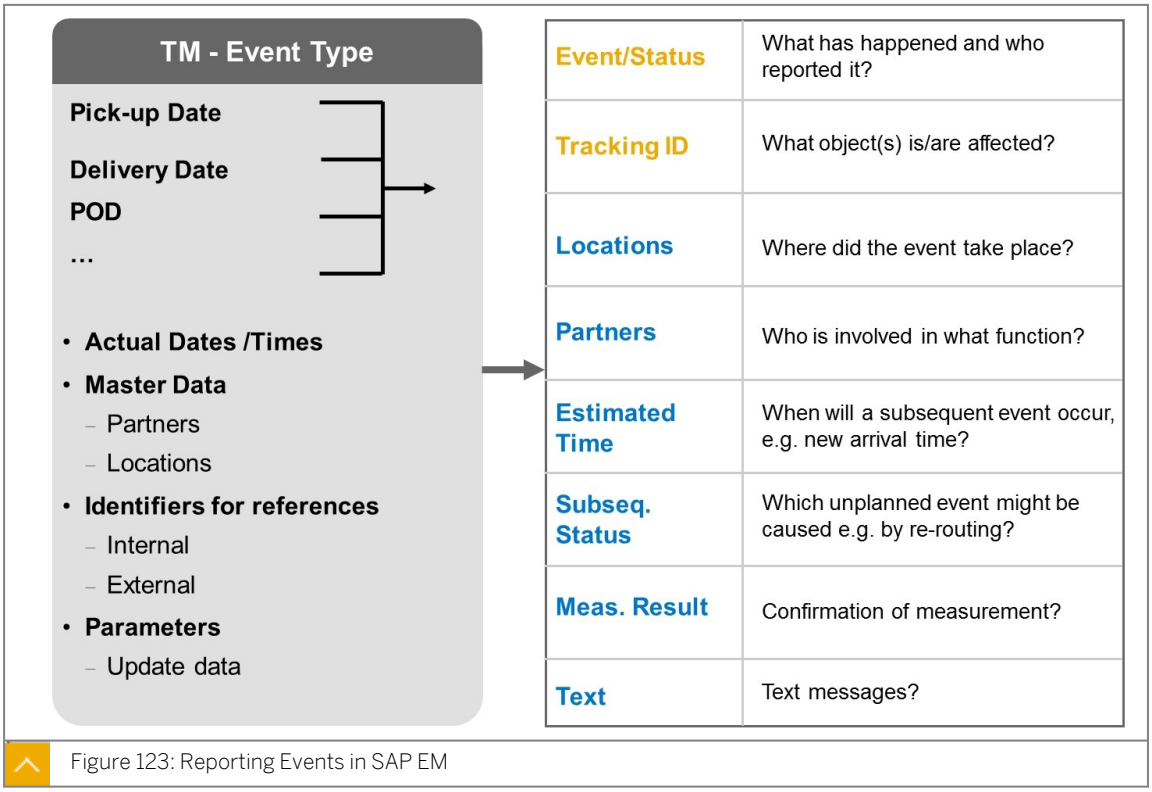

Figure 123: Reporting Events in SAP EM

An event handler represents a business document (for example, freight order, freight unit, or transportation unit) or a business process (for example, within a Transportation Execution) that is relevant to tracking or monitoring functions. SAP EM creates an event handler for each object. The event handler contains all of the information necessary to track this application object. It contains this information in a form that is independent of its origin, so that SAP EM can map and track business processes in a uniform way.

The event handler information makes it possible to enable the monitoring of events that are reported to SAP EM for an application object, and to check if the actual events occur in line with the expected events. In SAP TM, event types are used to send or report events to SAP EM.

GTT

The aim of SAP Logistics Business Network, global track and trace option is to capture, process and store tracking information about tracked processes and objects. Then, it allows business users to get real-time transparency of the execution of those processes. They can query any tracked process and display its retrieved data from end to end.

Further, SAP Logistics Business Network, global track and trace option can use rule-based triggering to automatically detect when certain predefined conditions occur such as delay or damage to goods. The rules can also be used to trigger follow-up activities such as sending emails to users or updating back-end systems.

SAP Logistics Business Network, global track and trace option is a cloud service. The service is an optional package you can select as part of the SAP Logistics Business Network solution.

Features:

1. A cloud-based track and trace service to capture, process and store messages with tracking information about business processes.

2. A cloud-based service that allows connected cloud apps to trace those business processes by retrieving tracking information.

3. Tools for an administrator to define and model the business processes to be tracked and their related events and properties. He or she can also configure business rules used by the event-to-action engine to process and evaluate received event messages and to trigger automated follow up actions.

4. Tools for an administrator to replicate master data (business partner, location and product) from connected back-end systems.

5. Tools for an administrator to manage on-boarding, configuration and setup.

6. Apps for a business user, for example, to query any tracked process or object and display it from end-to\u0002end, including to:

- display its milestones with planned and actual date/times
- display details of its processes
- report planned and unplanned events
- visualize related locations on a geographical map

LESSON SUMMARY

You should now be able to:

- Monitoring Events

Discrepancy Management

LESSON OBJECTIVES
After completing this lesson, you will be able to:

- Configure discrepancy management

Discrepancy Management

The actual quantity cannot be estimated precisely beforehand, for example, when transporting bulk freight. When the transportation execution starts, the actual quantity needs to be recorded as well. This process in the SAP TM functionality is called discrepancy handling. Discrepancies are a hassle for transportation execution because they might affect the choice of vehicle resource being used for the transportation or lead to a different charge calculation. Therefore, discrepancies need to be discussed with the shipper before transportation can continue. The transportation process starts as usual, requested quantities are entered into a forwarding order, and freight units are created out of this document. After the freight units are planned, the execution of the transportation may begin. The carrier now physically receives the cargo and checks the actual quantities against the requested quantities. This checking and reporting is performed by the carrier and communicated to us as the freight forwarder. We will then enter the actual quantities in the freight order's items.

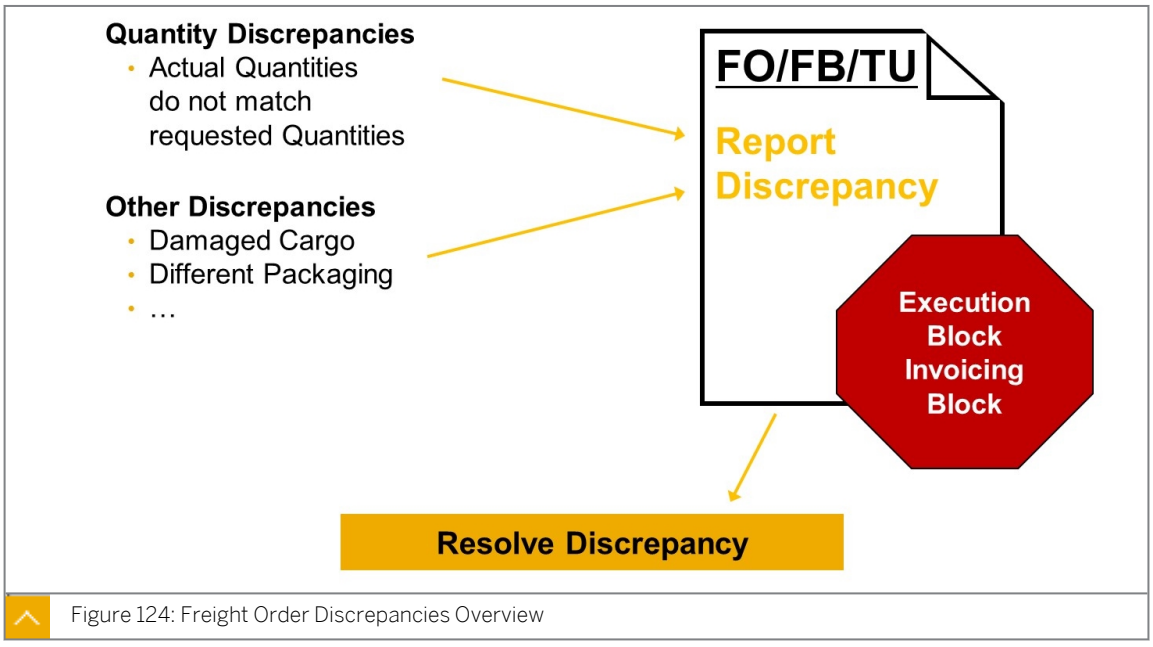

Figure 124: Freight Order Discrepancies Overview

If the carrier does not receive the cargo as planned, you need to report the discrepancy. In general, you can differentiate between two types of discrepancies as follows:

- Quantity discrepancies: The actual quantities are different from the requested quantities because of a change in the quantity, gross weight, or volume.
  - The actual quantity, the actual weight, or the actual volume is lower than expected.
  - The actual quantity, the actual weight, or the actual volume is larger than expected.
  - You have received unexpected cargo.
- Other discrepancies: Discrepancies that are not caused by a change in quantities are called other discrepancies. If the cargo is damaged, or documents are missing for the cargo, these events can be recorded as other discrepancies.
  - There is a dangerous goods item that you have not designated as such.
  - The packaging of an item is damaged.
  - You have received over dimensional or high-value cargo.
  - A different equipment type or package type has been used.

Customizing Discrepancy

Before you can handle any discrepancies in SAP TM, you define the discrepancy types in Customizing.

You can define different types of discrepancies in Customizing by following the IMG menu path *Transportation Management → Freight Order Management → Define Discrepancy Profile*.

In this Customizing activity, you can define discrepancy types and associate them with predefined events and discrepancy subcategories. Further, among the discrepancy types associated with the same event, you must select one discrepancy type as the default discrepancy type. You can also define lower or upper discrepancy tolerances.

You can define discrepancy profiles. If you do so, you can assign discrepancy types with different stop categories to them. You can assign discrepancy profiles to freight order types, freight booking types, and transportation unit types.

Methods of Entering Discrepancies

The following options are available when reporting discrepancies:

- Report quantity discrepancies in the *Items* tab of FO, FB, or TU and actual values in the *Quantities* tab of the item details.
- Report other discrepancies in the *Items* tab of FO, FB, or TU and enter detailed information in the *Discrepancies* tab of the item details.
- Add any necessary attachments to a reported discrepancy within the *Attachments* column on the *Discrepancies* tab of the item details.
- Add any necessary notes to a reported discrepancy within either the *Note* or the *Notes* column on the *Discrepancies* tab of the item details.
- It is possible to unassigned FUs for which discrepancies have been reported. FUs can be unassigned from a FO, FB, or TU in the FO/FB/TU screen or in the transportation cockpit. While the discrepancy and the block or blocks still exist on the freight unit level, they are removed in the FB, FO, or TU. This means that the cargo (without the goods of the unassigned FU) can proceed with further processing.

Features

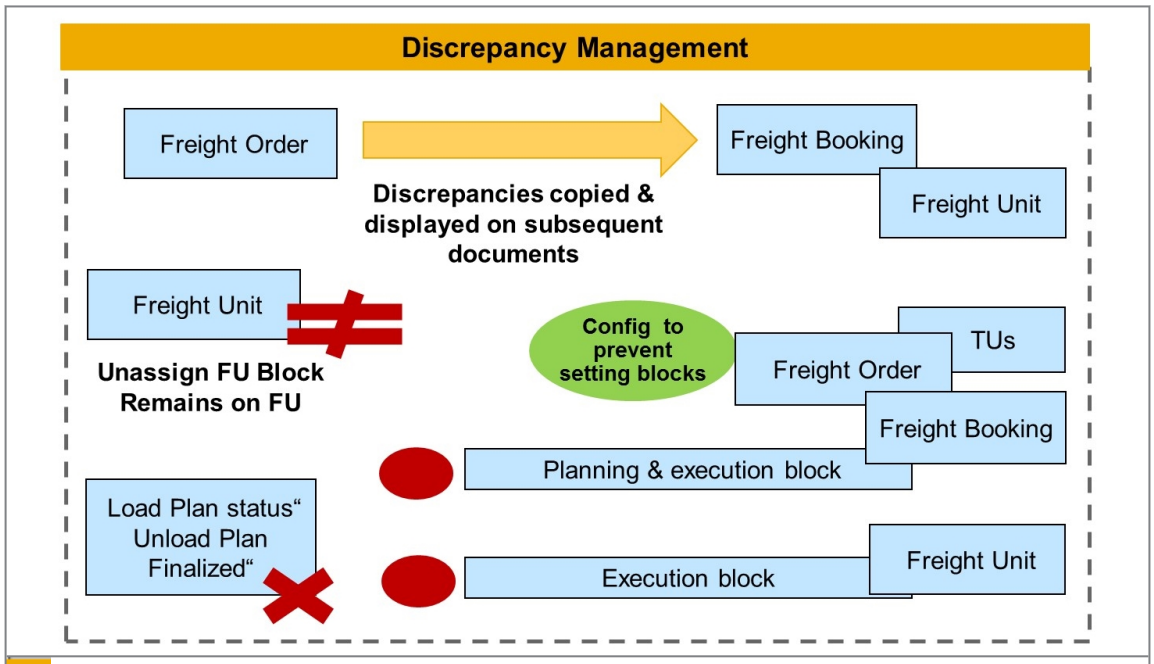

Figure 125: Discrepancy Management Features

When a discrepancy is reported in an FO, FB, or TU document, the system automatically blocks the subsequent stages of the transport when reported discrepancies are not yet resolved.

For freight units, further planning and execution are blocked.

For freight orders, freight bookings, and transportation units, execution and invoicing blocks are set.

In SAP TM, you can select a checkbox in the freight order, freight booking document, or transportation unit that prevents the system from setting a block.

If there are unresolved discrepancies in a document, it is not possible to set the freight execution status to *Freight Ready for (Un-) Loading*. Moreover, a block on an unresolved discrepancy implies that no goods receipt may take place; therefore, you cannot set the cargo receipt status.

Resolving Discrepancies

During execution, discrepancies can be determined between the actual quantities and the quantities that have been ordered by the customer. Furthermore, exceptions can occur, such as missing or damaged cargo. This data can be sent from SAP EWM to SAP TM, and either copied into the freight order or freight booking automatically, or entered into the freight order or freight booking manually.

The customer service agent or transportation planner must decide with the ordering party how to proceed with the discrepancies. Depending on this decision, the customer service agent can adjust the ordered data to the actual data, or can plan the subsequent delivery of missing cargo.

To support the exception handling process, the following functions of SAP TM have been added or enhanced:

- Discrepancy profile with the option to define discrepancy subcategories
- Personal object worklist (POWL) for discrepancies
- Copy of actual data from freight document to ordered data of forwarding order
- Change of forwarding order data after execution has started
- Assignment of local freight document items to forwarding orders and freight units
- Manual freight unit split after execution has started
- Manual corrections of items, for example, after transfer of data from SAP EWM

Conditions for Using the Resolve and Undo Resolve Buttons

You can use the actions associated with the *Resolve* button for specific discrepancy types only. The following conditions apply:

- Resolve discrepancy:

  This action is permitted for all discrepancy types, except for discrepancies with the subcategory *Missing Cargo*. You cannot execute the *Resolve* action for this subcategory if the *Quantity Update* column in the Customizing activity *Define Discrepancy Profile* has the value *Split Predecessor Document*.

- Resolve missing cargo (retain FU item):

  You can execute this action for discrepancies with the subcategory *Missing Cargo* only if the *Quantity Update* column in the Customizing activity *Define Discrepancy Profile* has the value *Split Predecessor Document*.

- Resolve missing cargo (delete FU item):

  You can execute this action for discrepancies with the subcategory *Missing Cargo* only if the *Quantity Update* column in the Customizing activity *Define Discrepancy Profile* has the value *Split Predecessor Document*.

- Resolve unexpected cargo (assign FWO item):

  You can execute this action only for discrepancies with the subcategory *Unexpected Cargo*.

You can use the action associated with the *Undo Resolve* button for specific discrepancy types only. The following conditions apply:

- The discrepancy must have the status *Resolved*.
- The discrepancy must not have the subcategory *Missing Cargo*. If the discrepancy does have the subcategory *Missing Cargo*, the action *Undo Resolve* can be executed only if the *Quantity Update* column in the Customizing activity *Define Discrepancy Profile* does not have the value *Split Predecessor Document*.

LESSON SUMMARY

You should now be able to:

- Configure discrepancy management

Learning Assessment

1. Which of the following are the allowed transportation unit categories?

   Choose the correct answers.

   - ☐ **A** Container
   - ☐ **B** Railcar
   - ☐ **C** Trailer
   - ☐ **D** Vehicle resource

2. You can also assign valid item types to your service order types.

   Determine whether this statement is true or false.

   - ☐ True
   - ☐ False

3. Which of the following statements are correct?

   Choose the correct answers.

   - ☐ **A** SAP EWM and SAP TM run as part of the SAP S/4HANA system since 1709.
   - ☐ **B** SAP S/4HANA was designed to reflect the principle of one design idea.
   - ☐ **C** Direct access to master data is not possible in the SAP S/4HANA environment.

4. Transportation Unit is not used when using Advance Shipping and Receiving functionality?

   Determine whether this statement is true or false.

   - ☐ True
   - ☐ False

5. Which of the following are conditions necessary for PPF Output Management?

   Choose the correct answers.

   - ☐ A Scheduling Condition
   - ☐ B Spool Condition
   - ☐ C Starting Condition
   - ☐ D Update Condition

6. When a discrepancy is reported in a freight order document, what blocks are applied to the freight order?

   Choose the correct answers.

   - ☐ A Planning block
   - ☐ B Execution block
   - ☐ C Invoicing block
   - ☐ D Delivery block

Learning Assessment - Answers

1. Which of the following are the allowed transportation unit categories?

   Choose the correct answers.

   [X] A Container

   [X] B Railcar

   [X] C Trailer

   [ ] D Vehicle resource

   Correct. Container, railcar, and trailer are the allowed transportation unit categories.

2. You can also assign valid item types to your service order types.

   Determine whether this statement is true or false.

   [X] True

   [ ] False

   Correct. You can also assign valid item types to your service order types.

3. Which of the following statements are correct?

   Choose the correct answers.

   [X] A SAP EWM and SAP TM run as part of the SAP S/4HANA system since 1709.

   [X] B SAP S/4HANA was designed to reflect the principle of one design idea.

   [ ] C Direct access to master data is not possible in the SAP S/4HANA environment.

   Correct. SAP EWM and SAP TM run as part of the SAP S/4HANA system since release 1709. The SAP EWM for SAP S/4HANA design was adapted to reflect the principle of one design idea. This meant direct access to master data without the need for replication.

4. Transportation Unit is not used when using Advance Shipping and Receiving functionality?

   Determine whether this statement is true or false.

   [X] True

   [ ] False

   Correct. The Advanced Shipping and Receiving process is based on the freight order and does not use the EWM transportation unit (TU) or the EWM vehicle.

5. Which of the following are conditions necessary for PPF Output Management?

   Choose the correct answers.

   [X] A Scheduling Condition

   [ ] B Spool Condition

   [X] C Starting Condition

   [ ] D Update Condition

   Correct. A scheduling condition defines the "why" for processing an action, while the starting condition defines the “when” for the processing.

6. When a discrepancy is reported in a freight order document, what blocks are applied to the freight order?

   Choose the correct answers.

   [ ] A Planning block

   [X] B Execution block

   [X] C Invoicing block

   [ ] D Delivery block

   Correct. When a discrepancy is reported in a freight order document, execution and invoicing blocks are applied to the freight order.