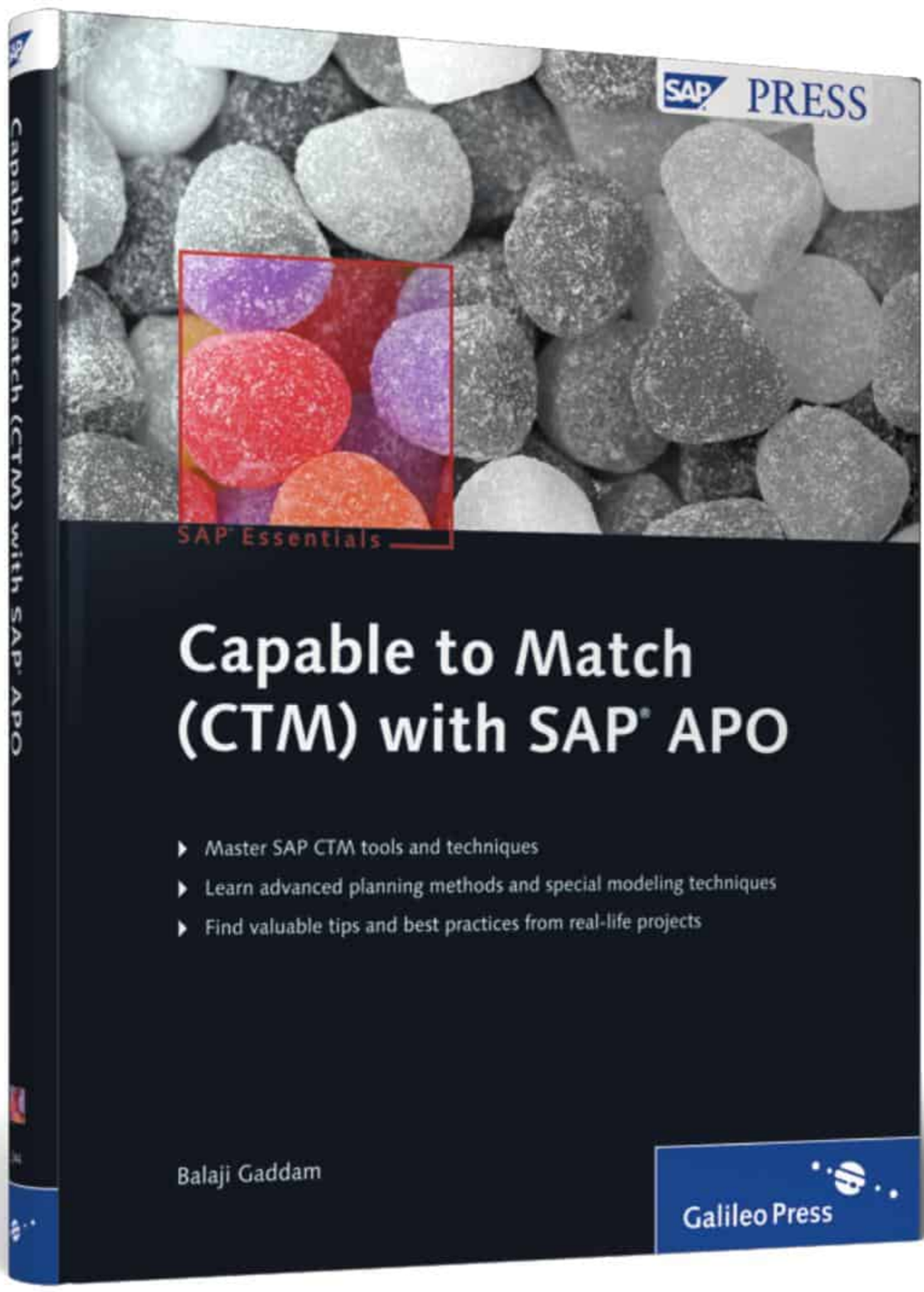
Balaji Gaddam

Capable to Match (CTM) with SAP® APO



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Contents

Acknowledgments 11

1 Overview of SAP SCM 13

1.1 SAP SCM Overview 14
1.1.1 SAP Advanced Planner and Optimizer (SAP APO) 15
1.1.2 Supply Chain Event Management (SCEM) 17
1.1.3 SAP Supply Network Collaboration 18
1.2 Supply Network Planning Methods in SAP SCM 18
1.3 CTM Planning Overview 21
1.3.1 CTM Planning Process Steps 22
1.3.2 System Landscape Requirement for CTM Planning 26
1.3.3 CTM Planning Run — Complete Overview 27
1.4 Configuration Using CTM Planning Parameters 31
1.5 Executing the CTM Planning Run 32
1.6 Summary 33

2 CTM Planning Scope 35

2.1 SAP SCM Master Data 36
2.2 CTM Master Data Selection 38
2.2.1 Master Data Selection Options 39
2.2.2 Automatic Master Data Selection 40
2.3 Master Data Attributes for CTM Planning 45
2.3.1 Location 46
2.3.2 Location Product 47
2.3.3 Resource 48
2.3.4 External Procurement 50
2.3.5 In-House Production 53
2.3.6 Product Substitution 57
2.4 Transactional Data Selection 58
2.5 Planning and Deletion Modes 59
2.5.1 Regenerative Planning with CTM 63
2.5.2 Net Change Planning with CTM 63
2.6 Planning Strategy with CTM 64

244_Book.indb 5 3/3/09 5:38:24 PM

2.6.1 CTM Time Stream 65
2.6.2 Capacity Planning 66
2.6.3 Planning Type 67
2.6.4 Late Demand Strategies 68
2.6.5 Scheduling Direction 69
2.6.6 Pegging Type 70
2.7 Summary 70

3 CTM Demand and Supply Processing 71

3.1 CTM Demand and Supply Attributes 72
3.1.1 CTM Demand Attributes 73
3.1.2 CTM Supply Attributes 75
3.2 CTM Demand Aggregation 76
3.2.1 Demand Aggregation by Time Bucket 77
3.2.2 Demand Aggregation by Rounding Value 79
3.2.3 Demand Aggregation by Hierarchy 80
3.3 Demand Prioritization 82
3.3.1 Demand Prioritization Using Demand Attributes 82
3.3.2 Demand Prioritization Using Descriptive Characteristics 87
3.4 Supply Aggregation 90
3.4.1 Supply Aggregation by Time Buckets 90
3.4.2 Supply Aggregation by Hierarchies 91
3.5 Supply Categorization 92
3.5.1 Supply Categorization by ATP Categories 93
3.5.2 Supply Categorization by Supply Limits 95
3.5.3 CTM Search Strategy for Source Selection 97
3.6 Summary 99

4 CTM Planning Algorithm 101

4.1 CTM Planning Algorithm 103
4.2 CTM Search Tree Generation 103
4.3 CTM Decision Criteria for Source Selection 106
4.3.1 CTM Supply Selection 106
4.3.2 CTM Source of Supply Selection 107
4.3.3 Source Selection with Procurement Type 108
4.3.4 Source Selection with Inbound Quota 110

244_Book.indb 6 3/3/09 5:38:24 PM

4.3.5 Source Selection with Procurement Priorities and Costs .. 113
4.3.6 Source Selection with Validity Date 114
4.3.7 Source Selection with PPM/PDS Lot Size 114
4.4 CTM Order Scheduling 115
4.4.1 Scheduling Planned Order 116
4.4.2 Scheduling Stock Transfer Order 126
4.4.3 Scheduling Purchase Requisitions 129
4.4.4 Scheduling Substitution Order 129
4.5 Scheduling Techniques for Late Demands 130
4.5.1 Late Demand Scheduling Modes 132
4.6 Additional Parameters Influencing CTM Scheduling 134
4.6.1 Scheduling Horizons 135
4.6.2 Order Creation and Deletion Start 135
4.6.3 Demand Selection Horizon 136
4.6.4 Order Creation Frame 136
4.6.5 Maximum Earliness for Planned Orders 138
4.6.6 Maximum Earliness for Dependent Demands (MPL) 139
4.7 CTM Planning Results Analysis 142
4.8 Explanation of CTM Planning Results 142
4.9 CTM Planning Result Indicators 147
4.10 Common Scheduling Issues with CTM Planning 148
4.10.1 CTM Planning with Multilevel Fixed Lot Sizes 148
4.10.2 CTM Planning with Local Search Strategy 150
4.10.3 Bucket Planning with Fixed Lot Size and Resource Underutilization 150
4.10.4 Fair Share Planning with CTM 153
4.11 Summary 155

5 Supply Control with CTM Planning 157

5.1 CTM Planning for Safety Stock Quantity 161
5.1.1 Safety Stock Requirement in SAP liveCache 163
5.1.2 Safety Stock Requirements as Virtual Demands in CTM ... 163
5.1.3 Safety Stock Virtual Demand Generation in CTM 165
5.1.4 Interval Planning with CTM for Reducing Time-Phased Safety Stock 172
5.1.5 Additional Planning Parameters for CTM SS Planning 176
5.2 CTM Planning with Safety Days of Supply 178
5.2.1 Safety Lead Time Calculation for Constant SDS 179

244_Book.indb 7 3/3/09 5:38:24 PM

5.2.2 Safety Lead Time Calculation for Time-Phased SDS 180
5.2.3 CTM Scheduling of Demands Using Safety Lead Time 181
5.3 Additional CTM Supply Control Techniques 184
5.3.1 Store Transport at Destination Location 185
5.3.2 Supply Distribution 187
5.3.3 Minimum Build of Supply 188
5.4 Summary 189

6 Advanced Planning Techniques with CTM 191

6.1 CTM Planning with Requirement Strategies 193
6.1.1 Make-to-Stock Production (10) 194
6.1.2 Planning with Final Assembly (20) 195
6.1.3 Planning Without Final Assembly (30) 196
6.1.4 Planning with Planning Product (40) 199
6.2 Make to Order Production with CTM 199
6.3 Production in Alternative Location 203
6.4 Supply Chain Planning in the Plant 205
6.4.1 Component Withdrawal in Another Location 207
6.5 Subcontracting Planning with CTM 209
6.6 CTM Planning with Product Interchangeability 212
6.6.1 Supersession 213
6.6.2 Form-Fit-Function (FFF) Class 216
6.7 CTM Planning with Substitution Rules 218
6.7.1 Product Substitution Procedure 219
6.7.2 Location Substitution Procedure 219
6.7.3 Product Location Substitution Procedure 219
6.7.4 Production Substitution for Supply 221
6.7.5 Production Substitution for Production (Down Binning) ... 222
6.8 Aggregated Planning with CTM 223
6.8.1 Hierarchy Definitions Used in CTM Planning 224
6.8.2 Master Data Selection for Aggregated Planning in CTM 227
6.8.3 Process Steps for Aggregated Planning in CTM 228
6.8.4 Aggregated Planning with Safety Stock 235
6.9 CTM Planning in Distribution Networks 237
6.10 Summary 238

244_Book.indb 8 3/3/09 5:38:24 PM

7 Technical Details of CTM Planning 239

7.1 CTM Planning Performance Optimization 239
7.1.1 STEP 1: Read Data and Delete Order 242
7.1.2 STEP 2: CTM Engine Planning for Demands 245
7.1.3 STEP 3: Write the CTM Planning Result in liveCache 253
7.1.4 STEP 4: Publish CTM Results to SAP ERP 255
7.2 Using Parallel Processing for CTM Planning 257
7.3 CTM Planning Business Add-Ins 260
7.4 Summary 261

Glossary 263

The Author 269

Index 271

244_Book.indb 9 3/3/09 5:38:24 PM

This chapter provides a basic overview of the SAP SCM application. Multilevel Supply Demand Matching (SDM) or more commonly known as Capable-to-Match (CTM) is a constraints-based, finite, multilevel supply planning solution available in SAP SCM. The key components and process steps of the CTM planning solution are explained in this chapter.

1 Overview of SAP SCM

Supply Chain Management (SCM) has evolved over the years but fundamentally SCM is based on two key aspects. The first is that practically every product that reaches an end user represents the cumulative effort of multiple organizations. These organizations are referred to collectively as the supply chain. The second aspect is that while supply chains have existed for a long time, most organizations have only paid attention to what was happening within their "four walls."

Few businesses understood, much less managed, the entire chain of activities that ultimately delivered products to the final customer. A key barrier was the cost of communicating with and coordinating among the many independent suppliers in each supply chain. The result was disjointed and often ineffective supply chains. SCM is the active management of supply chain activities to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by the supply chain firms to develop and run supply chains in the most effective and efficient ways possible. Supply chain activities cover everything from product development, sourcing, production, and logistics, as well as the information systems needed to coordinate these activities. The organizations that make up the supply chain are "linked" together through physical flows and information flows. Physical flows involve the transformation, movement, and storage of goods and materials. They are the most visible piece of the supply chain. But information flows are just as important. *Information flows* allow the various supply chain partners to coordinate their long-term plans and to control the day-to-day flow of goods and material up and down the supply chain. The following are five basic components of SCM:

244_Book.indb 13 3/3/09 5:38:24 PM

- **Plan**
  This is the strategic portion of SCM. You need a strategy for managing all of the resources that go toward meeting customer demand for your product or service. A big piece of planning is developing a set of metrics to monitor the supply chain so that it's efficient, costs less, and delivers high quality and value to customers.
- **Source**
  This is the step in which you choose the suppliers that will deliver the goods and services you need to create your product. Develop a set of pricing, delivery, and payment processes with suppliers, and create metrics for monitoring and improving the relationships. Put together processes for managing the inventory of goods and services you receive from suppliers, including receiving shipments, verifying them, transferring them to your manufacturing facilities, and authorizing supplier payments.
- **Make**
  This is the manufacturing step. Schedule the activities necessary for production, testing, packaging, and preparation for delivery. As the most metric-intensive portion of the supply chain, measure quality levels, production output, and worker productivity.
- **Deliver**
  This is the part that many insiders refer to as logistics. Coordinate the receipt of orders from customers, develop a network of warehouses, pick carriers to get products to customers, and set up an invoicing system to receive payments.
- **Return**
  This is the problem part of the supply chain. Create a network for receiving defective and excess products back from customers and supporting customers who have problems with delivered products.

1.1 SAP SCM Overview

SCM is possible today mainly due to advancement in technology that has simplified communication and coordination across the supply chain. Companies recognize that costs can be reduced while customer satisfaction is increased when production and inventory decisions are based on analysis of the total system of delivering products and services.

244_Book.indb 14 3/3/09 5:38:25 PM

The SAP SCM application provides comprehensive, industry-specific SCM capabilities and offers a standard interface for SAP ERP for seamless integration of the supply chain planning and supply chain execution functions. SAP SCM contains solutions for the following:

- Supply chain planning
- Supply chain execution
- Supply chain coordination
- Supply chain collaboration

1.1.1 SAP Advanced Planner and Optimizer (SAP APO)

SAP Advanced Planner and Optimizer (SAP APO) provides a robust and scalable solution for real-time collaborative decision support, advanced planning, simulation, and optimization. The powerful memory resident analytical engine (SAP liveCache) and highly flexible and configurable SAP BW technology support strategic, tactical, and operational planning. SAP APO contains several advanced optimization algorithms to support supply network, production, distribution, and transportation planning and optimization.

The core components of SAP APO are listed here:

- **Demand Planning**
  SAP APO Demand Planning (DP) creates a forecast of market demand for the finished products. DP allows you to take into consideration many different causal factors that affect demand. The result of SAP APO DP is the demand plan. DP offers several user-specific planning layouts and interactive planning books to enable you to integrate people from different departments, and even different companies, into the forecasting process. Using the DP library of statistical forecasting and advanced macro techniques, you can create forecasts based on demand history as well as any number of causal factors, carry out predefined and self-defined tests on forecast models and forecast results, and adopt a consensus-based approach to reconcile the demand plans of different departments.
- **Supply Network Planning**
  The seamless integration of DP with *Supply Network Planning* (SNP) supports an efficient SAP Sales and Operations Planning (SAP SOP) process. Using the demand plan, the supply planner uses SNP to create a feasible, synchronized,

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and optimized supply plan in a mid-term horizon. SNP offers three main planning options:

SNP Heuristics provides an infinite supply planning function that must be followed by capacity leveling to generate a feasible plan.

SNP Optimizer is a cost-based finite capacity planning function.

Capable-to-Match (CTM) is a constraints-based, multilevel finite capacity planning function.

- **SNP Deployment**
  The *SNP Deployment* function determines how and when inventory should be deployed to distribution centers, customers, and vendor-managed inventory accounts. It produces optimized distribution plans based on constraints, such as transportation capacities, and business rules, such as minimum cost approach or replenishment strategies. The *Transport Load Builder* (TLB) function maximizes transport capacities by optimizing load building.
- **Production planning and detailed scheduling**
  You use the *production planning and detailed scheduling* (PP/DS) component in SAP APO to create procurement proposals for in-house production or external procurement to cover product requirements. PP/DS Optimization functions help to optimize and plan the resource schedule and the order dates and times in detail.
- **Transportation planning and vehicle scheduling**
  Transportation planning/vehicle scheduling (TP/VS) is available in SAP APO to plan and optimize shipments for orders (sales orders, purchase orders, returns, and stock transport orders) and deliveries. You assign the orders and deliveries for which you plan shipments to vehicles. You can take various restrictions into account, for example, requested delivery dates or transportation capacities when assigning the vehicles. The result of TP/VS planning is the creation of planned shipments. TP/VS also supports various processes such as outbound delivery, inbound delivery, and cross-docking.
- **Global Available to Promise**
  Global-ATP (GATP) contains the functions for the ATP check in SAP APO. This includes transportation and shipment scheduling, which is carried out in SAP APO. The ATP check, also known as the availability check, represents an online search that should ensure that your company can provide the requested product at the requested time in the quantity requested by the customer.

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Figure 1.1 shows the core components of SAP SCM.

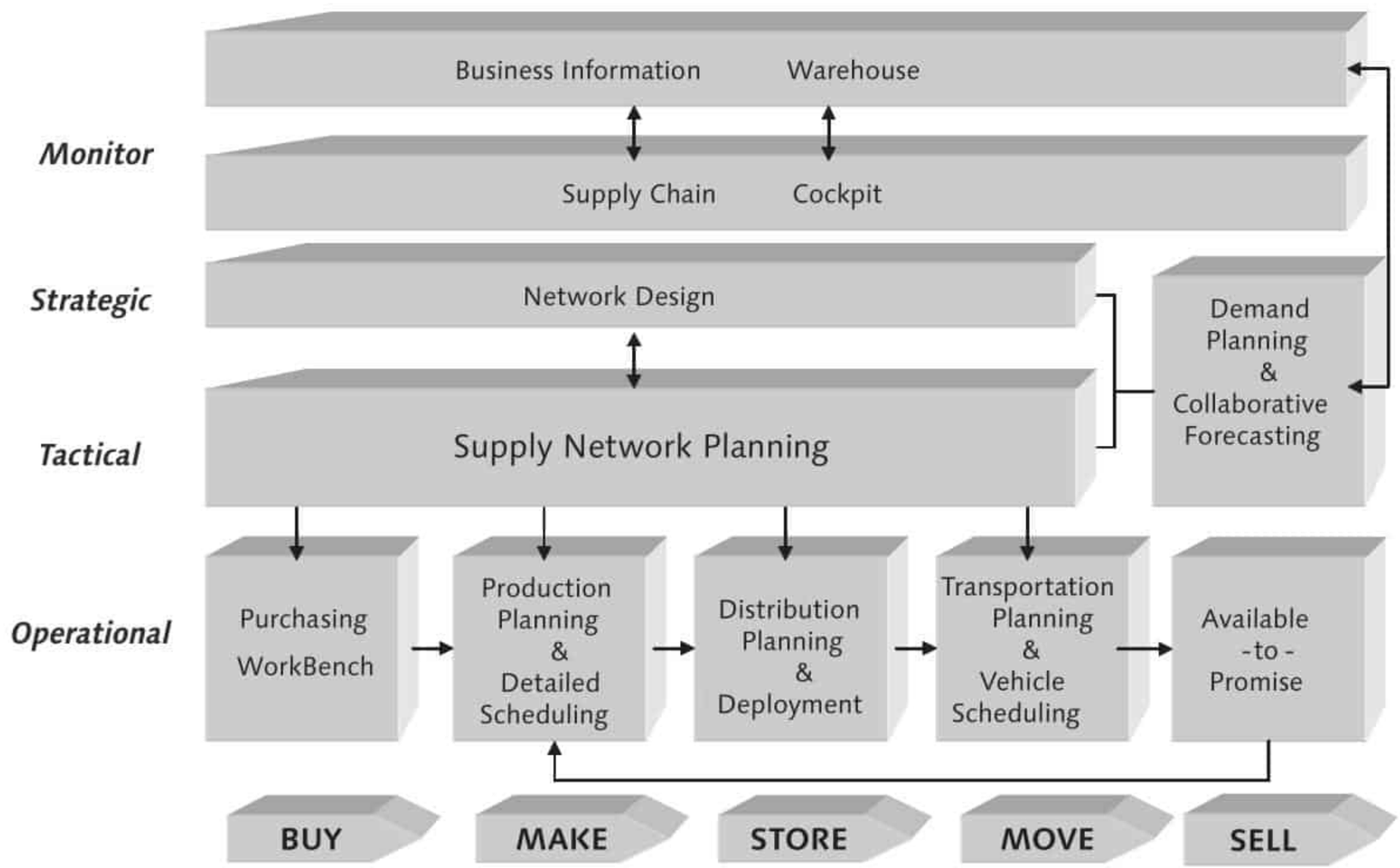

Figure 1.1 Overview of SAP APO

Supply Chain Execution functions such as material management, manufacturing, warehouse management, and transportation execution are done in SAP ECC.

1.1.2 Supply Chain Event Management (SCEM)

SAP SCM provides advanced solutions for *supply chain coordination*. The *Supply Chain Event Management* (SCEM) component provides or improves visibility within your logistics processes for both planning and execution. Due to the flexibility of the solution, you can map, control, and check all required business processes. A role-based approach makes it possible to view the same business process from various points of view.

You can use SAP SCEM to process messages about the events in business processes and thereby notify in various ways those involved in the supply chain network about business events that have occurred. By actively notifying the responsible persons and making them aware of critical situations or exceptions, you can optimize reaction times and improve quality and customer satisfaction.

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1.1.3 SAP Supply Network Collaboration

SAP Supply Network Collaboration is one of the core capabilities of adaptive supply chain networks, a fundamental principle for the networked and outsourced enterprise of today and tomorrow. Through SAP Supply Network Collaboration, customers and suppliers can simultaneously eliminate inefficiencies in their supply chains by synchronizing the flow of information between them. SAP Supply Network Collaboration offers a 360-degree view on supply chain collaboration, offering firms different ways to effectively collaborate with customers, suppliers, third-party logistics providers, and outsourced manufacturing partners.

For *supplier collaboration*, SAP Supply Network Collaboration offers upstream business processes such as supplier managed inventory (SMI), discrete purchase order management, scheduling agreement release handling, and web-based kanban signals.

For *customer collaboration*, SAP Supply Network Collaboration offers comprehensive downstream business processes such as responsive replenishment, which represents the next generation in demand-driven replenishment and collaboration.

SAP Supply Network Collaboration also offers market-leading capabilities for collaborating and monitoring contract manufacturing relationships. For outsourced manufacturing, the main capabilities include cross-tier visibility of inventory, supply and demand, and a collaborative work order process that tracks work-in-progress, material consumption, and BOM changes at the outsourced manufacturing partner.

1.2 Supply Network Planning Methods in SAP SCM

SNP integrates purchasing, manufacturing, distribution, and transportation so that comprehensive tactical planning and sourcing decisions can be simulated and implemented on the basis of a single, consistent global model (see Figure 1.2). SNP uses advanced optimization techniques, based on constraints and penalties, to plan product flow along the supply chain. The result is optimal purchasing, production, and distribution decisions; reduced order fulfillment times and inventory levels; and improved customer service.

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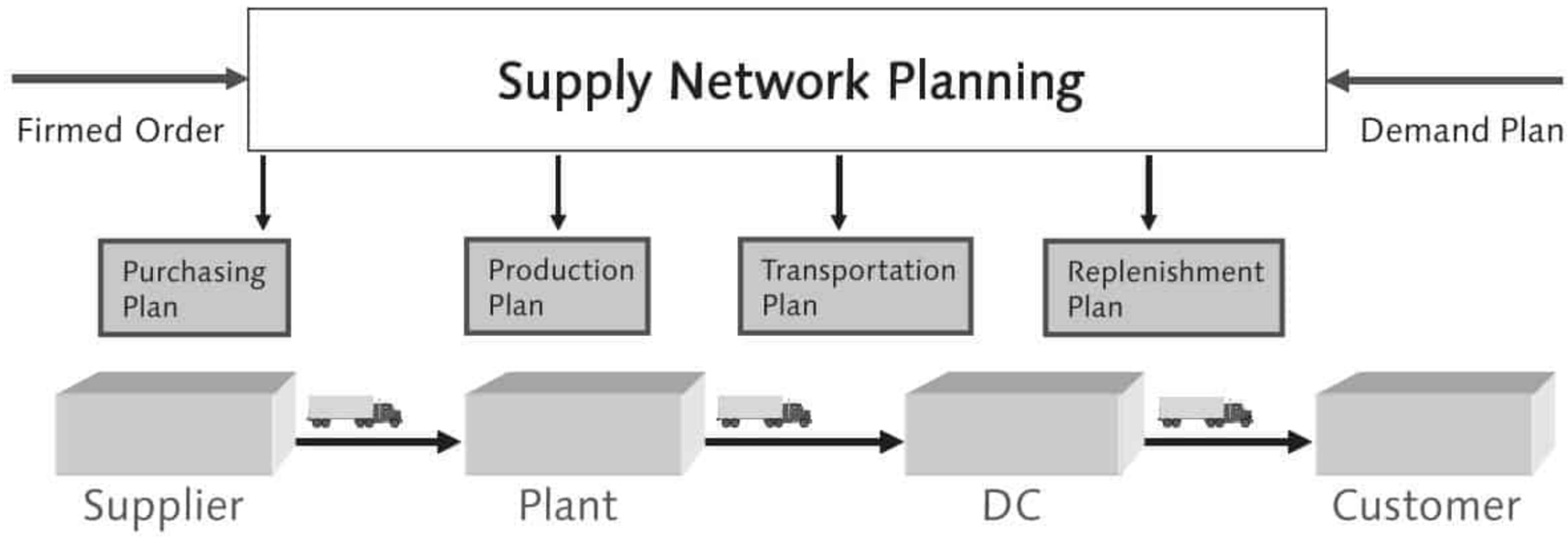

Figure 1.2 SAP APO Supply Network Planning Overview

Starting from a demand plan, SNP determines a permissible short- to medium-term plan for fulfilling the estimated sales volumes. This plan covers both the quantities that must be transported between two locations (e.g., distribution center to customer or production plant to distribution center), and the quantities to be produced and procured. When making a recommendation, SNP compares all logistical activities to the available capacity.

SNP can be executed finitely. In this way, the production, warehouse, or transport resources of your network can already be taken into account in rough-cut planning. In principle, planning in SNP takes place based on so-called time buckets, that is, on the basis of freely defined time bucket profiles. The smallest unit in SNP is one day. In terms of performance, bucket-oriented planning is much better than detailed scheduling in SAP APO PP/DS, so that planning of more complex networks is also possible. Network planning within SNP generally takes place in two steps. In the first step, the stock transfer orders are created to optimally distribute and meet the requirements in the network. After production has taken place in the production plants, planned orders are deployed to meet the requirements at the distribution centers of the network.

In SNP, different planning strategies are available to generate an optimal and feasible supply plan for the entire supply chain network. Supply planning in SAP APO can be performed using the following:

- SNP Heuristics
- SNP Optimizer
- Multilevel Supply Demand Matching (SDM)

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SNP Heuristics is a repair- or alerts-based planning strategy where no capacity checks are considered for planning. The sourcing decisions are influenced by the quota arrangements. Capacity leveling must be used to generate a feasible production plan to cover the requirements.

SNP Optimizer on the other hand uses cost-based optimization strategy. The finite supply plan is created with the primary objective of reducing production cost, transport cost, nondelivery cost, storage cost, and so on while considering the production, transport, and handling capacity constraints. SNP Optimizer searches through all feasible plans in an attempt to find the most cost-effective supply plan. The optimizer uses the linear programming method to consider all planning-related factors simultaneously within one optimal solution. As more constraints are activated, the optimization problem becomes more complex, which usually increases the time required to solve the problem. The optimizer makes a distinction between continuous linear optimization problems and discrete optimization problems.

In contrast, Multilevel Supply Demand Matching (SDM), more commonly known as *Capable-to-Match* (*CTM*), creates a multilevel supply plan for the complete supply chain network. The supply plan is created for each of the prioritized demands. Any supply or resource constraints identified at each of the intermediate planning levels are propagated to the finished product demand. CTM uses all available procurement alternatives to create an in-time solution for the demand. Available resources and supplies are allocated in sequence to each of the prioritized demands selected for planning.

Figure 1.3 shows the differences among the three SNP planning strategies. The key difference among the SNP planning methods is process flow. Heuristics uses the low-level code planning approach; that is, the complete supply chain network is resolved into the linear supply chain for planning. The planning levels are identified using the low-level code determination function. The planning is then executed level by level.

The main focus of this book is to explain the CTM planning process in detail, including the key process steps, configurations, functions, master data and transactional data relevant for CTM planning.

The next section provides the overview of the CTM planning process and the key steps involved in CTM planning.

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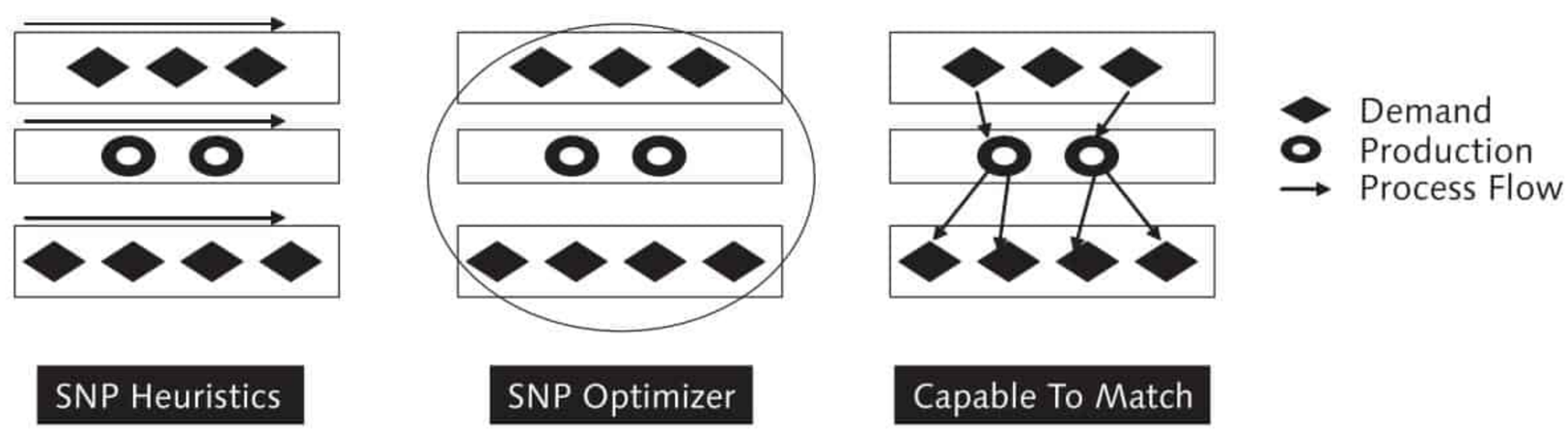

Figure 1.3 Comparison of SNP Strategies

1.3 CTM Planning Overview

CTM planning uses a *constraints-based, multilevel, finite, top-down* planning approach for cross-location checks of supplies, production, and transport capacities. CTM does that on the basis of predefined supply categories and demand priorities. The goal of CTM planning is to calculate a feasible solution for fulfilling all demands and match the demands to the available sourcing alternatives. All sourcing alternatives are checked first for *in-time* demand fulfillment before switching to *late demand* fulfillment. CTM first prioritizes the demands and then schedules them in sequence based on the unique prioritization sequence. CTM then matches the supplies and demands on a first-come, first-served basis while taking the production capacities, means of transports, and existing supplies into consideration. In the standard SAP APO solution, the term and menu option *Multilevel Supply Demand Matching* is used to refer to the CTM planning and supply distribution functions. Due to the limitations of the supply distribution function in CTM, this function has seen very limited adoption by SAP APO customers. As a result, the terms SDM and CTM are used interchangeably. In SAP SCM 5.1, the supply distribution function is significantly developed to overcome the limitations and can be used to finitely plan transporting and handling resource capacities.

Historically, the CTM planning solution was developed in close cooperation with several high technology companies during the late 1990s. Due to its flexibility and scalability, CTM has been implemented in several other industry segments as well. The CTM planning solution isn't only used for SNP but also, in some cases, has been successfully used for near-term production planning. This is possibly due to the generic planning algorithm used by CTM. The planning engine uses the same data model for both time series- (bucket oriented) and order- (time continuous)

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based planning. The CTM engine is capable of scheduling both bucket and time continuous resources to provide daily and up-to-the-second scheduling results.

The CTM planning results are closely integrated with the SNP planning book and PP/DS planning board for interactive planning. CTM can use both the SNP and PP/DS master data, so the CTM planning results can be seamlessly integrated with either of the interactive planning tools for further processing. CTM can also create both SNP and PP/DS order types. The main advantage of CTM planning is the creation of fixed pegging relationships. The planning solution can be easily traced using the fixed pegging created by CTM. SNP Heuristics and SNP Optimizer lack this capability because they work mainly in the bucket-oriented planning mode.

Because CTM offers both bucket-oriented SNP and time continuous PP/DS planning functions, it's important to understand the key differences and limitation of CTM planning in both of these planning modes.

1.3.1 CTM Planning Process Steps

The complete CTM planning process flow is shown in Figure 1.4. As a first step, you must define the scope of CTM planning. The scope of CTM planning includes the master and transactional data. The CTM planning process contains several parameters — which can be maintained using CTM global customization — and strategies.

The CTM profile is the most fundamental setting required to start the CTM planning process and is supplemented using CTM global customization. The CTM profile contains additional attributes such as planning horizon, capacity planning strategies, and late demand strategies.

The CTM planning process can be optionally followed by the supply distribution function. Using supply distribution, you can create stock transfer orders for the excess supplies. The planning results can be analyzed using the SNP planning books or PP/DS product or receipt view. The constrained supply plan created by CTM can be used to provide input to the demand plan or to propose product allocation data for GATP checks.

To use the CTM planning function, the data selection and planning strategies are combined and configured using the CTM profile. A CTM profile can be created using SAP APO Transaction /SAPAPO/CTM or the SAP Easy Access menu ADVANCED PLANNING AND OPTIMIZATION • MULTILEVEL SUPPLY AND DEMAND MATCHING • PLANNING • CAPABLE TO MATCH PLANNING.

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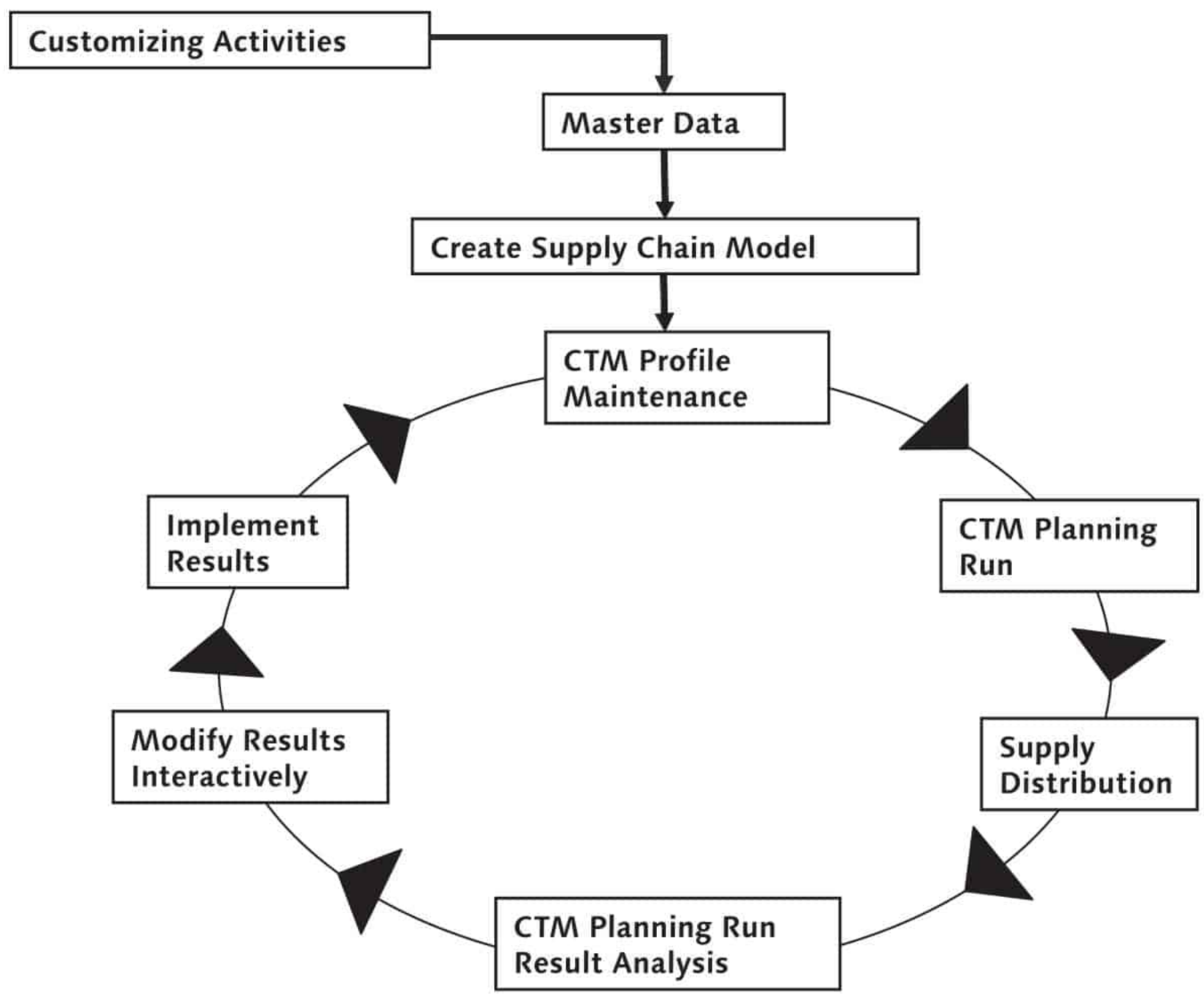

Figure 1.4 CTM Planning Process Steps

As the central access point for working with CTM, the planning profile offers several settings to configure and model the planning requirements. The key configuration settings available in the CTM profile are explained in detail in later chapters. The planning run can be executed online using the CTM profile.

The CTM planning configuration in the profile is divided into multiple tabs as shown in Figure 1.5. The key profile sections are listed here:

- Planning Scope
- Planning Strategies
- Demand and Supply Aggregation
- Demand Prioritization
- Supply Categorization
- Settings

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Figure 1.5 CTM Planning Profile Overview, SAP APO Transaction /SAPAPO/CTM

Online interactive planning using a CTM profile can be used for smaller models. You can create a smaller master data selection to check the demands and supplies used for planning using the demand and supply simulation list. Using the demand and supply simulation function in the CTM profile, you can select the demand and supplies that will be selected for CTM planning. The master data check function in the CTM profile can be used to display the planning attributes of master data objects selected for planning. CTM profile configuration can be transported using the standard SAP transport request to ensure a robust change management process in the production system. This is important because the CTM planning run is very sensitive to the configuration. The CTM planning run can be negatively influenced by incorrect or unintentional changes in the production system.

In addition to the CTM profile, the CTM global customization shown in Figure 1.6 contains the parameters relevant for CTM planning. The planning process starts with identifying the key requirements for the planning mode in the global customization. This can be accessed using the SAP APO Transaction /SAPAPO/CTMCUST

244_Book.indb 24 3/3/09 5:38:30 PM

or in the SAP IMG under ADVANCED PLANNING AND OPTIMIZATION • SUPPLY CHAIN PLANNING • MULTILEVEL SUPPLY AND DEMAND MATCHING • CAPABLE TO MATCH • DEFINE GLOBAL VALUES AND DEFAULT VALUES.

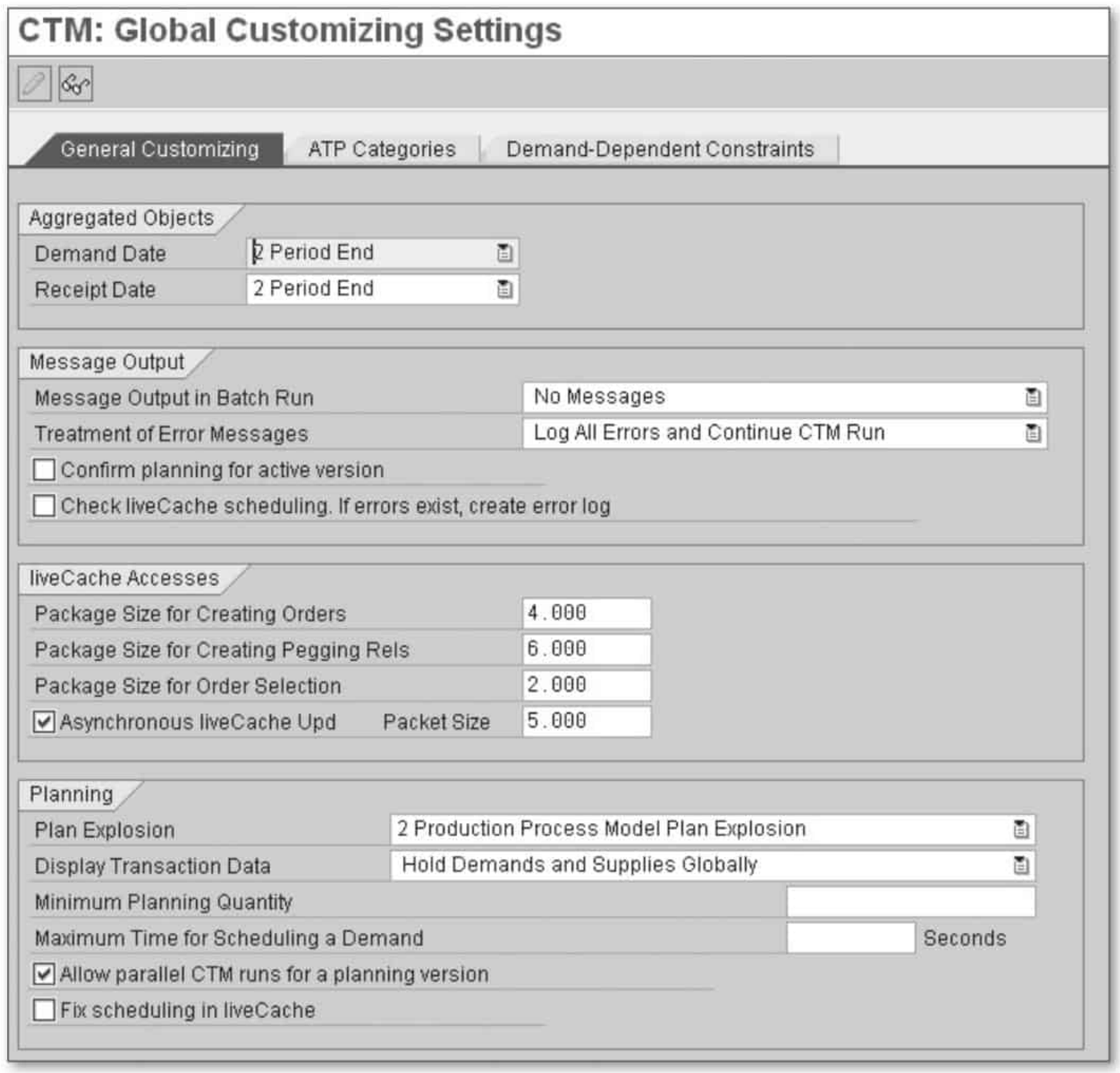

Figure 1.6 CTM Global Customization Settings

Global settings that will be applied to all product locations and across all CTM profiles are Late Demand Fulfillment, Order Creation Frame, and Allow Shortage Setting for the Demands. Performance-related configuration parameters for reading and writing data to liveCache are also maintained under CTM global customization.

Supply distribution is an optional step that is available with multilevel SDM. By using the CTM supply distribution function, excess supply can be distributed to

244_Book.indb 25 3/3/09 5:38:31 PM

the next location in the supply chain identified by the transport lanes. The distribution quantities are derived using outbound quotas for the source location. The CTM supply distribution functionality is very limited in comparison to the standard SNP Deployment function. It can be started using the SAP APO Transaction /SAPAPO/CTM10 or via the SAP Easy Access menu ADVANCED PLANNING AND OPTIMIZATION • MULTILEVEL SUPPLY AND DEMAND MATCHING • PLANNING • SUPPLY DISTRIBUTION.

Supply planning requirements can be very complex and can't be accomplished using a single CTM planning run or CTM planning profile. To accomplish overall planning requirements, several CTM profiles are required in sequence, which can be combined with other planning steps (PP/DS, SNP Optimizer, SNP Deployment, etc). After all CTM planning jobs are finished, the results can be validated and modified using the SAP SCM interactive planning tools such as the SNP planning book and PP/DS planning board. You can also use exception-based results analysis using the SAP SCM Alert Monitor.

1.3.2 System Landscape Requirement for CTM Planning

The SAP APO system is used for real-time supply chain planning and simulation for the complete supply chain network. In SAP APO, large volumes of data must be permanently available and changeable. For this reason, the relational database system in SAP APO is extended to enable actual data structures and data flows (such as networks and relationships) to be mapped more easily and effectively. All of the transactional data is saved in the additional database called SAP liveCache.

The SAP liveCache object-oriented database is an enhancement of the MaxDB database system. SAP liveCache operates with its data in the main memory of the database system, if configured optimally. SAP liveCache is a memory-resident database capable of providing fast access to the data and contains analytical functions for real-time scheduling of production resources.

The traditional database in the SAP SCM system contains all of the master data required for planning, and liveCache contains the transactional data.

In addition to SAP liveCache, both SNP Optimizer and CTM require a special optimizer server to execute the respective planning engines. Figure 1.7 shows the minimal SAP APO system landscape required for CTM planning.

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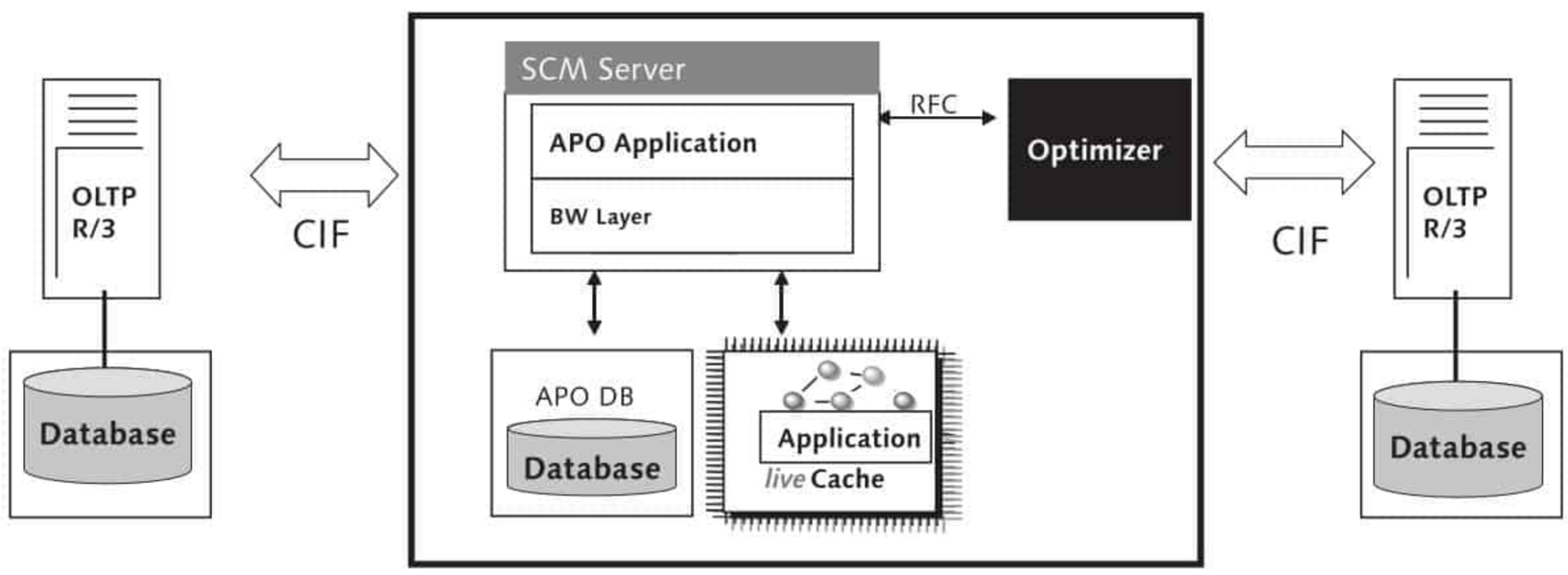

Figure 1.7 SAP APO Minimal Landscape for CTM Planning

The CTM planning engine as of SAP SCM 5.0 is only supported for the Windows operating system. The CTM planning engine is the core of CTM planning, which provides advanced constraint-based planning algorithms and is implemented in C++ to provide a scalable and high-performance planning solution for managing large data models. The SAP APO system is the primary source of master and transaction data for the CTM engine. The communication between the SAP SCM system and the CTM engine is established using standard RFCs. The SAP APO planning system can be connected with one or more R/3 systems for order execution, with communication between the two managed by Core Interface (CIF). To use the CIF function in SAP ERP, you must import a suitable SAP R/3 plug in up to and including SAP ECC 5.0. As of SAP ECC 6.0, CIF is an integrated part of SAP ERP. CIF is also an integrated part of SAP APO.

1.3.3 CTM Planning Run — Complete Overview

A CTM planning run consists of several steps as shown in Figure 1.8. Steps 1-4 are required for CTM planning data preparation. CTM planning is generally executed in the complete replan mode. For example, the previously created supply plan is deleted, and a new plan is recreated. The deletion step can be combined with the planning run, although the deletion can be done independent of the planning step.

Order data in SAP APO can be deleted using the SAP APO Transaction /SAPAPO/RLCDEL. We recommend using the CTM planning profile to delete the current plan to ensure that the orders are deleted consistently with respect to CTM planning strategies.

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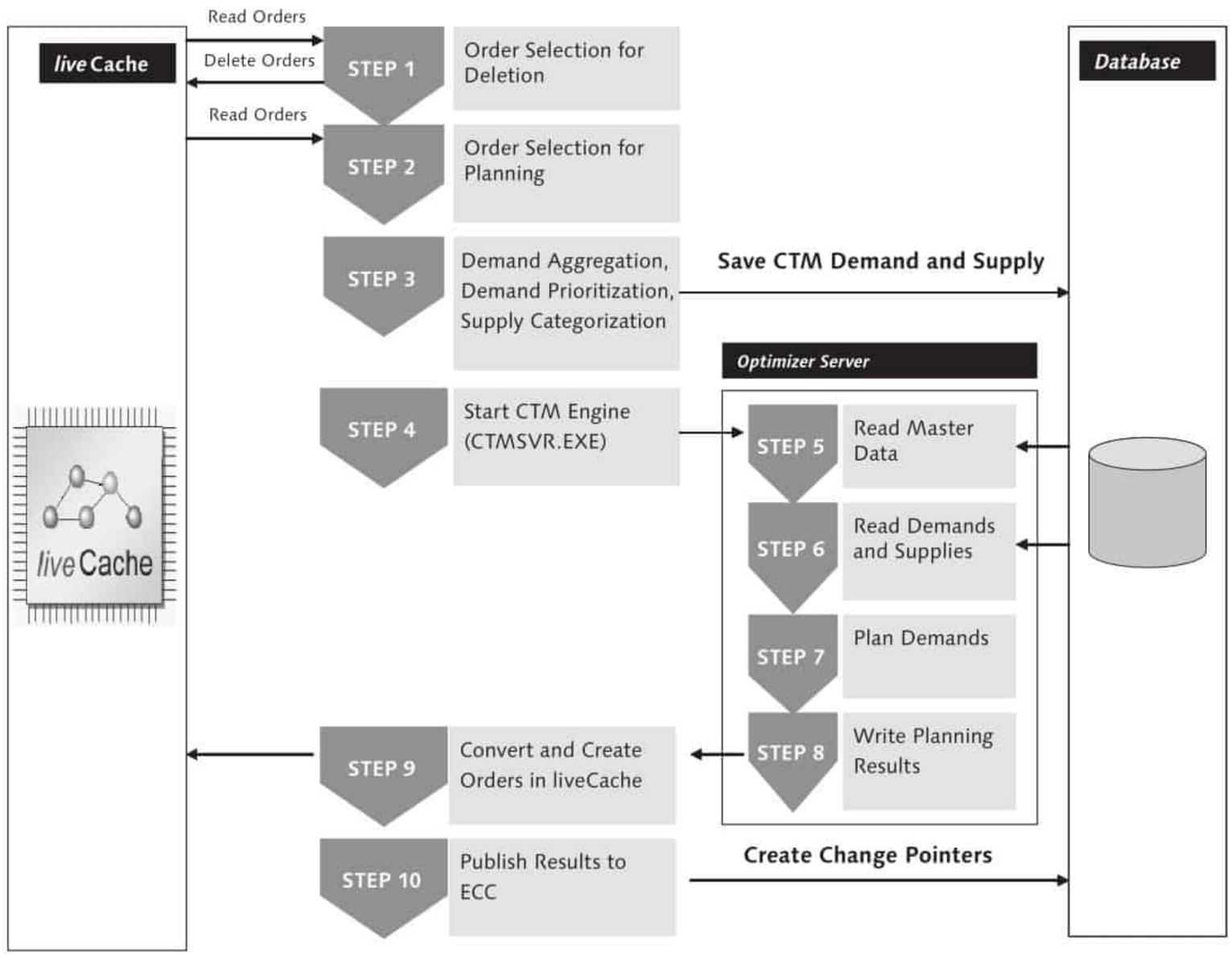

Figure 1.8 Complete CTM Planning Overview

After order deletion, the next planning steps involve selecting master and transaction data. The master data model must be complete and consistent to ensure that the planning results are correct. The CTM master data consistency check function can be used to validate the consistency of the master data used by the planning engine. Depending on the planning option, the master data objects typically consist of products, locations, transport lanes, production process mode/production data structure (PPM/PDS), and resources. In special cases, master data objects may also be ATP rules, super session chains, FFF (Form-Fit-Function) classes, and hierarchy definitions.

The transactional data relevant for planning is also selected in the CTM profile. When a complete regenerative planning is used with CTM, all of the unfirmed orders are selected for deletion. During this step, not only are the unfirmed orders deleted but so is the fixed pegging across firmed orders. This ensures that the open

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supply will be reallocated to the demand using the latest prioritization sequence. After the unfirmed orders are deleted, the open orders are selected and converted to CTM demand and supplies.

CTM Demand and CTM Supply: Defined

It's important to understand the definition of the CTM demand and CTM supply. CTM demand is similar to any requirement element in SAP SCM with additional planning constraints and planning parameters assigned to them, for example, Late Demand Frame, Early Fulfillment Frame, Pegging type and so on. More detailed description of CTM demand is provided in later chapters. Similarly, CTM supply is a receipt element with additional parameters for CTM planning, for example, Supply Category. This is an important aspect because some of the core CTM functions are applicable only for the CTM demands and supplies and not for the dependent demands and supplies created during the planning run.

Step 3 corresponds to the aggregation step and is used to aggregate the demands and supplies across a given product location and ATP category. For example, if there are multiple sales orders for a given product location, then all of the sales orders can be virtually aggregated to a single sales order for planning using demand aggregation.

The aggregation time buckets can be selected as daily, weekly, monthly, quarterly, or yearly. The main advantage with CTM demand aggregation is that the CTM engine has to plan fewer demands, and the supply plan consists of fewer orders, thus reducing the overall runtime of the planning run. Although aggregation offers many advantages, it's important to understand that aggregation loses the detailed level attribute information required for planning.

If there are several sales orders with different priorities, the aggregated sales order won't have the priority assigned to it mainly because it's not possible to aggregate multiple priorities to a single priority. This is critical if the demand prioritization is based on sales order priority.

Demand aggregation is optional and is followed by demand prioritization where the CTM demands are prioritized using the sort sequence. Demand prioritization is followed by the supply categorization.

Steps 5-8 correspond to CTM engine planning steps. The selected master data, prioritized demands, and categorized supplies are uploaded to the CTM engine. The

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CTM engine then uses the input data to generate a feasible supply plan considering the sourcing rules and capacity constraints.

As shown earlier in Figure 1.7, the CTM engine is executed in a separate optimization server. Chapter 4 provides a more detailed description of the planning algorithm and planning parameters that can be configured to achieve the desired planning results.

The CTM planning algorithm is very flexible and generic in terms of the input parameters that can be configured. After the input parameters are selected, the planning logic is fairly constant — the results depend on a set of key rules. CTM planning rules are fixed and consistent and can't be modified by customers using any user exits or Business Add-Ins (BAdIs). On the other hand, several extension points (BAdIs, user exits) are available in the planning data preprocessing and postprocessing steps. Stable core CTM logic also ensures that the planning results are much more explainable and understandable. As shown in Figure 1.9, the core CTM algorithm executes multilevel finite planning using the prioritized demands and categorized supplies. Each source is selected using the priority to generate an in-time feasible plan. Constraints that are detected for any of the assemblies and raw materials are propagated to the finished product demand. As a result, the dependent demands are always satisfied in-time. Late solution is allowed only for the finished product demands that are selected for CTM planning.

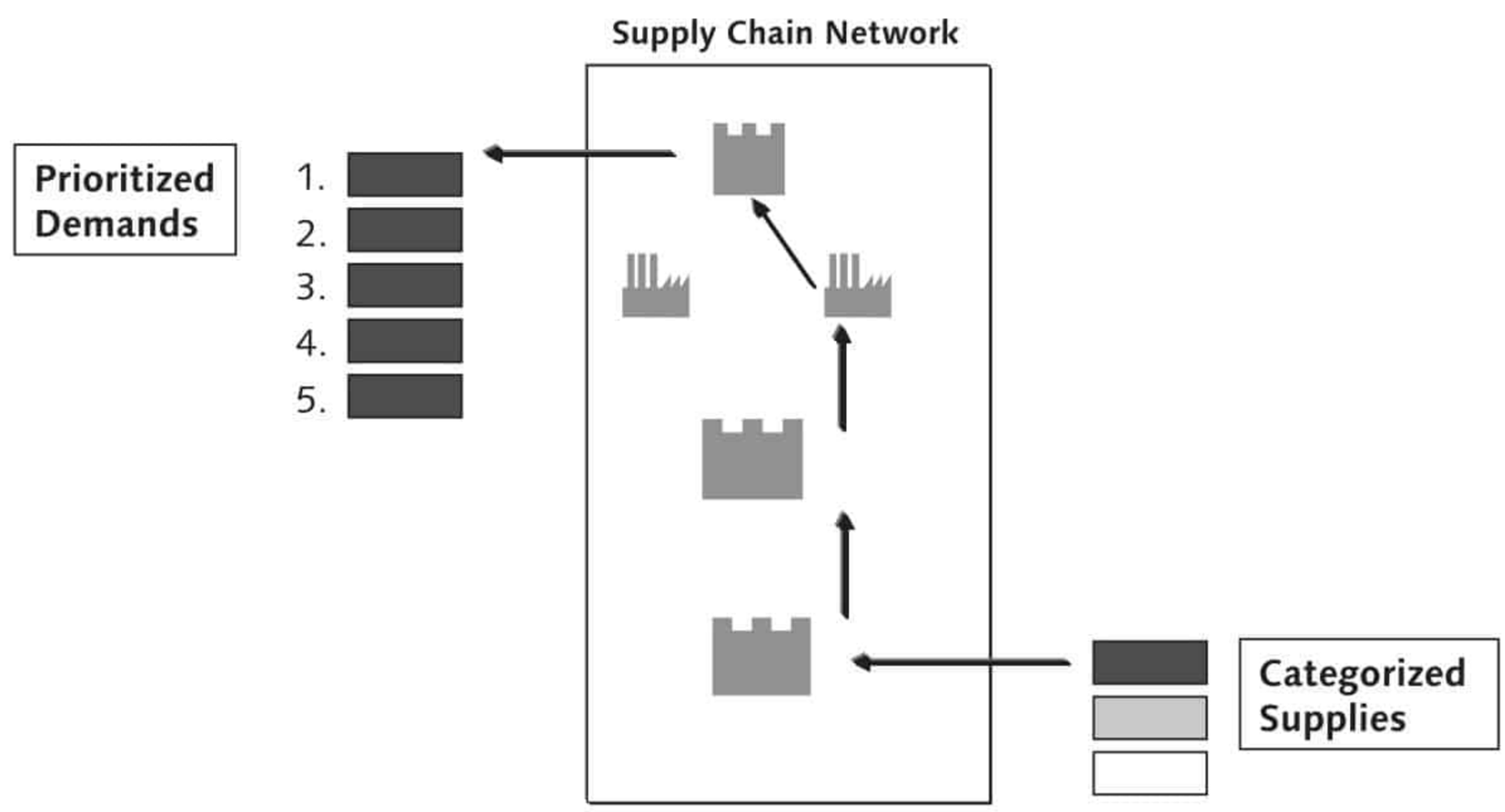

Figure 1.9 Multilevel SDM Using CTM

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After the CTM engine generates the supply plan, the results are persistently saved in SAP liveCache in Step 9. In Step 10, CTM planning results are published to the ECC system. Publication of the planning results in SAP SCM is allowed when the planning data is created in the active version (000). The publication is done using the CIF delivered with the SAP SCM solution. There are two options for publishing the results. You can choose to publish the results immediately or collect the planning results and publish them in batch mode at periodic intervals. The latter option is recommended for CTM planning to ensure the planning results are published optimally without causing any performance bottleneck in CIF.

In the next section, you'll learn how to enable special planning functions using CTM planning parameters.

1.4 Configuration Using CTM Planning Parameters

CTM planning parameters can be used to implement a specific behavior or a new function without changing the interface to the planning engine in a given SAP SCM release. In customer projects, the interface often has to be extended to implement a new functionality that can be switched on or off. By using planning parameters, it's not required to extend the interface. The planning parameters provide a generic interface to transfer additional planning attributes to the CTM engine.

You can search the list of all CTM planning parameters in the SAP Service Marketplace in the Notes section. Some parameters must be recommended by SAP because they are available for specific requirements only. Using these parameters in an unsupported function can lead to incorrect results. The parameters follow the naming convention. All parameters names for the CTM engine (C++) are in lowercase, and the rest are in uppercase. CTM planning parameters are profile-specific; that is, you can specify in the CTM profile whether a parameter should be applied or not. The parameters are maintained in a separate screen, but they belong to the profile. The parameters are saved together with the normal profile. The planning parameters can be accessed from the CTM profile and are available under the Control menu item (see Figure 1.10).

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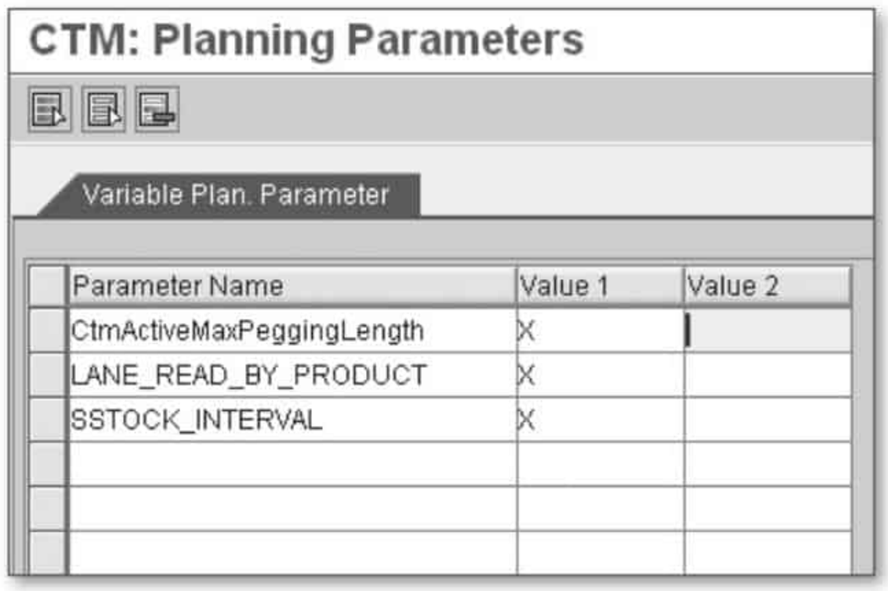

Figure 1.10 CTM Planning Parameters Screen

1.5 Executing the CTM Planning Run

CTM planning can be executed in the online mode using the CTM profile, in the background mode using the SAP APO Transaction /SAPAPO/CTMB, or by scheduling the background job using the SAP APO Report /SAPAPO/CTMPLRUN. The CTM planning process step is also available in the Process Chain central job scheduling tool (see Figure 1.11).

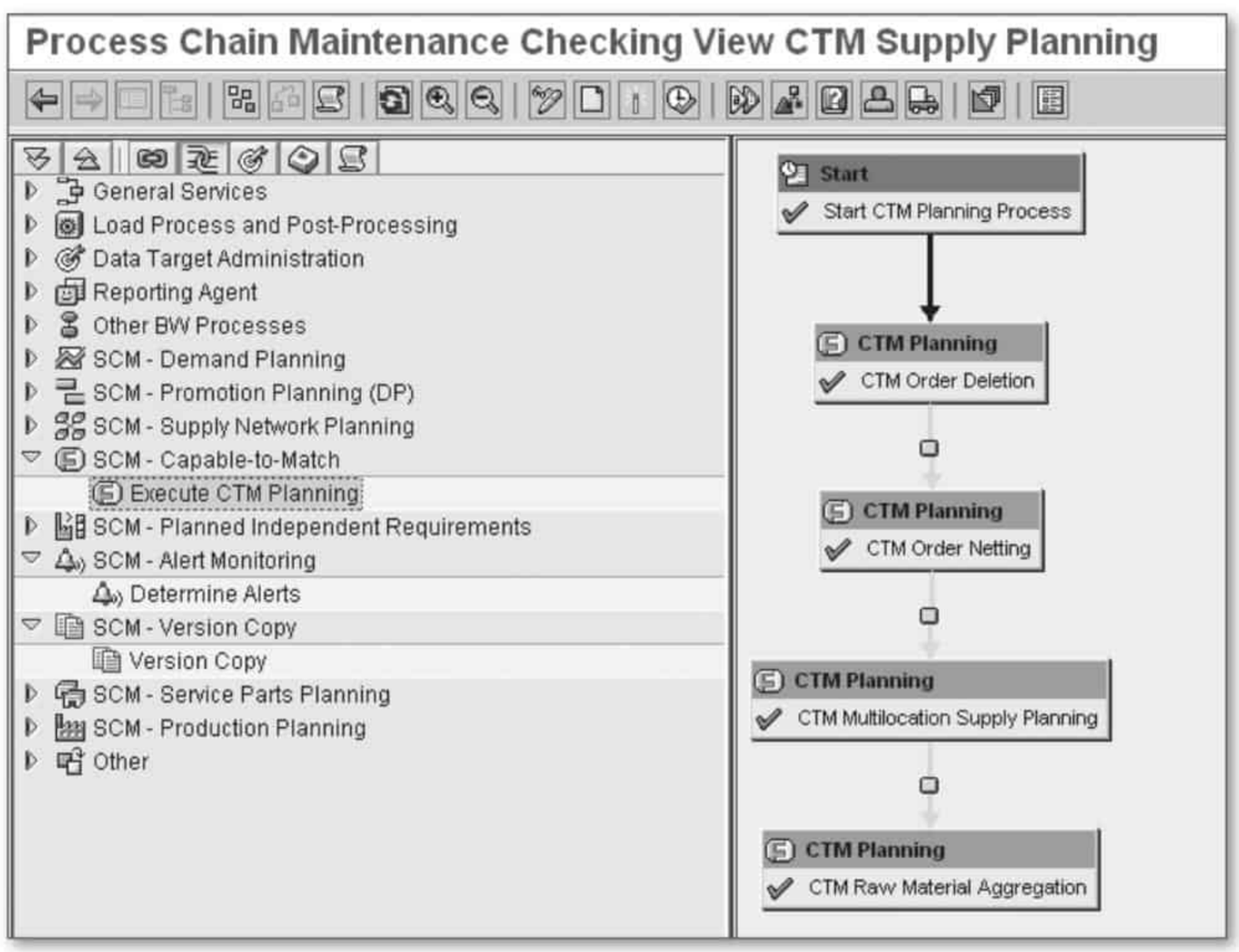

Figure 1.11 CTM Process Chain Definition in the Central Job Scheduling Tool

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The CTM process can be easily integrated with other planning steps to implement the complete business process. If you use process chains, you can automate the complex schedules in the SAP SCM system with the help of the event-controlled processing, visualize the schedule by using network applications, and centrally control and monitor the processes.

1.6 Summary

This chapter explained the basics of the SAP SCM solution. We showed you the SAP APO SNP planning functions and the key difference among SNP Heuristics, SNP Optimizer, and CTM planning logic. Now that you understand the CTM planning process steps, you can execute the CTM planning run with basic configuration.

In the next chapter, you'll learn about the CTM planning scope, which includes the master data, transactional data, and detailed planning strategies that are available for CTM planning.

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This chapter explains the CTM planning strategies and options available in the CTM profile. The chapter will familiarize you with the key decision points that must be understood and answered when selecting the CTM supply planning function.

2 CTM Planning Scope

Successful planning with CTM requires careful analysis of the key business requirements you need to address. When considering using CTM, it's important to first understand that CTM is a heuristic-based planning method and not an optimization solution. CTM is mostly used for rough-cut capacity planning and determining the optimal sourcing decisions in the medium- to long-term horizon when considering finite material and capacity constraints. Although CTM is considered part of the SNP solution, along with SNP Heuristics and SNP Optimizer, there are several key differences you should understand.

CTM is an order-based planning solution that can operate in both the Supply Network Planning (SNP) bucket planning mode and production planning and detailed scheduling (PP/DS) time-continuous planning mode. Additionally, CTM planning can be used to create fixed pegging relationships between the receipt and requirement elements in both the SNP and PP/DS planning modes.

This chapter explains the key steps you need to perform for executing the CTM planning run. There are several key decision points we'll evaluate in detail, but the main aspects of CTM planning are to understand the master data, transactional data, and strategies applied for planning. Also keep in mind that in many practical situations, the complete planning requirements can't be addressed with one single CTM profile. For instance, in some productive environments, customers have used up to 10 CTM profiles to address the complete CTM planning requirements.

We'll start exploring the CTM planning process with a look at the SAP SCM master data because the CTM planning process provides very flexible master data selection options. There are several master data objects available in the SAP SCM appli-

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cation that are supported in the CTM planning process. In the next section, you'll learn about the SAP SCM master data objects and the attributes that are used for CTM planning.

2.1 SAP SCM Master Data

The master data in SAP Advanced Planner and Optimizer (SAP APO) consists of locations, location products, PPM/PDS, resources, and transport lanes. Most of the master data objects are transferred from the SAP ERP system using the Core Interface (CIF). The Supply Chain Model (SC Model) is the basis for planning in SAP SCM, so you can create the SC Model in SAP SCM using the SAP APO Transaction /SAPAPO/MVM or use the SAP Easy Access menu path ADVANCED PLANNING AND OPTIMIZATION • MASTER DATA • PLANNING VERSION MANAGEMENT • MODEL AND VERSION MANAGEMENT.

The model combines all of the master data and is used and accessible for all planning tools in SAP APO. Model 000 refers to the active model, and the master data is created for the active model when transferred from SAP ERP. The planning version contains all of the transactional data relevant for planning. And each version contains a separate copy of the transactional data and is assigned to the model, so you can create and assign one or more versions to a given model.

Version 000 refers to the active version. Only the planning results generated in the active version can be published to SAP ERP and vice versa. Simulation versions are mostly used for what-if analysis and can be created using the copy from the active version. Some additional master data required for what-if scenarios can also be assigned to a version. After the planning in the simulation version, you can merge the planning data completely or partly into the active version before publishing the results to SAP ERP. Figure 2.1 shows the model and version management transaction in SAP APO.

The key master data elements, such as products and locations, are transferred from SAP ERP or created directly in SAP APO. It's very important to understand that the mere presence of parameters in the master data does not imply that the parameter is supported by all of the planning tools. For example, in the product location master, the Shelf Life parameter is available under the Properties tab but isn't supported by CTM. Similarly the Order Creation Frame parameter available

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under the SNP2 tab is only supported by CTM and not by SNP Heuristics or SNP Optimizer.

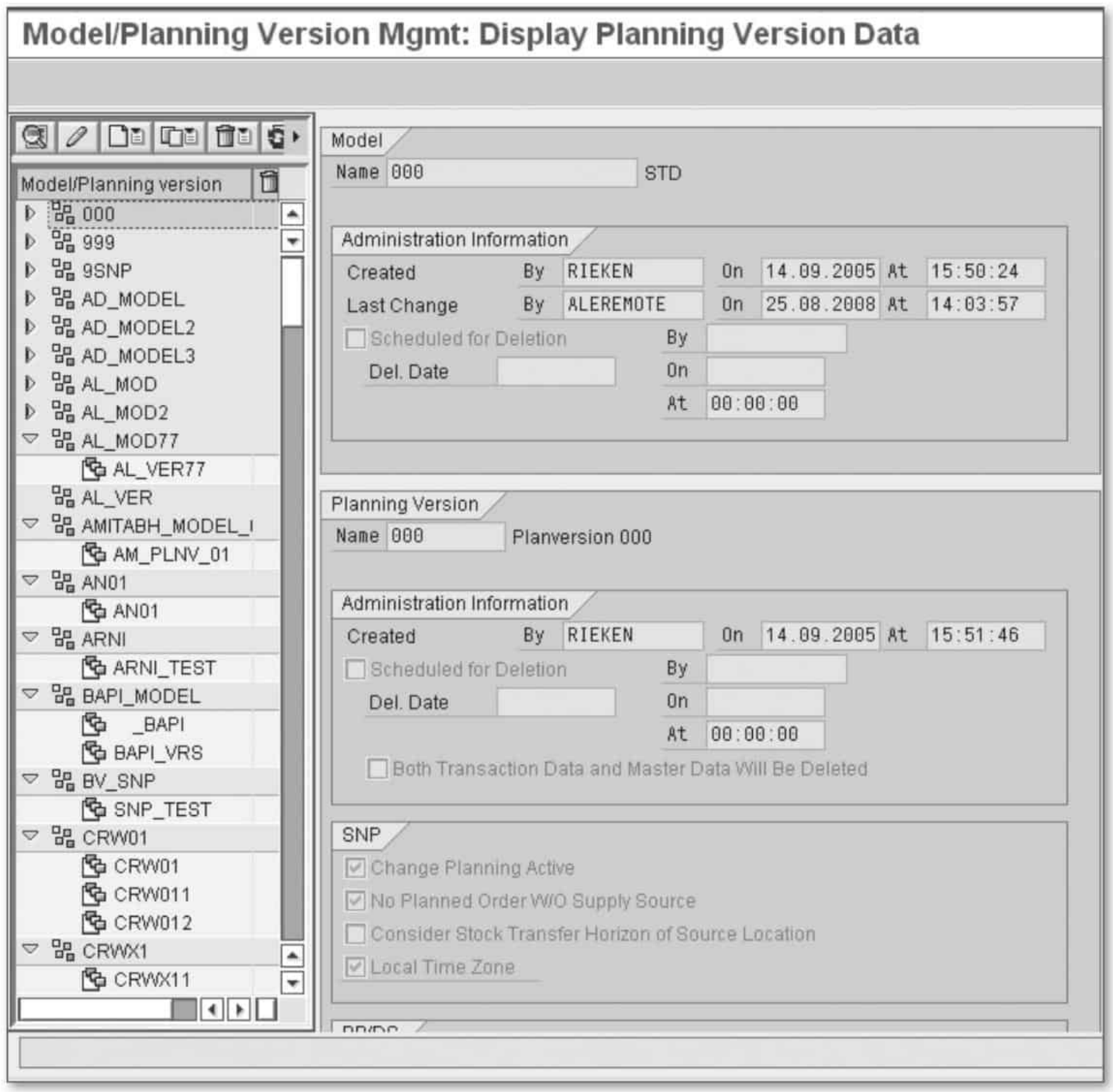

Figure 2.1 SAP SCM Model and Version Management, SAP APO Transaction /SAPAPO/MVM

Now we need to look at how to use the CTM master data selection identifier (ID) to create a subset of the SC Model. During supply network planning for a complex network, it isn't always desirable to use CTM planning for the complete model. CTM master data selection ID provides you with extensive functions to manually and automatically define logical subsets of master data selections for CTM planning.

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2.2 CTM Master Data Selection

CTM planning can be executed with reference to the complete SC Model or a small subset of the model using the Master Data Selection ID as shown in Figure 2.2. The CTM master data selection transaction offers flexible data selection functions for selecting a smaller subset of the SC model. For example, you can use master data selection to limit CTM planning to a specific bill of material (BOM) level of your finished product.

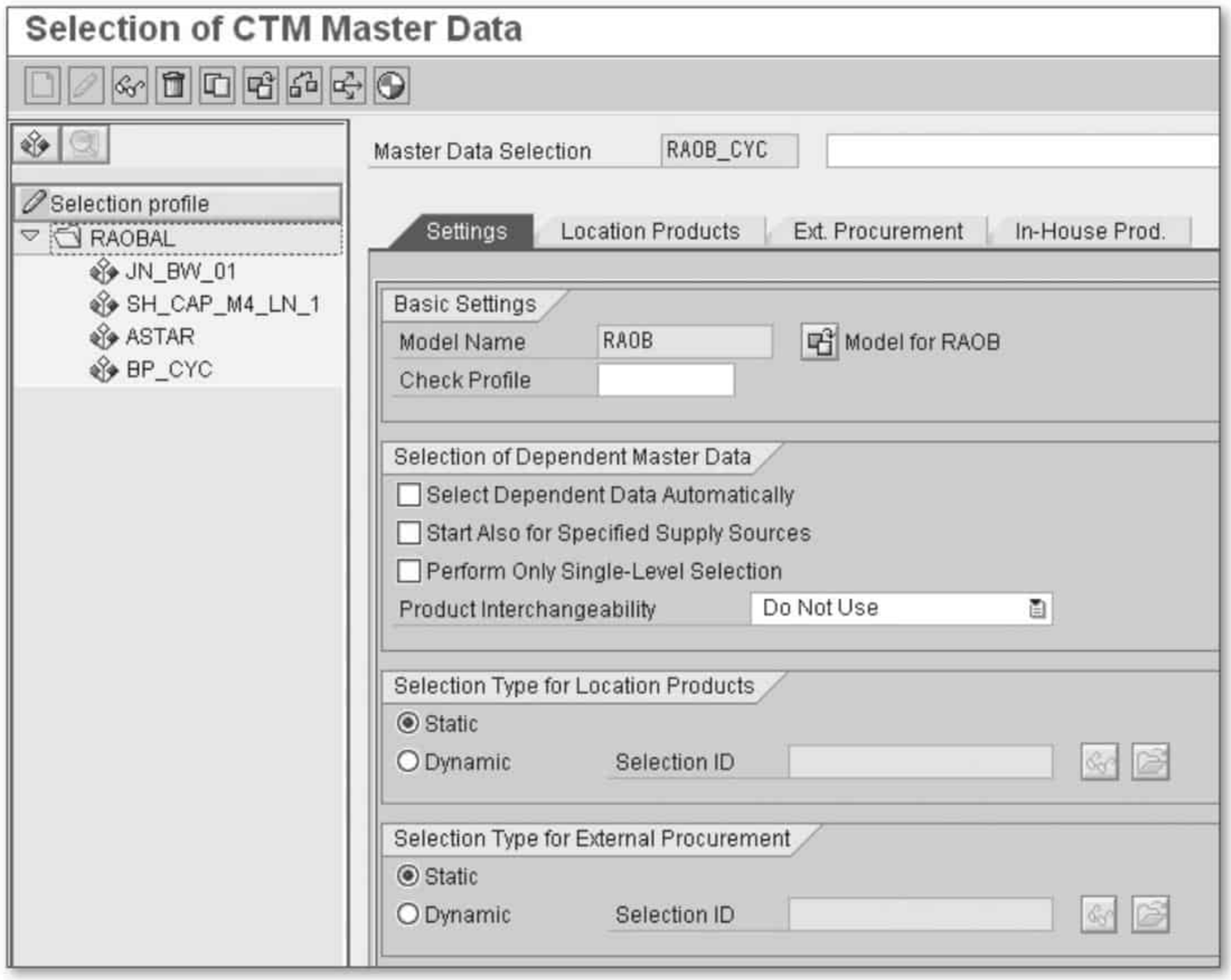

Figure 2.2 CTM Master Data Selection Identifier (ID)

CTM profiles offer two options for master data selection. The complete master data assigned to the model can be used directly in the CTM profile using the All Master Data in Model option available in the Planning Scope section of the CTM profile. For scenarios where CTM must be executed for a subset of the model, it's possible to define the CTM master data selection ID. Once defined, the master data selection ID can be used in multiple CTM profiles.

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The CTM master data selection ID can be created and changed using the SAP APO Transaction /SAPAPO/CTMMSEL or can be accessed using SAP Easy Access menu ADVANCED PLANNING AND OPTIMIZATION • MULTILEVEL SUPPLY AND DEMAND MATCHING • ENVIRONMENT • MASTER DATA SELECTION. This function offers very flexible master data selection options. The main planning objects products, transport lanes, and PPM/PDS can be selected individually to create an SC Model suitable for your business requirements.

Example

If some of the sourcing decisions are predetermined, the corresponding transport lanes can be included in CTM planning. It's also possible to generate the dependent master data automatically using the finished products.

2.2.1 Master Data Selection Options

Each of the planning objects — product locations, transport lanes, and PPM/PDS — can be selected using the Shuffler function in the master data selection ID. Selection of each of the planning objects is supported by several attributes. Table 2.1 shows the attributes available for each of the master data objects.

Object	Selection Attributes
Product Location	Product and Location Custom Material Location Attributes *(AT101, AT102, AT103, AT104, AT105)* Custom Material Attributes *(ATT01, ATT02, ATT03, ATT04, ATT05)* SNP and PP/DS Planner
Transport Lane	Source Location Destination Location Location
In-House Production	Product PPM Name Resource Production Location, Planning Location

Table 2.1 Attributes of Each Master Data Object

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The master data selection ID can be created using the following selection options:

- **Static data selection**
  Static data selection is used primarily when the SC Model is very stable, and changes to the model aren't very frequent. In this mode, the master data objects are saved with the selection ID. The selection can be done using the Shuffler function, which is most commonly used in DP and SNP planning books. After the planning objects are selected and saved with the CTM master data selection ID, any changes in the master data model aren't automatically available for CTM planning. Using static selection, it's possible to manually add and delete additional objects to the selection ID. CTM saves the materials and locations required for planning in the master data selection ID. The material and location attributes are selected during the CTM planning run.
- **Dynamic data selection**
  Dynamic data selection is used mainly for SC Models where frequent changes are anticipated. For example, the BOM is changed in SAP ERP. In this case, the CTM planning must adjust the planning scope in real time to reflect the new BOM structure. When using the Dynamic master data selection option, only the selection definition is saved with the master data selection ID. During the planning run, the SC Model is evaluated that meets the selection criteria. And when using Shuffler, you can define and save the selection ID and assign it to the Dynamic selection.

2.2.2 Automatic Master Data Selection

The CTM master data selection function also offers an automatic master data selection option that can be used to automatically select the dependent products, transport lanes, and PPM/PDS for planning. When using this function, only the finished products will be initially selected. However, the dependent objects relevant for planning are evaluated and selected if they are required for planning a demand. Automatic data selection can be used either in Static mode to select the model or in Dynamic mode during the planning run. Figure 2.3 shows the interface between the master data objects in SAP ERP and SAP APO and the usee of automatic master data selection in the CTM profile.

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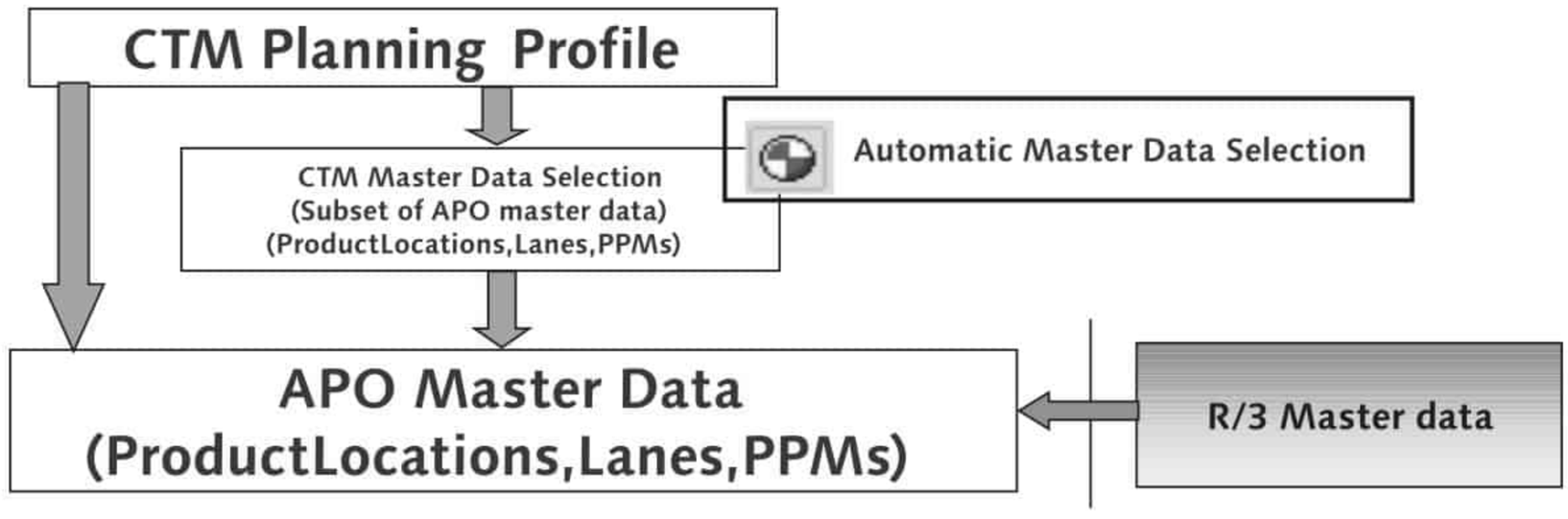

Figure 2.3 Automatic Master Data Selection

The master data is then replicated in the SAP APO system from SAP ERP and is assigned to the SAP APO model 000. The CTM master data selection function selects and saves the master data objects for CTM planning. Using manual selection of dependent data, the master data objects are selected and saved with the CTM profile. Typically, CTM planning is executed as a nightly batch run without any manual intervention because it isn't practical to execute the master data generation function manually before every CTM run. The Select Dependent Data Automatically option can be used in this scenario to generate the master data during the planning run. This step is executed automatically with no manual intervention required. The dependent master data selection uses the finished product locations as input to select dependent master data objects. The relationships are then evaluated using the transport lanes and PPM/PDS. Master data dependencies due to the super session chains and FFF classes are also evaluated for automatic master data selection.

Note

Keep in mind that dependencies due to the ATP rules aren't evaluated during automatic master data selection.

Figure 2.4 shows the SC Model used for all of the examples shown in this book. As you can see in this figure, the automatic master data selection is triggered using the finished product BP_CYC at location BL_FRNK_DC. As a result, all of the products and locations in the plant and supplier locations are also selected (BP_FRM and BP_TYR). Keep in mind that the dependent data selection is based on the direction of material flow, so, for example, using BP_TYR at supplier location BL_FRM_VEND as input for master data selection would not generate any addi-

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tional objects because no further sourcing options exist for this product location. However, two additional master data selection functions are available for flexible SC Model selection:

- **Start Also for Specified Supply Sources**
  Using this option, the master data selection is generated using the SOS (transport lane and PPM/PDS) selected in the In-House Prod. tab.
- **Perform Only Single Level Selection**
  Using this option, the master data is generated only for the single level of the SC Model using the initial selection of product locations.

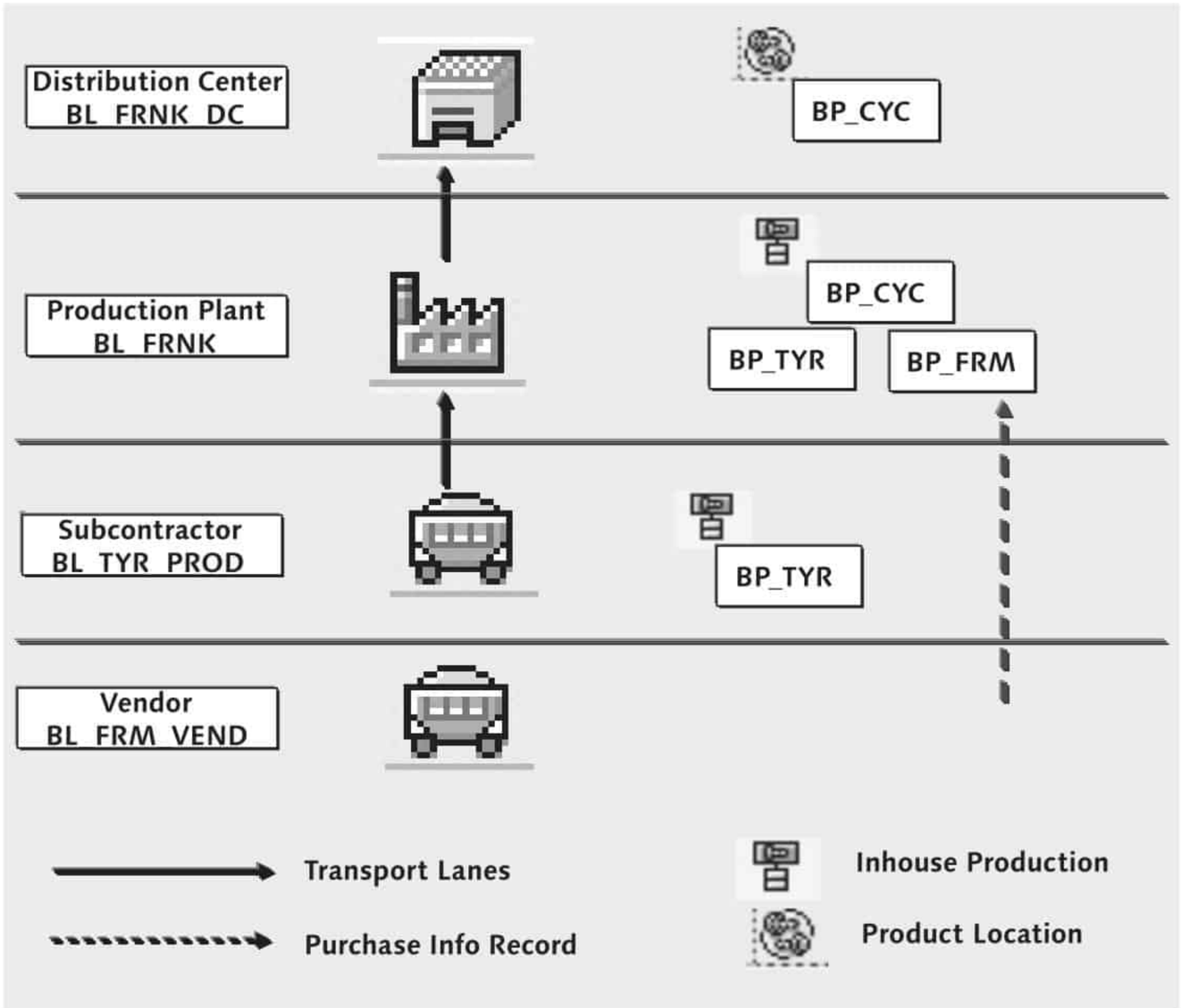

Figure 2.4 Example of CTM Planning Model

Master data parameters used by CTM can be displayed using the master data check function available in the CTM profile or by using the SAP APO Transaction /SAPAPO/CTM01. This function can also be accessed using the SAP Easy Access

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menu path ADVANCED PLANNING AND OPTIMIZATION • MULTILEVEL SUPPLY AND DEMAND MATCHING • ENVIRONMENT • CONSISTENCY CHECK FOR CTM MASTER DATA. The master data check function shown in Figure 2.5 is very useful in CTM because it provides an overview of the master data parameters used for planning by the CTM engine.

For example, the Production Horizon defined in the number of days is translated to the date time with reference to the CTM planning start date. The consistency of the CTM model used for planning is also verified by the CTM master data check function. So if any of the input components used in a PPM/PDS aren't included in the model, the consistency check displays the error.

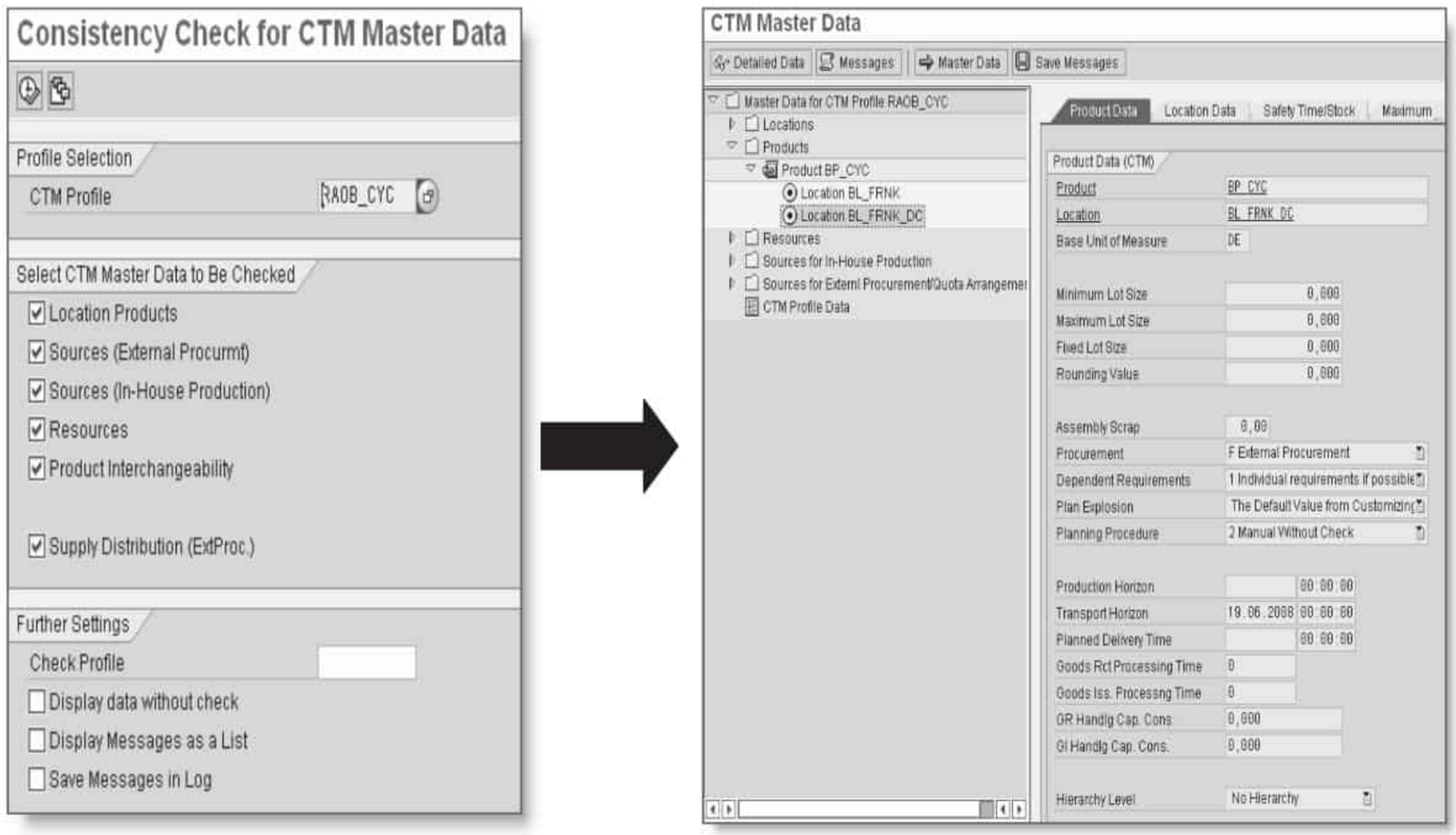

Figure 2.5 CTM Master Data Consistency Check

Note

Keep in mind that with the master data check function, only the syntax of the master data is checked, and an error report is generated. The semantics of the master data, such as lot sizes or cyclical supply networks, aren't detected and reported using the CTM master data check function.

Using the model consistency check profile available in SAP APO, you can configure and apply checks with reference to allowed tolerance limits. For example, you can define a minimum and maximum planned delivery time tolerance. This is very

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useful in detecting incorrect planning parameters entered by the planners. The model consistency check profile shown in Figure 2.6 can be started using the SAP APO Transaction /SAPAPO/CONSPRF or using the menu path ADVANCED PLANNING AND OPTIMIZATION • MASTER DATA • MODEL CONSISTENCY CHECK • MAINTAIN PROFILE.

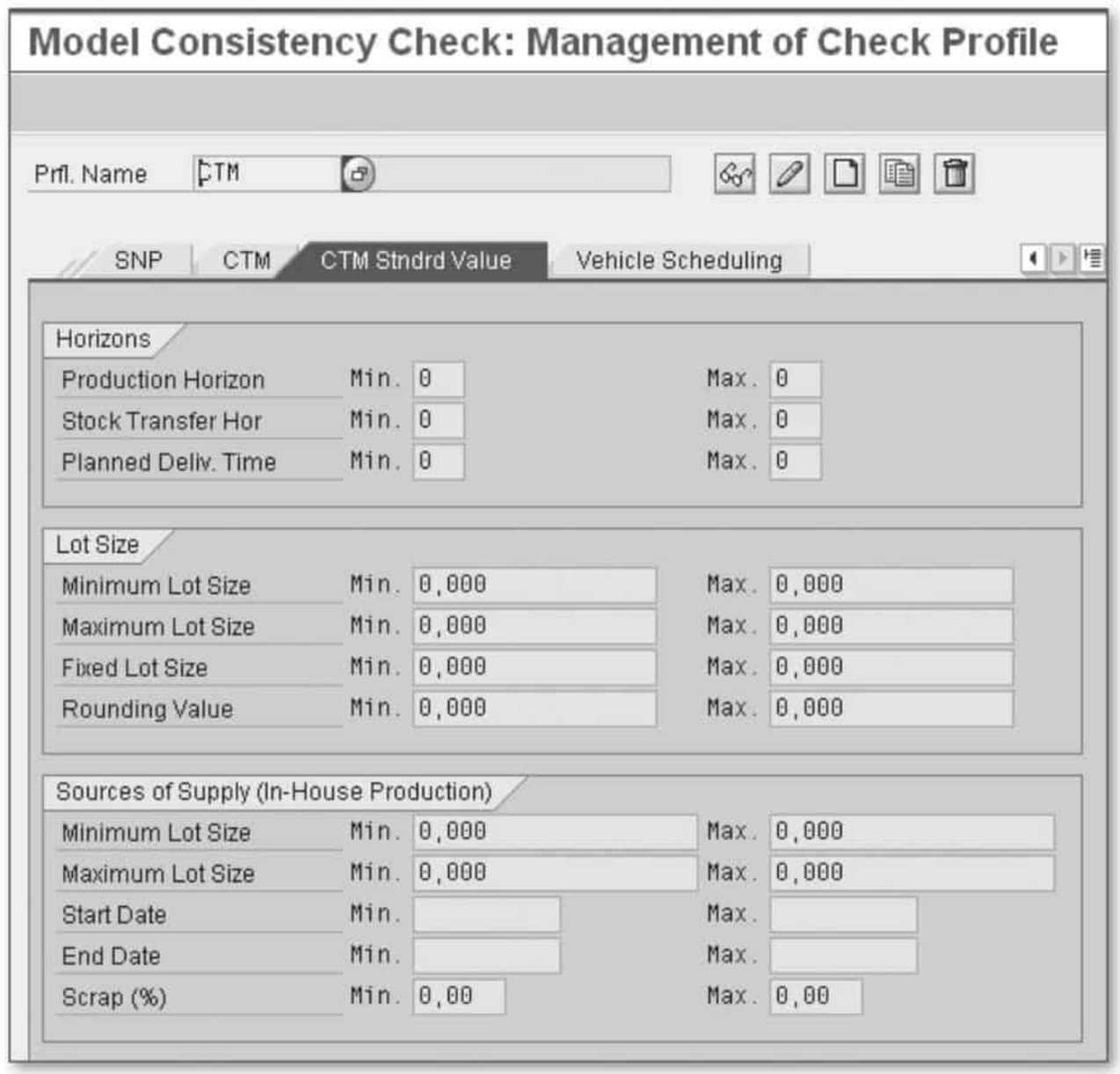

Figure 2.6 CTM Model Consistency Check Profile.

The consistency check profile can be used in the CTM planning profile to check the parameters defined in the check profile. The master data consistency check in CTM is also used to validate all of the master data values assigned to the planning objects. For example, for safety stock planning in CTM, you can display the safety stock parameters used for planning in CTM. Similarly, the hierarchy and FFF classes used in CTM planning can be displayed and validated. This function can also be used to understand and validate all of the parameters available in the master data objects that are supported in CTM.

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Example

In the material master, the Shelf Life parameter is maintained, but in the master data check, the field isn't displayed indicating that the parameter isn't supported in CTM.

Now that you know how to define the master data selections and check the consistency of the model, in the next sections, you'll learn about the master data attributes that are supported for CTM planning.

2.3 Master Data Attributes for CTM Planning

Several master data parameters and attributes are available in SAP SCM for each of the master data objects. But as mentioned earlier, not all parameters are relevant for CTM planning or supported in CTM planning. The CTM master data check function provides an overview of all of the parameters used in CTM planning. In this section, we'll explain all of the master data objects and parameters that are relevant for CTM planning.

The key master data objects supported by CTM planning include the following:

- **Locations**
- **Location products**
- **Resource**
  - Production, transport, and handling
- **External procurement alternatives**
  - Transport lanes, purchasing info records
- **In-house production alternatives**
  - Production process mode (PPM)
  - Production data structure (PDS)
- **Hierarchy**
  - Location product, resource
- **Substitution alternatives**
  - Super session chains, FFF classes, ATP rules

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All master data objects can be accessed under the SAP Easy Access menu ADVANCED PLANNING AND OPTIMIZATION • MASTER DATA, and the mass maintenance Transaction MASSD can be used to maintain the values in SAP APO for a large set of product locations.

In the next sections, you'll learn about the master data objects and the attributes that are supported by CTM. We'll start with location master data.

2.3.1 Location

Location in SAP APO represents the central point where all of the physical logistical processes are executed. The location represents the physical place where products or resources are managed. A single location object in SAP APO represents all of the different SAP ERP locations and is differentiated using the location type. For example, the location Production Plant is location type 1001, Vendor is location type 1011, Customer is location type 1010, Transport zone is location type 1005, and so on. The locations are selected for CTM planning based on the selected products.

The following parameters assigned to the location are supported in CTM planning:

- Location Time Zone
- Location Priority
- Receiving Calendar
- Shipping Calendar
- Inbound Handling Resource
- Outbound Handling Resource

The usage and function of each of these parameters in CTM planning is explained in later sections or chapters. Figure 2.7 shows the location master data object in the SAP SCM system that can be maintained using the SAP APO Transaction /SAPAPO/LOC3.

After the location master data object is created, you have to create and extend the products to the appropriate locations of the supply chain to create receipt and requirements during the CTM planning run.

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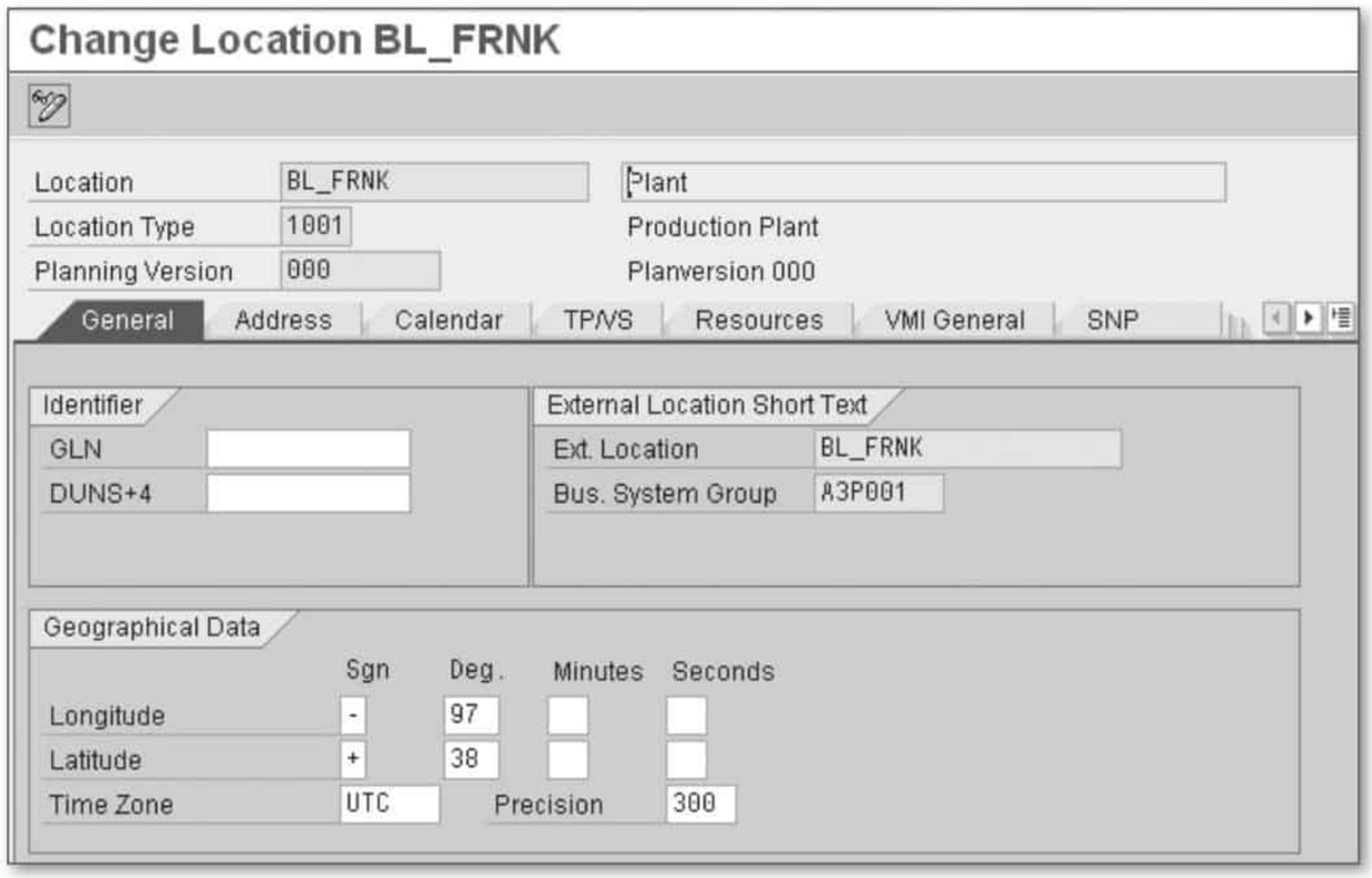

Figure 2.7 Location Master Data Maintenance in SAP APO

2.3.2 Location Product

Product in SAP APO represents the goods or services used in the value chain upon which all business activities are executed. Product parameters can be maintained at the global and location level. Most of the product location parameters are transferred from the SAP ERP system, but it's also possible to maintain SAP APO specific master data for planning. Figure 2.8 shows the product location master data object that can be maintained using the SAP APO Transaction /SAPAPO/MAT1in the SAP SCM system.

The following parameters assigned to a location product are supported in CTM planning:

- Lot Size (Minimum/Maximum/Fixed), Rounding value
- Procurement Type, Assembly Scrap
- Horizons (Production, Stock Transfer)
- Planned Delivery Time
- Safety Days' Supply, Safety Stock and Maximum Earliness
- Order Creation Frame, Product Priority, and Demand Selection Horizon
- GR/GI Times and GR/GI Capacity Consumption

244_Book.indb 47 3/3/09 5:38:42 PM

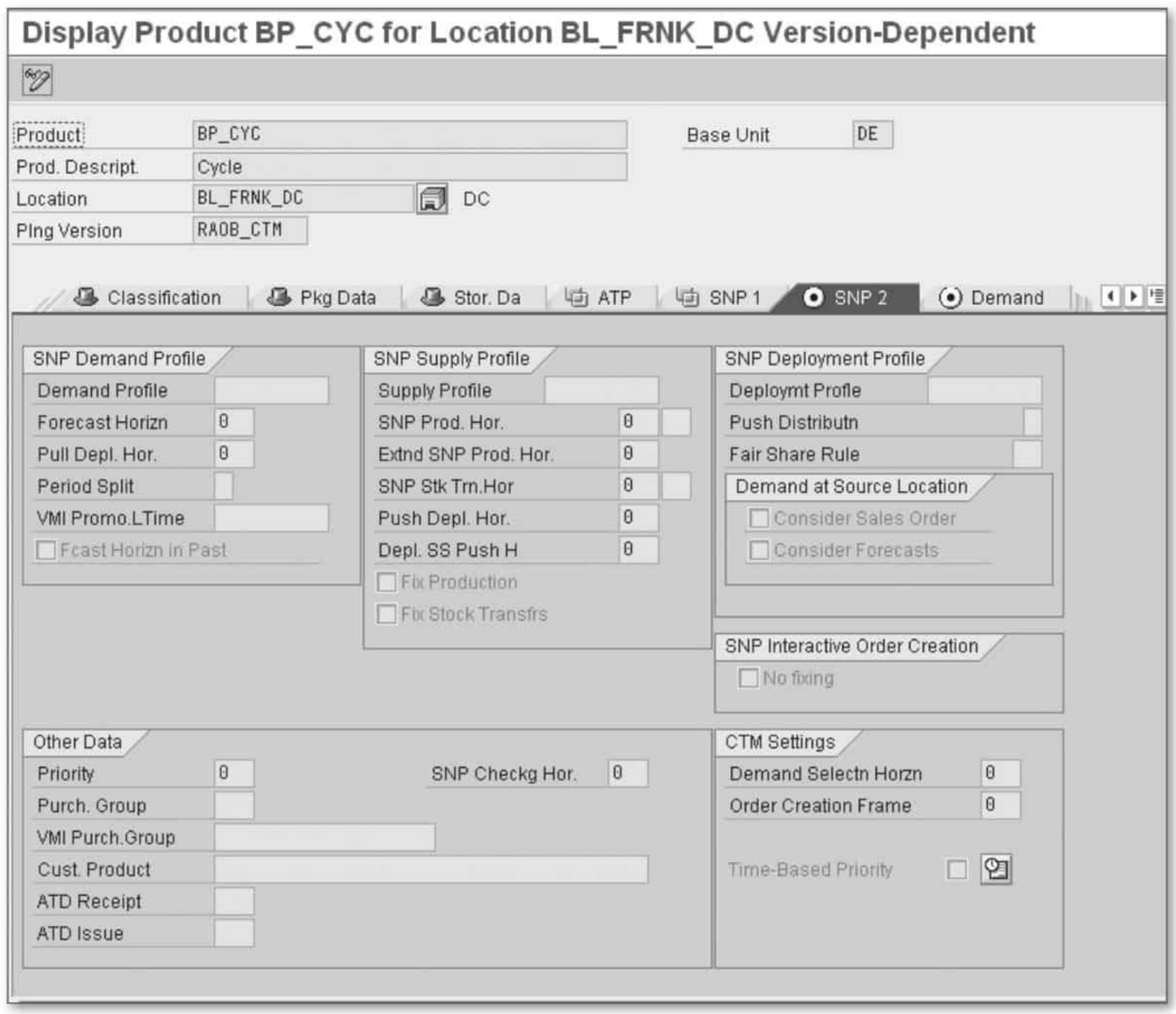

Figure 2.8 Product Location Maintenance in SAP SCM

2.3.3 Resource

Resources in SAP APO are used to represent capacities for machine, labor, and transport modes. Each resource is assigned to a model, and version-specific master data can be maintained for the resources. The work centers in SAP ERP are transferred to SAP APO as resources. And, planning and scheduling with resources depend on the type of the resource.

There are three main types of resources available for CTM planning:

- **Time-continuous resource**
  Time-continuous resources are used mainly for PP/DS planning where the scheduling is done in the time-continuous mode with exact start and end times

244_Book.indb 48 3/3/09 5:38:42 PM

Index

A

Aggregated planning, 223
Airline strategy, 131
ATP rules, 57
Automatic master data selection, 40

B

Bucket planning mode, 68
Bucket resources, 49

C

Capable to Match (CTM), 16
Capable-to-Match planning, 21
Capacity planning, 66
Component Withdrawal in Another Location, 207
Constant safety stock planning, 166
CTM application log, 239
CTM BAdI, 260
CTM demand and supply attributes, 72
CTM engine trace, 248
CTM engine trace evaluation, 250
CTM order scheduling, 115
CTM planning engine, 27, 101
CTM planning parameters, 31
CTM planning steps, 242
CTM search strategy for source selection, 97
CTM source of supply selection, 107
CTM supply selection, 106
CTM time stream, 65

D

Decision criteria for source selection, 106
Deletion modes, 61
DEMAGGBYLOTSIZE, 79
Demand aggregation, 76
Demand prioritization, 82
Demand selection horizon, 136
Depth first strategy, 103
Descriptive characteristics (DCs), 89
Domino strategy, 130
Down binning, 222
Dynamic data selection, 40
Dynamic pegging, 60

E

Explanation profile, 143
External procurement relationships, 50

F

Fixed pegging, 60
Form-Fit-Function (FFF) class, 216

G

Global-ATP (GATP), 16

I

Interval planning, 172

L

LANE_NOSOURCE_IGNORE, 52
Late demand frame, 131
Late demand scheduling, 132
Late demand strategies, 68
Late demand strategy, 130
Location, 46
Location product hierarchy, 224

244_Book.indb 271 3/3/09 5:40:15 PM

M

Make-to-Order (MTO), 199
Make-to-Stock Production, 194
Master data check function, 42
Master data selection identifier, 38
Maximum Earliness, 139
Maximum Earliness for Planned Orders, 138
MBDAT_TZ, 86
Minimum build, 188
Mixed resources, 49
Model consistency check profile, 43

N

Net change planning, 63, 64

P

Parallel processing, 257
Pegging type, 70
PIR Segment, 194
Planning modes in CTM, 61
Planning strategy, 64
Planning with Final Assembly, 195
Planning Without Final Assembly, 196
Planning with Planning Product strategy, 199
PP/DS time-continuous planning mode, 35
PPM/PDS hierarchy, 225
Procurement processes within the plant, 205
Procurement type, 108
Product interchangeability, 57, 212
Production data structure, 53
Production in alternative location, 203
Production planning and detailed scheduling (PP/DS), 16
Production process model, 53
Product location, 47
Publish CTM results to SAP ERP, 255

R

Regenerative planning, 63
Requirements strategy, 193
Resource hierarchy, 225
Resources, 48
Resource utilization, 125
Result indicator, 147

S

Safety days of supply, 159
Safety lead time, 179
Safety stock planning, 157
SAP Advanced Planner and Optimizer (SAP APO), 15
SAP APO Demand Planning (DP), 15
SAP APO Supply Network Planning (SNP), 18
SAP liveCache, 26
SAP Supply Network Collaboration, 18
Scheduling direction, 69
Scheduling of planned order, 116
Scheduling purchase requisitions, 129
Scheduling stock transfer order, 126
Scheduling substitution order, 129
SNP Deployment, 16
SNP Heuristics, 20, 35
SNP Optimizer, 20, 35
Sort sequence, 84
Source selection with inbound quota, 110
Static data selection, 40
Storage location MRP area, 207
Store Transport and Prod. at Destination Location, 185
Subcontracting planning, 209
Substitution rule, 218
Supersession, 213
Supply aggregation, 90
Supply categorization, 92
Supply chain coordination, 17
Supply Chain Event Management (SCEM), 17
Supply Chain Management (SCM), 13

244_Book.indb 272 3/3/09 5:40:15 PM

Supply distribution, 25
supply distribution (SD), 187
Supply Network Planning (SNP), 15

T

Time-continuous planning mode, 67
Time-continuous resource, 48
Time-phased safety stock, 168
Transactional data selection, 58
Transportation planning/vehicle scheduling (TP/VS), 16
Transport Load Builder (TLB), 16
Transport Receipts Elements Individually, 186

U

Unscheduled break, 125

244_Book.indb 273 3/3/09 5:40:15 PM