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In this chapter, you'll learn about the application architecture for logistics and manufacturing in SAP S/4HANA. After an overview of the organizational units, master data, and business objects, you'll explore key cross-functions and integration scenarios.

"Logistics and Manufacturing"

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Chapter 12
Logistics and Manufacturing

SAP S/4HANA comes with optimized and innovative logistics functions powered by SAP HANA, for example, live material requirements planning and real-time inventory. In this chapter, you'll learn about the business objects, engines, and cross-functions in manufacturing and logistics in SAP S/4HANA.

This chapter explains how SAP S/4HANA implements the core logistics and manufacturing processes. It introduces logistics and manufacturing, reviews the organizational units used, briefly defines the master data objects required in logistics and manufacturing, and continues with the transactional business objects. Finally, calculated business objects, engines, process controls, and cross-functions are discussed.

We define *logistics* as follows:

- Planning, controlling, optimizing, and executing physical or logical movements of products within an organization. Logical movement entails changing the availability of a product for a certain business process, for example, reserving stock for quality checks.
- A generic term that comprises procurement, material flows within production, inventory management, quality management, picking, packing, and sales and distribution.

Logistics and manufacturing cover an essential part of the external procurement and sales processes and is thus external facing, involving suppliers, customers, or third-party logistics providers. It also covers an essential part of the internal production and distribution processes, with a strong link to warehouse management.

In this chapter, we'll begin with an overview of the logistics architecture in Section 12.1. To understand the handling of logistics and manufacturing processes in SAP S/4HANA, it's essential to understand the semantics of the involved organizational units and business objects. Organizational units structure an enterprise organization according to business or legal requirements, which we'll cover in Section 12.2. Business objects either represent master data (objects that are referenced in multiple business transactions) or transactional data (objects created within the context of a business transaction). We'll discuss them in Section 12.3 and Section 12.4, respectively. We'll also discuss calculated business objects and engines in Section 12.5, cross-functions between logistics and manufacturing in Section 12.6, and integration scenarios in Section 12.7.

How manufacturers configure the core logistic processes in SAP S/4HANA essentially depends on their business model. SAP S/4HANA supports the following production processes:

- *Engineered-to-order* (ETO) production processes for highly individualized products
- *Make-to-order* (MTO) and *make-to-stock* (MTS) production process for mass production
- Wholesale or retail-like processes with no production, just sales and distribution

In real life, a manufacturer's business processes are always a blend of these processes.

12.1 Architecture Overview

Figure 12.1 depicts the core logistics data flow, including production planning with company-internal and external procurement, production execution, inventory management, and sales. Details of the sales process are described in Chapter 9. Details of the procurement processes are described in Chapter 11.

Logistics and manufacturing deals with products and materials. Typically, these are tangible objects such as machines or fluids that are assembled or produced, stored, and transported. However, logistics also deals with nontangible products such as software applications or music, if they are moved by downloading or streaming. In the context of logistics and manufacturing, we use the term *material* as it appears on several corresponding user interfaces (UIs). However, the business object refers to the product master (see Chapter 8, Section 8.1).

As soon as your business processes include handling of tangible or nontangible materials, SAP S/4HANA creates a *material document* (centered in Figure 12.1). Material documents record any material movement in the enterprise. By summing up those records, any stock at any point in time is calculated on the fly. SAP S/4HANA calculates stock in real time without using persisted aggregates. This is the cornerstone of inventory management (Section 12.5.1) and a significant difference from stock calculation in SAP ERP.

Inventory changes can be triggered by goods receipt from external procurement (see Figure 12.1, bottom, and Chapter 11 for details) or from internal production (see Figure 12.1, center). The internal production is triggered by a *direct requirement element*, such as a sales order or by *planned independent requirements* (PIR) created manually or automatically in SAP S/4HANA.

PIRs are processed by *material requirements planning* (MRP), which triggers the production or external procurement of the required materials. Alternatively, MRP can be triggered by, say, a sales order in the MTO process. MRP relies on several types of master

data. It uses a product master and bill of materials (BOM) because it needs to know how materials are composed of components and ingredients (see Chapter 8, Section 8.1 and Section 8.2).

For production planning, MRP also needs to know which steps are required to produce a material and what production capacities are available. For that, it uses routing and work center master data. Several algorithms are available for MRP. As materials typically consist of other materials as components or ingredients, the planning algorithms are applied recursively for each included material. The results of the planning process are purchase requisitions for materials that need to be purchased or *planned orders* if the components are produced internally.

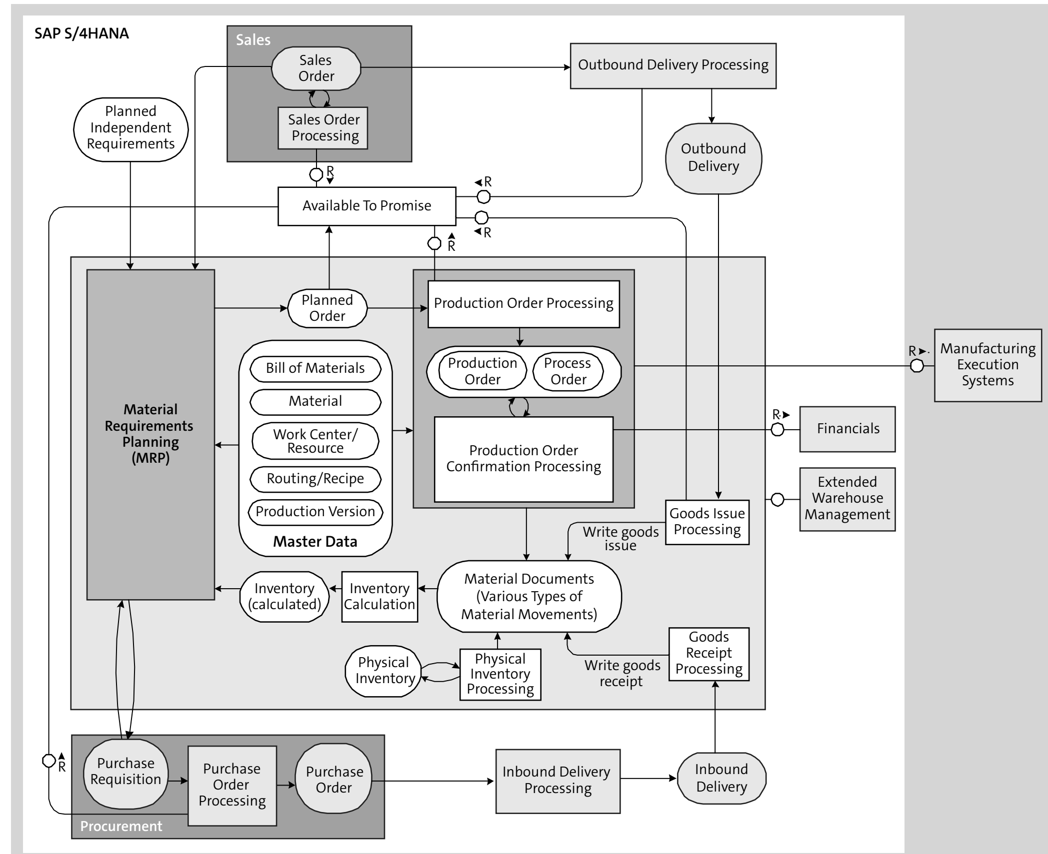

Figure 12.1 Logistics Architecture Overview

Purchase requisitions are eventually converted into purchase orders to execute the external procurement, and planned orders are converted into production orders or process orders to execute the production process. In both cases, the company gets new material, which SAP S/4HANA records by creating a material document that represents a goods receipt.

The top of Figure 12.1 depicts the sales process in which a sales order initiates logistics execution by creating an outbound delivery document. As the sold material decreases the inventory, goods issue processing creates a corresponding material document. Details of the sales process are explained in Chapter 9. Other inventory changes are internal movements, scrapping, or posting of physical inventory differences (see Figure 12.1, center).

Note that common cross-functions, such as quality management, batch management, handling unit management, serial number management, and inter/intracompany stock transport, aren't shown in Figure 12.1. They are detailed in Section 12.6.

Section 12.7 describes integration scenarios to external systems, such as warehouse management and manufacturing execution systems in more detail.

This section explained the flow of the core logistics processes and their links to other SAP S/4HANA processes. The next section introduces the organizational units in core logistics.

12.2 Organizational Units

The logistics and manufacturing processes in SAP S/4HANA rely on organizational units (see Figure 12.2). Across logistics, plant, storage location, and shipping point are used, whereas MRP area and production supply area are used in production planning and execution only. The organizational units have a common configuration, which is shared by several processes, such as description, address, currency, and they have a process-specific configuration, which is used by specific business processes only, such as inventory management, batch management, and logistics execution.

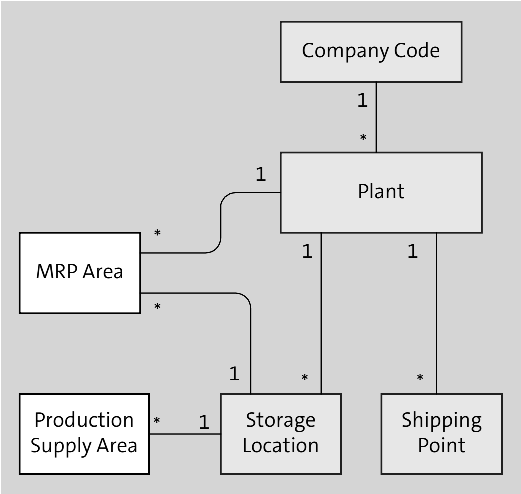

Figure 12.2 Organizational Units in Core Logistics

In logistics and manufacturing, master data and transactional business objects are created with reference to organizational units. The MRP area and production supply area organizational units have a strong relationship to master data objects—in particular, the product master—as they support the production planning process.

12.3 Master Data Objects

In this section, you'll get to know the master data business objects used in core logistics and manufacturing. These objects have already been outlined in the architecture overview in Figure 12.1.

In SAP S/4HANA, the product master (see Chapter 8, Section 8.1)—in logistics preferably called the material—is the main master data object used to create inventory and goods flow (see Figure 12.3). It represents a tangible product, such as a screw or a truck, or a nontangible product or service, such as a software application or a movie to be streamed. Materials are created in the product master. A material object includes views, which collect business process–specific data linked to a specific organizational unit. Most important for core logistics are the plant view and the MRP views.

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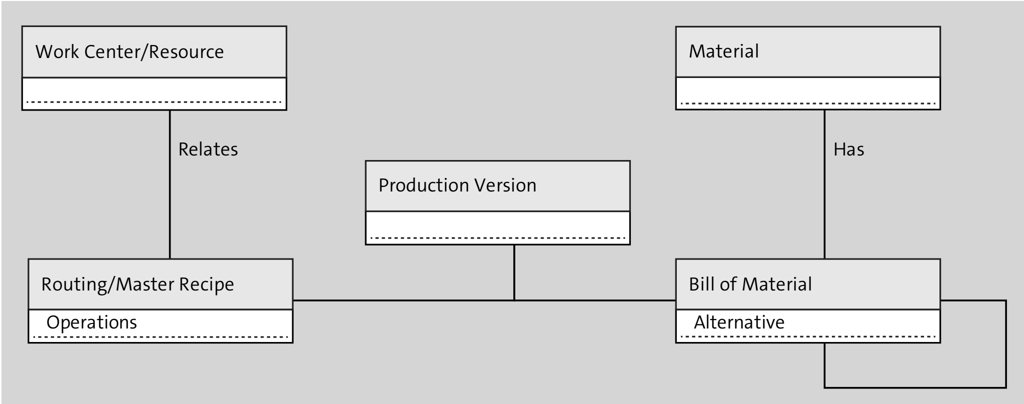

Figure 12.3 Master Data Business Objects with Relationships

A BOM (see Chapter 8, Section 8.2.1) is a directed hierarchy of materials describing which child components are contained within the parent. BOMs have a time-dependent validity, a business usage, and an alternative, which is an additional key allowing you to define several BOMs for one parent as valid at the same time.

A *routing* (called a *master recipe* in the process industry) describes how a material is created in a plant. Routings contain a series of operations called routing steps, which represent the work on the shop floor. They can be nested and have a relation to one or more work centers. A *work center* (called a *resource* in the process industry) represents a machine, production line, or employee in production, where operations are carried out. It contains data on capacity and scheduling. The *production version* is the time-dependent relation between a routing and a BOM, which describes how the defined lot size of a material must be produced at a certain point in time.

All master data objects are involved in production planning, production execution, inventory management, and logistics execution. They are referenced by the transactional business objects explained in the next section.

12.4 Transactional Business Objects

We start with an overview of the transactional business objects already outlined in Figure 12.1 and focus on the relationship between the business objects (see Figure 12.4). Planned orders are the result of the production planning process. They represent the planned production or procurement of a material. They can be converted into purchase requisitions if the material is to be procured externally or into production orders if the material is to be manufactured internally. Although it's possible to customize SAP S/4HANA in such a way as to create a purchase requisition from a planned order, we recommend implementing the process flow as described and creating purchase requisitions via the production planning process. In a repetitive manufacturing process, the planned order is directly reduced by a production confirmation using the first in, first out (FIFO) approach.

Purchase requisitions represents a planned external procurement. If they are converted into a purchase order, the procurement is initiated. The procurement process ends with the material document *goods receipt* either based on the purchase order or on an inbound delivery created from the purchase order (see Chapter 11, Section 11.2, for more information about the procurement processes). If a material is procured externally on a regular basis, a *scheduling agreement* defines the fixed conditions of the procurement process. Each external procurement of this material is initiated based on the scheduling agreement.

Production orders initiate the internal manufacturing of goods in a discrete manufacturing process, as do process orders in the process industry. Based on the routings, BOMs, and work center master data objects, the manufacturing is executed. The production process creates a *production order confirmation* to report the successful manufacturing of the product. The manufactured product is recorded as inventory by a goods receipt.

The physical inventory itself is verified on a regular basis by physical inventory documents. If there is a posting difference, their posting can create a material document.

When a product is sold, a sales order is created. When the sales process completes, it creates an *outbound delivery*. When the outbound delivery is posted, the delivery process creates a corresponding goods issue. Figure 12.4 shows the material document and the related business objects that are involved in procurement, sales, and production of

goods. In SAP S/4HANA, all logistics processes involving the physical or logical movement of goods are recorded by material document postings. Material documents represent a journal of material movements. Section 12.5.1 explains how the journal entries are used to calculate the stock quantities. Unlike other documents mentioned in this section, material documents are immutable. They can't be deleted. To cancel a material movement described by a material document, the creation of a new material document is required, which compensates the movement of the original document.

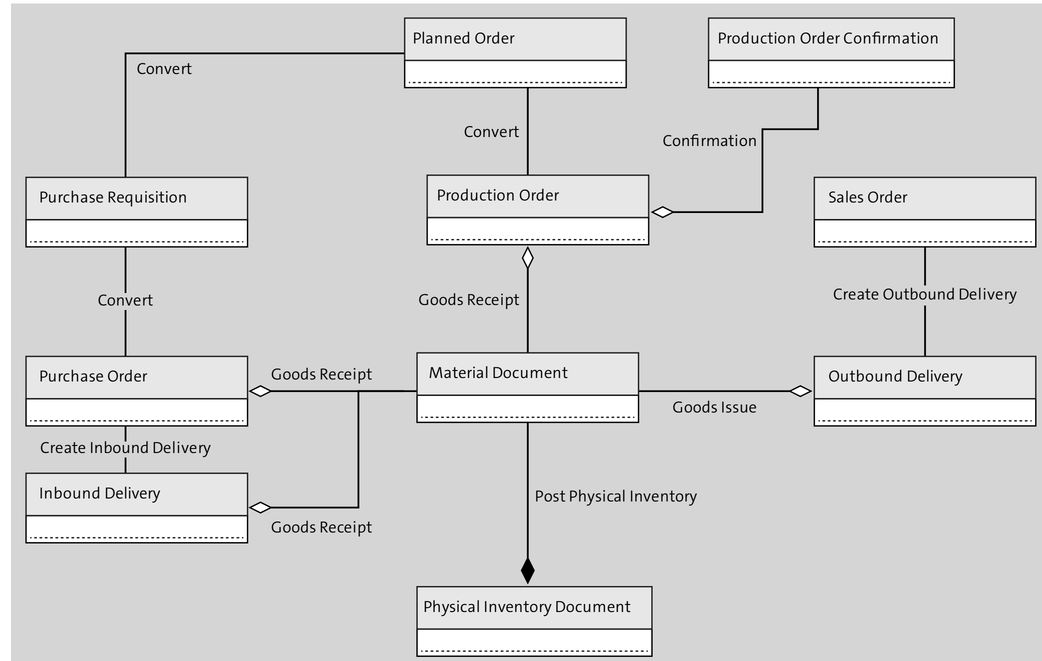

Figure 12.4 Transactional Business Objects and Process Steps

The *material reservation* is a special kind of transactional object. Reservations are transient business objects created by different business processes to indicate that a certain quantity of inventory stock is possibly consumed in the near future by a dedicated logistics process, such as MRP (Section 12.5.3) or available-to-promise (ATP; Section 12.5.2).

All transactional business object instances are linked to each other by business process steps and store a reference to their predecessor or successor business object instance. This section digs deeper into the semantics of each transactional business object and explains the keys of the transactional business objects and their most important business semantic attributes. This additional level of detail is shown in Figure 12.5.

Let's start with the external procurement, which you see on the right-hand side of Figure 12.5. The purchase order has one key, and the business semantic on the header level is defined by the purchase order type. The purchase order item business semantic is defined by the purchase order item type and the account assignment category. The purchase order item type controls the procurement process, whereas the account assignment category influences the goods receipt, invoice verification, and account determination process. If the purchase order item is set for confirmation, an inbound delivery creation for the purchase order is mandatory for the goods receipt.

The internal production is based on the production order (one key) and the order type defining the business semantics on the production order item (see top-center of Figure 12.5).

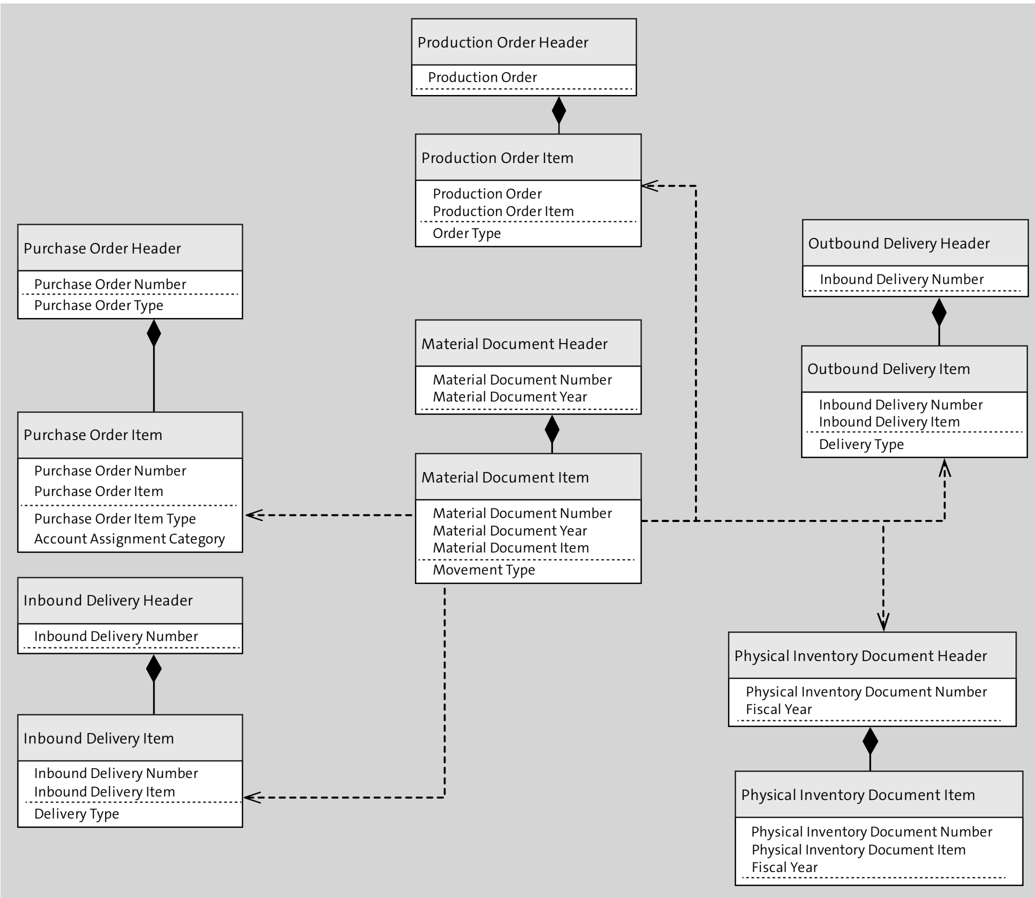

Figure 12.5 Transactional Business Objects with Business Keys and Semantic Attributes

The material document in the center of Figure 12.5 has two keys: material document number and fiscal year. The business semantics are controlled by the movement type on the item level. For example, movement type 101 is used for goods receipt against the purchase order, and movement type 321 is used to transfer goods from quality inspection to unrestricted stock.

In most cases, the items of one material document posting belong to a dedicated business process step referencing the items of one predecessor document. For example, when creating a goods receipt for external procurement, the movement type can be selected from several options, whereas the movement type of a goods receipt for the production order as part of the production order confirmation is configured.

The outbound delivery is shown on the right side of Figure 12.5. It has one key, and the business semantics are controlled by the delivery type (e.g., outbound, inbound, returns) on the item level, which directly controls the movement type of the goods issue.

The physical inventory document (Figure 12.5, bottom-right) has two keys. Each physical inventory document item represents a physical inventory counting process of one material in one plant in one storage location. The process comprises the mandatory steps of counting, posting, and, optionally, recounting. The movement type of the corresponding material document is hard linked to the physical inventory document item.

As explained, there are various mechanisms that determine the business semantic attributes during the flow of transactional documents in SAP S/4HANA, such as user input, configuration, coded rules, or customer enhancements.

12.5 Calculated Business Objects, Engines, and Process Controls

The instances of calculated business objects aren't persisted in a database table. If business logic accesses a calculated business object instance, the corresponding algorithm calculates the values on the fly. The nature of the business object—whether calculated or persisted—is hidden for the business object consumer and normally based on implementation considerations. Calculated business objects often represent figures, the output values of which depend on many input variables and need to be consumed in real time.

Engines represent complex algorithms executed on a regular basis to mass-process input variables based on configuration settings to reach the next step in a business process. We'll get to know a set of these calculated objects in the following sections.

12.5.1 Inventory

In previous products, such as SAP ERP, inventory was persisted in a number of database tables. In SAP S/4HANA, this is no longer the case; instead, inventory is a calculated business object. As mentioned, the material documents serve as a journal to record any movements of material in SAP S/4HANA. Therefore, any inventory figures can be calculated from this journal at any given date. Figure 12.6 outlines the differences of the data model. Previously, inventory was a persisted business object based on a key figure model; in SAP S/4HANA, it's a calculated business object based on an account model in the database table. This simplification improves transparencies, reduces redundancies, and significantly accelerates the material document posting.

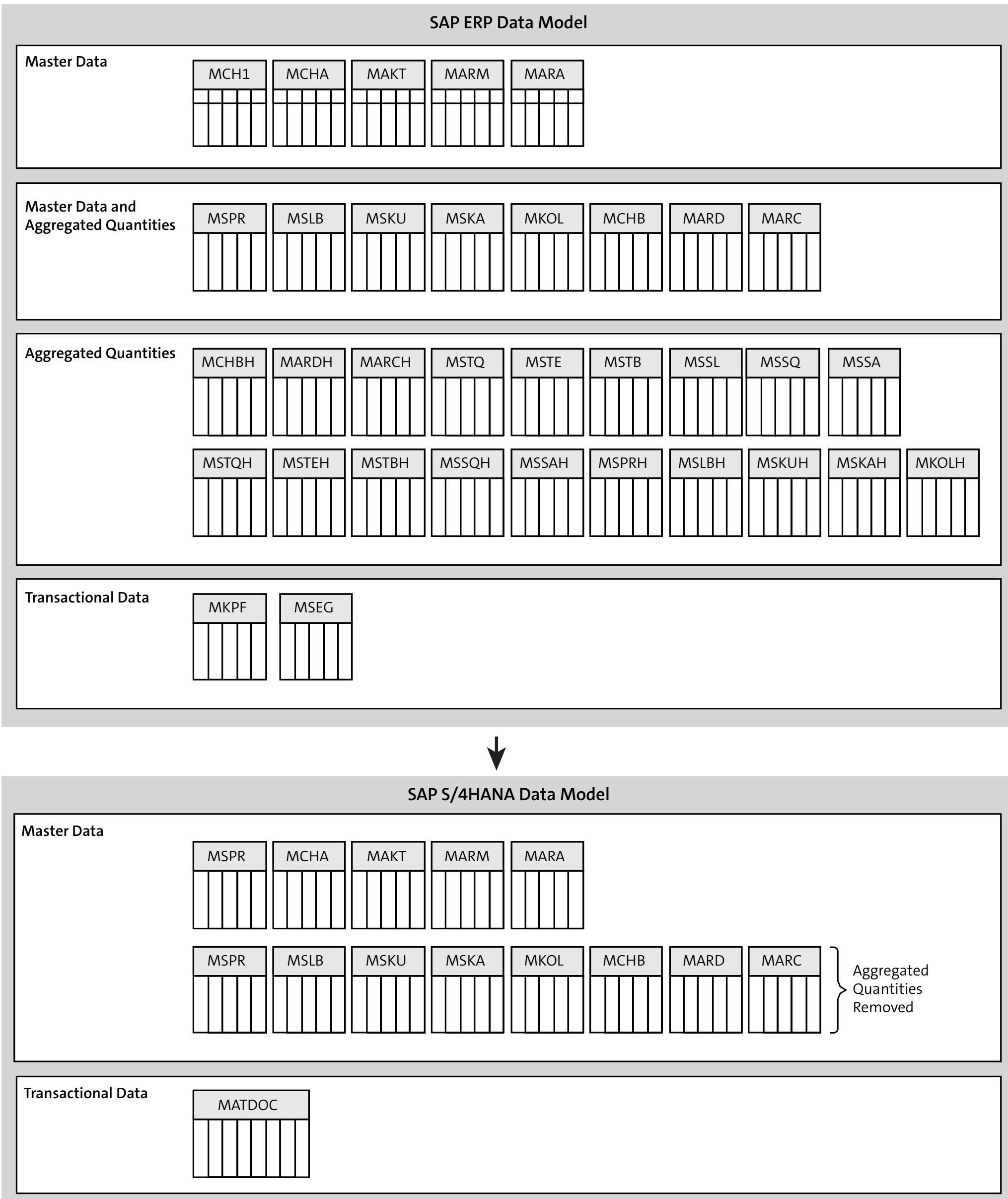

Figure 12.6 Inventory Data Model in SAP ERP and in SAP S/4HANA

A combination of logical keys identifies all different inventory stocks These keys are the stock identifying fields (SIDs) in the material document table `MATDOC` (see Figure 12.6). SAP S/4HANA calculates approximately 60 different types of inventory stocks

based on these SIDs. The SIDs reference organizational units such as plant and storage location, which describe where the inventory belongs. Furthermore, the SID contains business-related attributes such as `InventoryStockType` and `InventorySpecialStockType`, which describe the business process(es) the inventory belongs to.

`InventoryStockType` describes standalone stock types, such as unrestricted-use stock or quality inspection stock (Section 12.6.2). Contrary to that, `InventorySpecialStockType` can only be used in conjunction with additional SID fields, such as supplier (supplier consignment stock), customer (customer consignment stock), sales document, and sales document item (order-at-hand stock). For example, a supplier consignment stock posting has the stock type consignment, and, among others, the SID attribute supplier is filled in the material document. Some inventory stock types aren't managed by the material documents but by other functionalities. Examples are nonvaluated goods receipt, blocked stock (managed by purchase orders), and reserved stock (managed by material reservation documents).

12.5.2 Available-to-Promise

The available-to-promise (ATP) check is a service that calculates the availability of a specific product in a specific plant. The most prominent use cases are sales order processing (including delivery creation and goods issue) and production planning (in particular, the conversion of planned orders into production orders).

The result of an ATP request is a confirmation. It might be a simple pair of a specific confirmed quantity at one specific date, or it may be a time series consisting of quantity/date pairs. For example: 10 pieces of product A are requested in plant 0001 for next Monday; and the ATP check confirms only 5 pieces on the requested date next Monday but 3 additional pieces next Wednesday. The remaining 2 pieces unfortunately can't be confirmed.

SAP S/4HANA uses two different algorithms for calculating a confirmation for a given requirement in an ATP check:

- Product availability check
- Product allocation check

The product availability check algorithm calculates product availability based on existing supply and demand elements, which are represented by business objects stored in the database, such as stocks, sales orders, or production orders. The algorithm aggregates all relevant stocks and supply elements in daily buckets in real time and compares them with the aggregated demand elements. If the cumulated supply exceeds the cumulated demand, the resulting positive ATP quantity is used to confirm the requirement being checked. Working with cumulated quantities rather than dedicated supply and demand elements ensures that the confirmations calculated by the product availability check algorithm are robust and near immune to the minor changes that often impact transactional business objects. This degree of stability makes an ATP confirmation a reliable statement with a high business value.

The product allocation check algorithm, in contrast, is based on planning figures rather than real supply elements and can consider almost every additional attribute assigned to a demand element. For example: A certain group of products has export restrictions to certain countries. A time series with appropriate granularity, such as per month, can be created to reflect that restriction; for example, 100 pieces are allowed to be shipped each month. In addition to the previous sales-driven example, it's also possible to model capacity restrictions such as transport and/or production capacity. The planning figures in the product allocation check could, for example, represent the weekly transport capacity of a ship to a foreign country or the capacity of a machine that restricts the quantities that can be produced each day.

Both allocation check types, sales and capacity product allocation, can be checked in one single ATP check. The sales product allocation check is always performed before the product availability check. The capacity product allocation check is performed after the product availability check. The requested quantities and dates of the current check are based on the result confirmation(s) of the preceding check.

There can be multiple characteristics for one restriction (either sales or capacity restriction), and on top multiple characteristic combinations that can be logically combined (with AND and OR). The restriction is called a product allocation object (product allocation object), and the quantities maintained per bucket are the product allocation quantities (product allocation quantities). During the ATP check for a concrete requirement, all relevant product allocation objects are identified, and the system checks if the product allocation quantities are sufficient to confirm the request. Of course, the confirmed quantities need to be consumed; for this reason, the product allocation algorithm has dedicated persistent database tables.

From a business perspective, the product availability check decides to which extent a requirement *can* be confirmed based on supply. The product allocation check calculates if a requirement *should* be confirmed from a business point of view or based on capacity restrictions. Another difference is that the first come, first served principle of the product availability check can be weakened by product allocation to reach a more "fair share"–oriented confirmation approach. For example, if allocation quantities are maintained for different customers, the sales order for the first customer can't use all available stock. Instead, the first customer can only get the maximum quantity of the maintained allocation quantity of stock. The remaining stock can then be used to fulfill later sales orders for other customers.

Besides the two basic ATP check methods, additional features and functions can be used to manage and optimize the confirmation capabilities of ATP:

- Supply protection
- Supply creation-based confirmation

- Backorder processing
- Alternative-based confirmation
- Characteristic catalog/object and value determination
- Business process scheduling

Let's start with supply protection. Supply protection enhances the capabilities of the product availability check algorithm by introducing additional virtual demand elements into the check. These demand elements virtually reduce the available supply and therefore lead to lower and/or later confirmation. The supply protection object is used to define a kind of safety stock for requirements with certain attributes. When supply is short, supply protection helps to prevent the confirmation of requirements that don't match the supply protection object. For requirements matching with a supply protection object, the protected quantities of the matching supply protection objects are ignored, and don't lead to virtual demands being introduced into the product availability check.

Based on this logic, supply protection also allows the definition of supply protection groups with protected quantities in different time buckets. Other requirements that don't match the defined attributes of any supply protection object must respect the complete protected quantities as restrictions. Requirements matching with one supply protection object must respect the restriction of all other supply protection objects. You can define multiple protection groups within one supply protection object; the protection groups can have different priorities, such as the customers of supplying group A have priority over the customers of supplying group B or C. All equal or higher prioritized groups must be respected as restricted quantities. Requirements matching a protection group of a supply protection object reduce the protected quantity according to the confirmed quantity calculated by the product availability check algorithm.

From a business perspective, supply protection helps retain supply for high-priority groups even in times of high demand from lower-priority groups. It protects minimum quantities, whereas the product allocation check defines the upper limit.

An additional and powerful feature to calculate a realistic order confirmation is the supply creation-based confirmation: in case of insufficient supply, supply creation-based confirmation allows the ATP check to verify if the missing supply can be produced or procured. supply creation-based confirmation uses the capability of embedded production planning and detailed scheduling (PP/DS) planning functionality to simulate the creation of a corresponding supply element (e.g., a planned order). This is done in a finite way (reserving resource capacities) and across multiple BOM levels. The calculated output dates and quantities for the header material are taken over as the ATP confirmation into the corresponding requirement document (currently only sales orders); if the document is saved, the real supply element is created automatically.

The ATP check for a single order is triggered whenever an order is created or changed. The ATP confirmation always considers all concurrent orders and their confirmations, even if the corresponding order documents haven't yet been saved. This leads to a strict first-come, first-served behavior that companies often want to overcome later. The tools that allow these necessary mass changes of ATP confirmations are backorder processing or release for delivery.

Backorder processing is a batch job that can be configured flexibly according to business needs. The user can select specific order items to be included in the backorder processing run, define their priority, and control their confirmation behavior. For example, the *gain confirmation strategy* means that assigned requirements should at least retain their confirmation or—if possible—improve. The backorder processing run selects requirements according to the attributes of the underlying transactional business document (e.g., sales order). Backorder processing recomputes the confirmations of the orders quickly and updates the orders efficiently due to parallelization.

Furthermore, in SAP S/4HANA, the backorder processing run can be combined with supply assignment (ARun), which assigns the most appropriate supply to fulfill a dedicated requirement (especially in a supply shortage situation). ARun creates a fixed pegging between supply and demand elements. The Release for Delivery app can be used to change the confirmations for multiple orders manually, with the goal of directly creating deliveries for those orders.

Alternative-based confirmation can be used to check for viable alternative plants, storage locations, and/or products with which a requirement can be confirmed. For example, the availability of a product in a requested plant is insufficient to confirm the requirement. ATP with alternative-based confirmation now determines all viable alternative plants automatically and substitutes the originally requested delivery plant with one or multiple alternative plants. Alternative-based confirmation can also substitute the requested product with products that have the same form, fit, and function or with a successor product. Combining the alternative plants with alternative products, you can improve the fulfillment of the customer requirement, for example, by providing more quantity or an alternative delivery date that better fulfills the customer's requirement than the originally requested product in the originally requested plant would have.

In alternative-based confirmation, you can define a substitution strategy so that alternative plants, storage locations, or products are determined, as well as whether the system should prefer full confirmation, on-time confirmation, or confirmation of as much requested quantity as possible on the requested date. You also can configure the strategy to consider alternatives when an ATP check is performed, when new requirements are created, or when requirements are posted. Alternative-based confirmation can therefore be used in the online processing of a sales order requirement, such as when a sales order is created, a sales order is changed, or even during backorder processing.

Alternative-based confirmation can be activated with a high degree of flexibility in specific situations by choosing a combination of attributes of the sales order document

together with process characteristics. For example, alternative-based confirmation can be activated just in case an order is created newly and for customers from Italy, only.

The different ATP features (product allocation check, backorder processing, alternative-based confirmation, supply protection, or business process scheduling) use various attributes of the requirement and its underlying transactional business object for different purposes. Within alternative-based confirmation, for example, attributes—more precisely, their values—can be used to determine if alternative-based confirmation should be activated and, if so, how alternative-based confirmation should behave. In backorder processing, attributes and their values are used to define filter and sort criteria to determine which requirements are to be included in a backorder processing run. The fields from the requirement documents used within ATP are called *characteristics*. In addition to the fields from the requirement document, classification characteristics from variant configuration (see Chapter 8, Section 8.2.3) can also be used. These classification characteristics and their values belong semantically to the requirement document but are stored technically in an independent persistence. The collection of all characteristics that may be used within a certain ATP application (e.g., product allocation check) and which can be derived from certain business documents (e.g., sales order) is called a *characteristic catalog*. A dedicated set of characteristics from a catalog is called a *characteristic combination*.

Object and value determination is a reusable ATP component integrated in different ATP applications. It's based on a catalog and used to determine application-specific entities such as objects (e.g., an alternative-based confirmation substitution strategy) or values (e.g., a business process scheduling duration). Object and value determination models access sequences, which are ordered lists of characteristic combinations, and allows you to assign a dedicated entity to a corresponding characteristic value combination. The ATP applications are using object and value determination by accessing the characteristic combinations in the defined sequence to determine the entities for the current characteristic values. Object and value determination is used by product substitution, plant and storage location substitution, alternative-based confirmation alternative determination, and business process scheduling.

Business process scheduling can be used to determine the relevant dates of a business process, which refers to the dates and times when specific business activities, such as transportation planning, picking, loading, and transportation, must start or end to fulfill the complete business process. For example, business process scheduling can be used to determine the requested material availability date (the input for the ATP check) based on the requested delivery date of a sales order requirement. With business process scheduling, additional scheduling activities can be defined and used in the scheduling logic. The determination of durations and working times, which are relevant to schedule a business activity, is configurable. For example, the duration can be determined based on the sales and distribution Customizing or on characteristic values of the sales document by using object and value determination. Business process scheduling can be used for sales documents, outbound deliveries, and stock transport documents.

12.5.3 Material Requirements Planning

Material requirements planning (MRP) is an engine that calculates the net requirements of a product—supply reduced by demand—based on its planned demand and PIRs for a given plant. Planning uses BOMs, routings, work centers, and material masters as additional input parameters (Section 12.3). The selected MRP type determines the planning algorithm, which defines the formula to calculate the net requirements. The plant and MRP area determine the organizational units of the planning calculation. Based on the algorithm, MRP runs recursively along the low-level code of each material until all components of a product are planned.

MRP in SAP S/4HANA follows a different architecture pattern than the traditional MRP known from SAP ERP. The new *MRP Live* executes most of the planning directly in the SAP HANA database. This design decision speeds up access to the various data required for an MRP run and makes the calculation very fast. MRP Live makes planning results available in real time.

Nevertheless, planning runs can also be scheduled as background jobs in SAP S/4HANA. The optimized algorithms used in MRP Live are based on a strict master data setup for production planning. If the setup is incomplete, the planning switches back to traditional MRP. SAP Note 1914010 (MD01N: Restrictions for Planning in MRP Live on HANA) explains the restrictions for each release.

For configurable products, the evaluation of the BOM, called a BOM explosion (see Chapter 8, Section 8.2.1), needs to be based on variant configuration object dependencies, such as constraints or selection criteria. This is called *low-level configuration* (for details, see Chapter 8, Section 8.2.11). To optimize the performance of MRP Live for configurable products as well, the BOM explosion and the evaluation of the related object dependencies are also directly executed on the SAP HANA database. The object dependencies are stored in a special format to be interpreted by algorithms that run directly in the SAP HANA database (see Figure 12.7).

When planning is started, MRP goes top-down through the BOM of the material to be produced. Initially, it plans the net requirements of the material to be produced. Then, the planning continues on a detailed level, which means all components listed in the BOM are considered. For each component listed in the BOM, MRP creates a dependent requirement. For each requirement, MRP checks whether there is enough supply of each component for the production. If not, MRP makes sure that the right quantity is available at the right time in the inventory. To do so, it creates either a planned order to produce the missing components or a purchase requisition to procure them.

During MRP, material master data is evaluated. For example, the MRP views of the material master define the procurement type (in-house production or external procurement) and the goods receipt processing time. In addition, the routing and BOM master data is also used by the MRP logic.

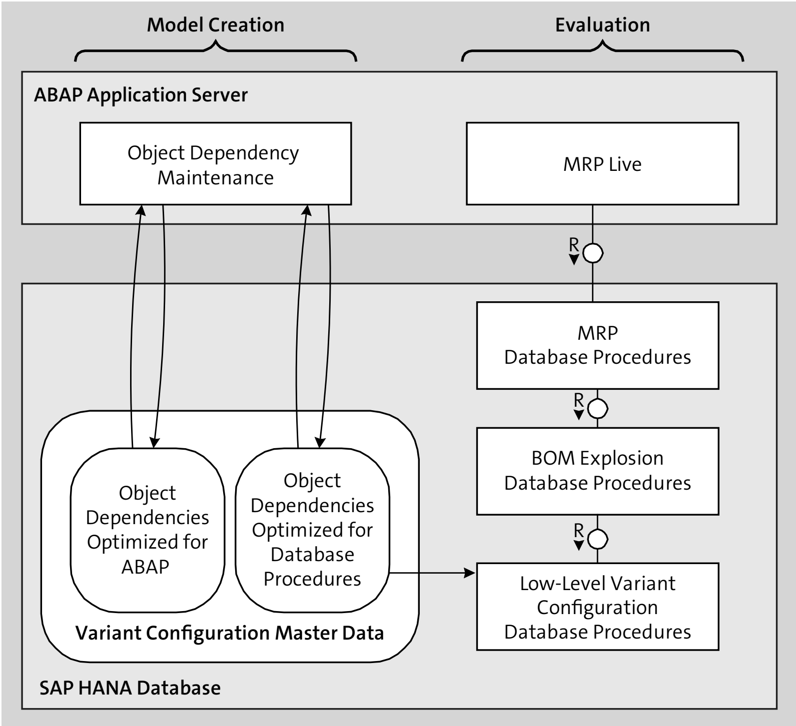

Figure 12.7 Optimized Low-Level Configuration in SAP HANA

The MRP logic has to make sure that the same BOM material isn't planned again. This is ensured through a planning file, which is an input queue for the MRP logic. The planning file is a record that consists of the materials that are relevant for planning. The MRP run happens only for the materials in the planning file. Once the material is planned, the entries are deleted from the planning file.

MRP logic calculates the net requirement of material to satisfy current or future stock shortages (see Figure 12.8). First, MRP reads the requirements and receipts. Next, it calculates net requirements, lot sizes, and sourcing, and then explodes the BOM. Finally, it creates or deletes receipts or dependent requirements. Receipts are either a planned order (for in-house production) or purchase requisition (for external procurement). The dependent requirements are then processed in the next iteration.

During the MRP run, SAP S/4HANA recognizes critical situations that must be assessed manually in the planning result. MRP creates exception messages that are collected and logged at every phase of the MRP run. The MRP controller can access the exception messages in the MRP Live cockpit. It's important to understand that the result of the MRP is infinite planning that is subsequently leveled by capacity planning (Section 12.5.8).

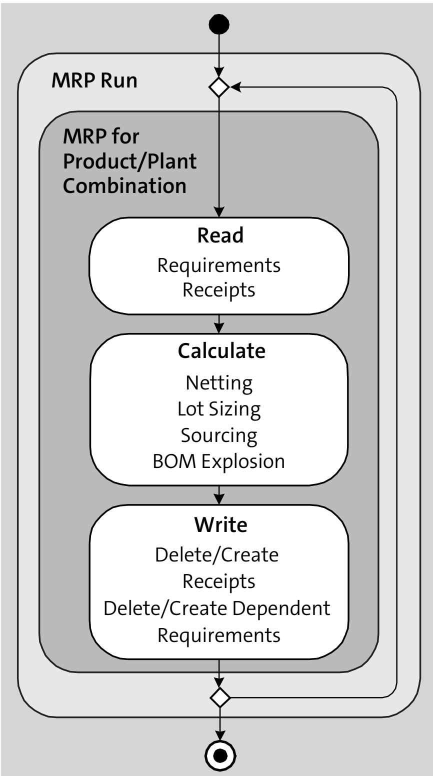

Figure 12.8 MRP Run

12.5.4 Demand-Driven Material Requirements Planning

Demand-driven MRP is a new planning algorithm offered in SAP S/4HANA as a separate MRP type, which reflects recent advances in production planning methodology. Demand-driven MRP is based on the assumption that a supply chain is more effective if certain critical steps within the production process are decoupled by buffering the subassembled product as stock. The prerequisite to plan with demand-driven MRP is defining the to-be-buffered product (buffer positioning) and the buffer sizing in the product master. Demand-driven MRP can be combined with existing planning algorithms so that within a supply chain, some products are individually planned according to selected MRP types, ad hoc planned, or buffered according to demand-driven MRP. For more information about demand-driven MRP, see, for example, *http://s-prs.co/v567513*.

12.5.5 Kanban

Kanban is a robust and simple method to continuously supply small quantities of a material to production processes based on actual consumption. The conceptual information model of the kanban architecture in SAP S/4HANA is shown in Figure 12.9. With the kanban process, a demand source asks for replenishment from a supply source once a specific quantity of a given material is needed. The demand source is located close to and consumes material from one or more *production supply areas*. The replenishment process itself is modeled in a *kanban control cycle*. The material is transferred from the supply source to the demand source in *kanban containers*, usually labeled with a printed kanban card that includes a barcode and other information.

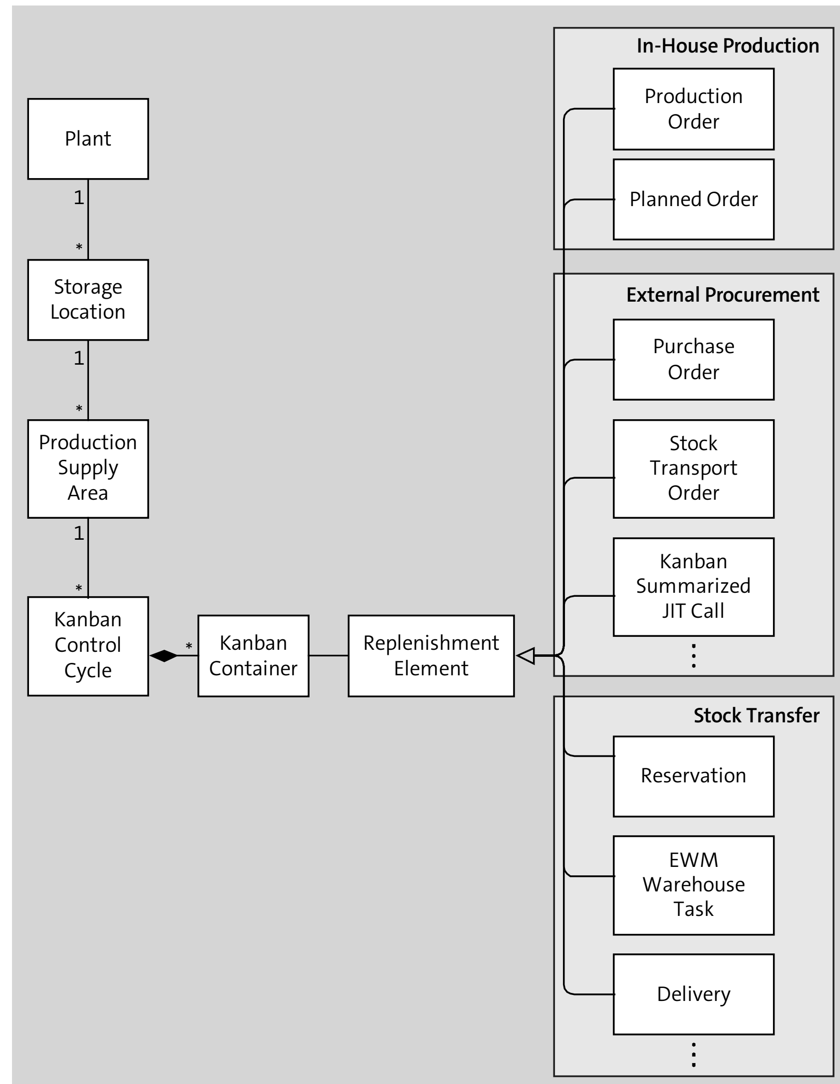

Figure 12.9 Kanban Architecture

There are two categories of kanban control cycles: classic and event driven. In classic control cycles, a constant number of kanban containers circulate between supply source and demand source. In event-driven control cycles, the demand source triggers the creation of new kanban containers once material is needed, for example, based on material requirements of soon to be executed production orders. Such kanban containers are automatically deleted after one cycle, so the number of containers can vary under this category.

Each kanban control cycle is configured to use a specific replenishment strategy from the stock transfer, external procurement, or in-house production categories:

- For stock transfer, the supply source could be a storage location (Section 12.2) or an embedded or decentral warehouse managed by extended warehouse management (EWM, see Chapter 13).
- For external procurement, the supply source is a supplier.
- For in-house production, the supply source is a production process.

The customizable replenishment strategies define in detail which business documents are created when the demand source requests the material. These business documents are called *replenishment elements* in the kanban process. Some examples of the many possible variants to create replenishment elements for a given material and requested quantity are as follows:

- For a stock transfer from a storage location, the kanban control cycle creates a stock transfer reservation document.
- For a stock transfer from an embedded EWM warehouse, the kanban control cycle creates an EWM warehouse task (see Chapter 13).
- For external procurement, the kanban control cycle creates a purchase order (see Chapter 11, Section 11.2).
- For in-house production, the kanban control cycle creates a production order.

The lifecycle of the replenishment element and the corresponding kanban container are interwoven: setting a container to empty (classic control cycles) or requesting a new container (event-driven control cycles) creates the replenishment element automatically, so the production worker doesn't need to know process details. Later in the process, there are two possibilities: either the container is set to full, which automatically confirms the replenishment element, or the replenishment element is confirmed, which sets the container to full.

12.5.6 Just-in-Time Processing

Just-in-time (JIT) supply is a process to efficiently replenish or provide discrete materials for manufacturing in quantity and on time. JIT supply is designed to suit both simple and complex scenarios. JIT processes are typical for the automotive industry with

its highly configurable and complex products and its mass production. Inventory reduction is the most obvious result of JIT supply, which not only reduces costs but also saves space—a very limiting factor in automotive production with its high variance of components and their bulkiness. JIT entails a tight B2B integration to ensure a supply to production using, for instance, kanban (Section 12.5.5) or scheduling agreements (see Chapter 11, Section 11.1).

In addition, outsourcing of production to save costs and accelerate vehicle assembly in mass production requires the supply of complex, bulky, and configuration-dependent preassembled products, such as cockpits, seats, engines, and axles, specific to each of the vehicles and replenished with reference to individual vehicle planned orders or production orders and in exactly the sequence of vehicle production. That variant of the JIT process is also referred to as *just-in-sequence* (JIS) supply. Depending on the number of variants expected for these preassembled products, either individual material numbers are used representing each of the variants, or the preassembled products are requested, delivered, and settled by the individual components used for preassembly. Depending on that, the vehicle BOM contains either items for the components of the preassembled products or items for the variants of the preassembled products.

The request for JIT supply is the *JIT call*. The processing of a JIT call is reflected by defined actions performed. Each action performed successfully results in an internal processing status of the JIT call. A specific action can be performed only if the JIT call has an internal processing status allowing that action to be performed. That relation of internal processing statuses allowing actions to be performed with resulting new internal processing statuses are configured as *action controls*. Multiple action controls can be maintained to suit different process variants.

In simple cases, a production operator requests the replenishment of a single component material by creating JIT calls for supply to production manually. The user would normally do this as soon as one of the containers for the material that was replenished previously gets empty, and the user then requests just another container to fill up the material stock at the production line or work center. As the request isn't specific to an individual planned order or production order, the JIT call created is of the summarized JIT call type.

For controlling and simplifying such requests, the production planner prepares the JIT control cycle, specifying the material to be replenished, the production supply area as destination, the requested quantity used as default, the container expected to be used, the source of replenishment together with the replenishment strategy applied, and the replenishment lead time used to schedule the JIT calls (see also Section 12.5.5 for kanban control cycles). For each combination of plant, production supply area, and material, there can be one control cycle. To create a new JIT call, the production operator just needs to enter the control cycle number or use a barcode scanning device, when barcode labels are used. The requested quantity proposed is based on the container quantity specified in the control cycle. The requested date and time for the replenishment to be completed is based on a forward scheduling using the replenishment lead time. Immediate requests are also possible for emergency cases.

The creation of JIT calls can also be planned and automated to relieve production operators from such tasks and to avoid peaks in requests. For *production supply planning*, the planning parameters must be specified in the JIT control cycles, including planning procedure, planning horizon, safety stock, and safety time. When using *consumption-based planning* as the planning procedure, new JIT calls for the planned JIT control cycle are created in case the current material stock at the production supply area is below the safety stock. When using *demand-driven planning* as the planning procedure, the planning also considers the dependent requirements from production assigned to the production supply area and a requirements date and time within the specified planning horizon.

As soon as the projected material stock at the production supply area within the planning horizon—derived from the current material stock by considering all the demands and existing JIT calls still to be supplied—falls below the safety stock, a new JIT call is scheduled accordingly. The material stock considered is either represented by the material stock at the storage location assigned to the production supply area or by the material stock at the warehouse storage bin assigned to the JIT control cycle. The use of warehouse storage bins is recommended if component materials are replenished to multiple production supply areas at the same production line, and the same storage location is used for all production supply areas of that production line. Very often, the consumption posting of component materials is done much later than the physical consumption or usage in production. Reporting point confirmations reduce that time lag, but even if the reporting is done close to the physical usage, the volume of components confirmed often require a collective posting decoupled from the reporting of production confirmations. For that, the calculation of the physical stock of materials at the production supply area also considers reported production confirmations for materials, where a goods issue hasn't been posted yet.

If the source of supply is an internal source, the JIT calls are used to transfer stock from a source storage location to the destination storage location, in one or two steps. If the stock is managed in a warehouse, the transfer is done using warehouse tasks created based on the JIT calls. The JIT calls get updated from that stock transfer, and the status is set to **Completed** when the stock is received at the production supply area, either by having the stock available in the warehouse storage bin specified in the JIT control cycle or by having the stock available at the destination storage location.

If the source of supply is an external supplier, the JIT call is sent to the supplier via an EDI message. With receipt of the material delivered, the goods receipt posting updates the JIT call and posts the stock directly to the storage location of the production supply area or to the warehouse storage bin specified in the JIT control cycle. The goods receipt posting also updates the purchase scheduling agreement item assigned to the JIT control cycle for external replenishment.

In complex cases of JIS processing, the JIT calls are created specifically for individual planned orders or production orders. As those are processed in a certain production sequence, the request is of type sequenced JIT call. If a preassembled product is requested by its components, a JIT-specific BOM must be maintained, including all possible component materials. In terms of JIT call processing, the preassembled product is represented as a component group material. The JIT control cycle for sequenced JIT calls is maintained for the component group material. The component materials are assigned to the JIT control cycle automatically based on the JIT BOM for the component group material. For each of the component group materials, a separate sequenced JIT call is created containing all related component materials for that specific planned order or production order. For each vehicle assembled, the system creates as many sequenced JIT calls as there are individual component groups determined for its components.

Sequenced JIT calls are created some days before the vehicle assembly starts and are subject to multiple updates until then. Updates can be caused by scheduling and rescheduling of planned orders or production orders until those are fixed. Changes to the order based on a re-explosion of the BOM could also result in an update of the JIT call and a change of its components. Sequence numbers are assigned in manufacturing execution systems based on production sequencing and changed in case of resequencing. Status updates are also provided based on production confirmation. Reporting points at the start or end of production lines could trigger updates to the sequenced JIT calls. Often the start of assembly is considered the final status of the JIT call. Relevant JIT call updates are forwarded to the supplier.

The supplier receives JIT calls from customers, either as summarized JIT calls or sequenced JIT calls. JIT-specific master data must be set up for processing customer JIT calls.

12.5.7 Predictive Material and Resource Planning

Operational material planning, like MRP, is executed daily. However, enterprises have to react to rising demands for their products and increase the production capacity of their plants. SAP S/4HANA provides *predictive material and resource planning (pMRP)* for such long-term preparational planning. Typically, enterprises use pMRP on a monthly or weekly cycle. The planning horizon of the preparation is long to midterm, which means it spans typically 3 to 12 months because the factory needs some time to implement proposed changes to the parameters. For example, adding an additional shift to increase production capacity requires an agreement by HR, and workers must be informed early enough.

pMRP has its own persistency to facilitate simulation and planning. This simplified image for planning (see Figure 12.10) is based on the following data:

- Set of master data objects
- Relationships between these objects
- Top-level demand
- Existing stock for products

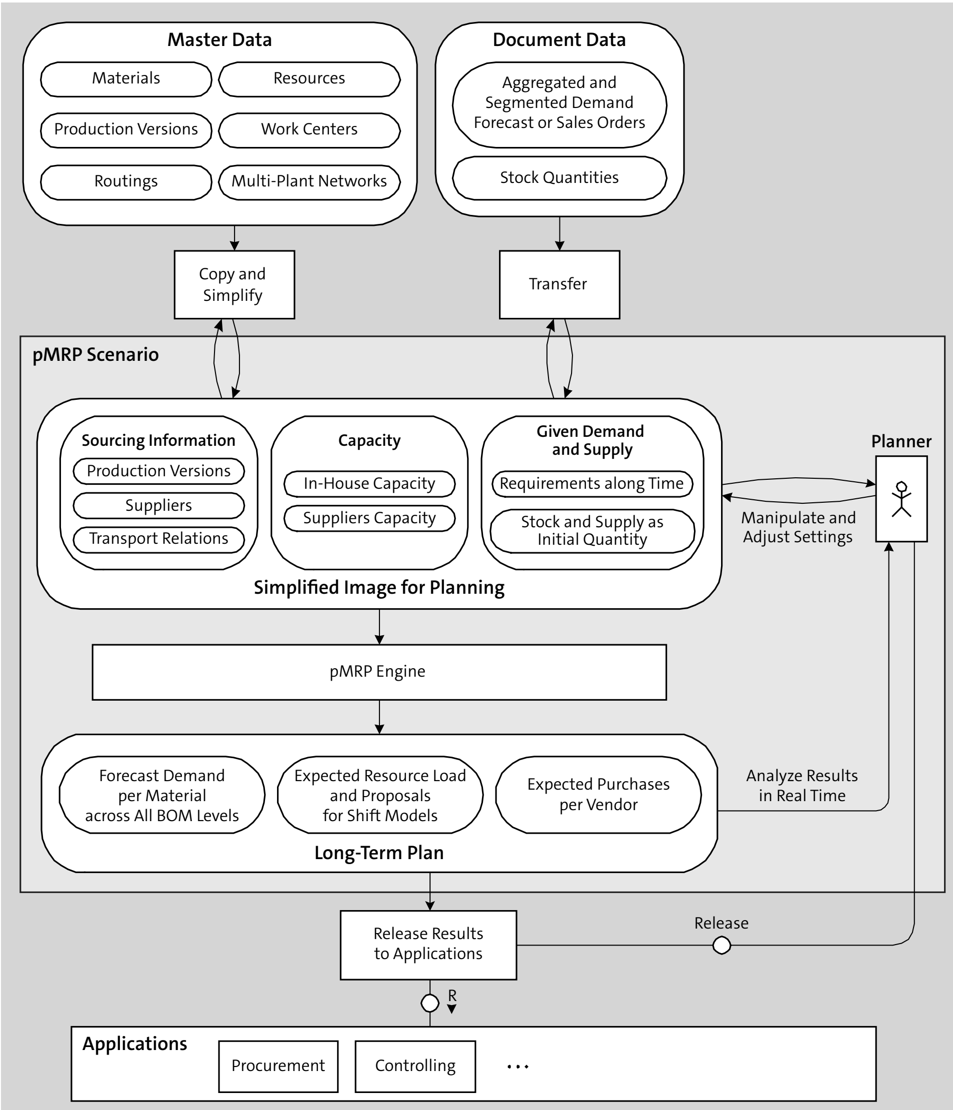

Figure 12.10 Architecture of pMRP: Simplified Image for Planning

For a certain set of objects, the pMRP engine calculates pegging relations between product demand, product receipts, capacity demand, and some given product stock, forming a pegging network.

pMRP uses the pegging network to predict required resources for in-house production (resource utilization), requirements for suppliers for externally procured products (schedule line forecast), and a forecast for externally procured products without a supplier.

The pMRP scenario consists of three steps:

1. A batch job regularly—every night or every week—analyzes the operative master data, simplifies it, and copies this simplified image to the data model of a pMRP scenario. The batch job also transfers aggregated document data such as forecasts and stock quantities.
2. When the planner interacts with the simplified image for planning, the pMRP engine calculates the result in real time. Then, the planner adjusts settings in the scenario, analyzes the results in real time, and takes further corrective actions. This is done in iterative cycles. To allow what-if analysis, the planner can work with multiple simulation versions.
3. If the planner is fine with the adjustments, the planner releases the results, such as a confirmed product forecast, changed shift models, or updated sourcing rules, back to the SAP S/4HANA operative data.

After that, the operational planning is executed using the updated planning parameters.

KPIs are calculated in real time to identify the following:

- Pegged top-level demand for any receipt or demand in the pegging network
- Pegged top-level demand for any capacity requirement
- The capacity requirement (indirectly) caused for inhouse production for each top-level demand
- The supplier demand (indirectly) caused for externally procured products for each top-level demand

In principle, by traversing the pegging network, you can calculate any other KPI based on date and quantity.

The time dimension is stored and processed in buckets. Buckets can be weeks or months, whereas the calculation of offsets (e.g., production time) can be days (work or calendar).

12.5.8 Capacity Planning

The result of MRP is a list of planned orders creating internal requirement elements (refer to Section 12.5.3 and Figure 12.1). The entire calculation is based on an infinite planning strategy that doesn't take constraints of work centers, shifts, or factory calendars into account. MRP solely plans based on the material flow. Thus, all parameters in the master data defining any durations (e.g., lead time) are gross times. After an MRP run, capacity planning is used to dispatch the planned orders and converted production orders to the work centers so that any work center overload is avoided. The possible means to do this are as follows:

- Checking the overload situation in the work center and changing the work center capacities (adding shifts or adjusting efficiencies)
- Rescheduling production orders or planned order operations
- Changing internal sourcing (changing the production version, transferring stock from other plants)
- Using external procurement (purchasing or subcontracting)

Unlike MRP, capacity planning is based on the net times defined in the master data. For efficient capacity leveling, the option to define pacemaker work centers (a decisive influence during production execution) or capacity buckets can be used.

Different strategies for capacity leveling are supported, which include *find slot* and *insert operation*. For capacity leveling, the scheduling direction can be chosen to control whether the affected orders are scheduled backwards or forwards in time. Capacity leveling uses SAP liveCache as an efficient scheduling engine.

12.5.9 Production Planning and Detailed Scheduling

Production planning and detailed scheduling (PP/DS) is a tool that supports you with various optimization algorithms during production planning operations. Traditionally, PP/DS functionality required a two-system landscape with PP/DS running in a separate SAP Advanced Planning and Optimization (SAP APO) server in addition to the SAP ERP system. In on-premise SAP S/4HANA, PP/DS is embedded and an integral part of logistics. It can be used to refine the planning results created by MRP Live (Section 12.5.3). Embedded PP/DS uses the SAP liveCache functionality of SAP HANA. If materials are flagged for PP/DS in the material master, the material is replicated to the PP/DS object store in SAP liveCache. There, the planning and detailed scheduling operations are performed with high performance in memory.

12.6 Cross-Functions in Logistics and Manufacturing

The logistics and manufacturing cross-functions implement business objects that are used in multiple logistics processes. Typically, such cross-functions require separate Customizing and master data so that they can integrate with the standard business process. Often, dedicated cross-functions are mandatory in special industry processes, such as batch management being mandatory in the pharmaceutical industry. We'll discuss the important cross-function areas in the following sections.

12.6.1 Batch Management

Batches allow subdivision of one material's stock into different groups based on common characteristics. For example, batch A of vitamin pills is produced from batch 001 of ascorbic acid with a shelf-life of three months and batch 101 of sodium carbonate with a shelf-life of six months. Some characteristics represent system fields, such as production date or shelf life. Some characteristics are freely defined key/value pairs representing technical or physical attributes. SAP S/4HANA can track these groups and process them automatically based on their characteristics.

Normally, batches are maintained on the material or material/plant level for each material (product master settings). Each material batch is identified by a unique number, and its inventory has a dedicated lifecycle starting with the batch creation and ending with the consumption of the last material batch stock. Figure 12.11 shows the batch business object and its relation to other processes in SAP S/4HANA.

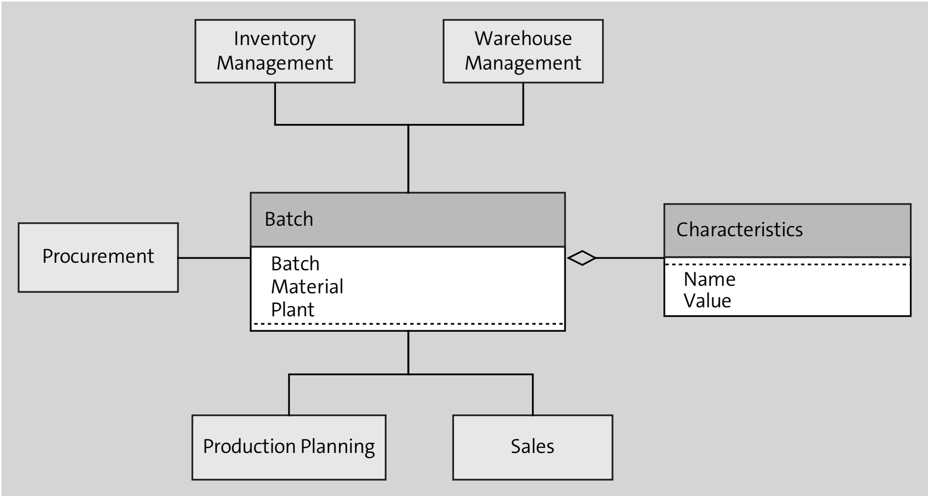

Figure 12.11 Batch Management

12.6.2 Quality Management

Quality management provides functionality to ensure the quality of the products that are produced, procured, and sold. It's based on business objects for the prevention, detection, and elimination of defects. It enables you to establish and document business processes that meet standards such as EN ISO 9000. Because of its ubiquitous nature, quality plays a role for internal processes and for the exchange with suppliers and customers.

Let's start with the primary motivation to strive for good quality—the expectation of all customers. The quality info record in sales business object allows you to assign a quality agreement and technical delivery terms by customer and sales organization using the document management system. It also allows you to define quality inspections for a specific material, which need to be successfully passed. If they're not, the delivery of the material can be blocked (see Figure 12.12).

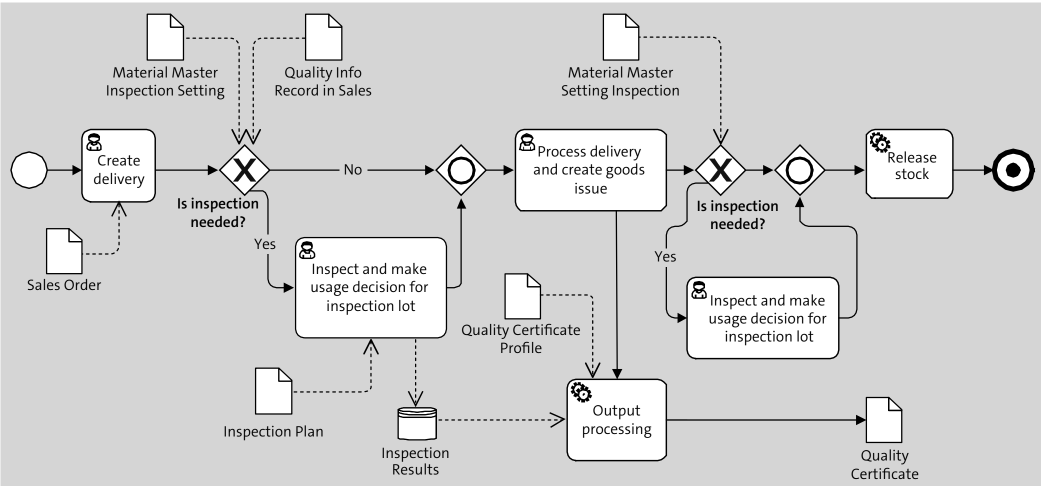

Figure 12.12 Quality Management in Sales

Along with the delivery papers, the customer often demands a quality certificate that proves certain characteristic values. The data retrieval for the required quality characteristic is implemented by the quality certificate profile business object. The assignment of certificate profiles to customers, materials, or other attributes of the delivery is managed in a flexible way with the condition technique.

When you procure products from suppliers, you expect good quality. The quality aspects of the relation to a supplier can be documented in the quality info record in procurement business object. This is defined per supplier, material, revision level, and plant. You can assign the quality assurance agreement to it using the document management system. It also triggers quality inspections for goods receipt or supplier source inspections, the creation of quality certificates, and the release of certain process steps in the procurement process (see Figure 12.13). Incoming certificates sent by the supplier can be assigned and managed by the quality certificate in procurement business object.

Quality inspections are done to monitor the quality of products sold to customers and products received from suppliers. The inspection lot business object is used to cover a quality inspection for certain business processes such as goods receipt or delivery. How the inspection will be conducted is defined in the quality view and especially in the inspection setup business node of the product master business object.

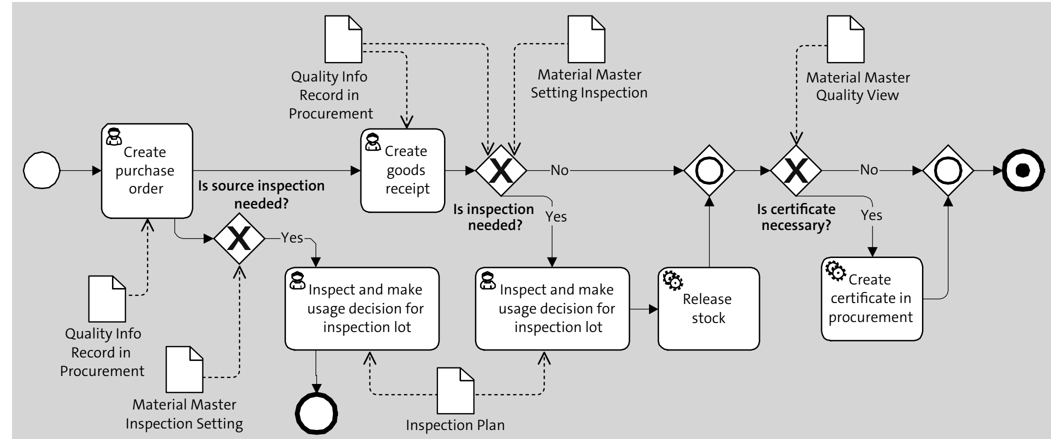

Figure 12.13 Quality Management in Procurement

The content of an inspection is planned by using a variety of master data. The material specification, inspection plan, and (for in-production inspection) production plan business objects contain the inspection plan characteristics business object, which defines the qualities to be measured. The inspection plan characteristics can refer to the master inspection characteristic business object. The inspection method business object can be used to describe how the characteristic must be measured. It allows you to attach documents using the document management system and can be assigned to a master inspection characteristic or directly to characteristics in the inspection plan.

The sample procedure, sampling scheme, quality level, and dynamization rules business objects define the selection of the sample to be controlled. The inspection point business object node defines the location where the inspection takes place.

In the process industry in particular, the inspection is done on numbered samples, which are represented by the material sample business object and planned by the sample drawing procedure master data business object.

Getting a view of an element's true quality is essential to react accordingly and ensure good quality if something goes wrong. The defect business object is used to document all quality issues that occur during internal processes such as quality inspection. Measures to remove the defect or for the prevention of recurrence can be documented in the quality task business object. The problem-solving process business object guides you through a more detailed analysis of the defect according to a methodology of quality management such as *eight disciplines of problem solving* (8Ds).

All incidents that your customers report or that you report to your suppliers can be documented in the quality notification business object. It can also be used to execute detailed analysis of or cost assignment to defects for which the defect can be converted into the quality notification item business object node. *Failure mode and effect analysis*

(FMEA) is a standard approach to prevent or detect quality issues and is covered by the FMEA business object, which is built on top of audit management.

Finally, there are objects to document compliance with quality standards such as the audit business object. The content of the audit is maintained in the question list business object. Audits are planned within the audit plan business object. The business objects of audit management use the generic project planning (CGPL) engine.

12.6.3 Handling Unit Management

Handling unit management is used to reflect packaging in logistics processes. Virtually representing physical packaging provides several advantages. A *handling unit* contains a set of products packed together. Goods movement processing is made more realistic and efficient by moving the handling unit itself—the package—instead of the included materials.

In discrete manufacturing, handling units can be planned against production orders. With the corresponding output management for handling units, handling unit labels can be printed and placed on the corresponding load carrier once a produced material is placed inside. The handling unit and its unique handling unit ID can then be used to post a produced material goods receipt.

Handling unit planning can also be performed for repetitive manufacturing processes. Backflushing of materials in the case of existing handling units can then also be conducted using the respective handling unit identifier.

Besides creating handling units in production processes, handling units can also be directly received from suppliers via inbound EDI. In this case, handling units are part of the inbound delivery, from which they are put into stock or directly used within production.

Although handling unit usage already at production provides significant benefits, it's also possible to create handling units only at the time of shipping. In the sales order, customers can define a packing proposal, which can be later used to create handling units in the outbound delivery. Alternatively, handling units can be directly created in the outbound delivery without packing proposals from the sales order.

To simplify handling unit creation and to avoid input errors, a set of packaging master data objects can be used:

- Packing instructions
- Determination records

In the packing instruction, manufacturers can define how a handling unit should be packed by providing a packaging material as a load carrier, as well as the respective materials and quantities that should be packed onto the load carrier. To avoid needing to create a potentially vast amount of materials packing instructions, manufacturers

can also decide to create packing instructions for reference materials. These reference materials in turn must be maintained in the product master of the materials the manufacturer would like to have packed according to the respective reference material packing instruction.

The packing instruction itself can't be found by the automatic packing functionality in the corresponding packing dialogs unless there is a corresponding determination record. The determination record, based on the condition technique known from pricing determination, creates the link between certain conditions and packing instructions. The easiest of all conditions is the direct relation from a material to a packing instruction, which should be drawn in case this material needs to be packed. However, manufacturers have the choice to expand the conditions to include ship-to parties and various other fields provided in the field catalog of the corresponding handling unit configuration. This differentiation is beneficial as soon as one material is packed differently depending on certain conditions. For example, it's possible to provide two different packing instructions for one material, depending on whether it's shipped to customer A or customer B.

In addition to using handling units for internal process optimization, they are also used to notify ship-to parties of the exact packaging they are about to receive. Using outbound advanced shipping notifications (ASNs), manufacturers can ensure that the handling units, including their content, are communicated to their customers prior to the actual shipment arriving.

To uniquely identify which serialized material belongs to which handling unit of any given reference document (i.e., outbound delivery), serial numbers of those materials reference the handling unit and are also provided in the outbound EDI message.

12.6.4 Serial Number Management

Serial numbers allow the identification and differentiation between individual items of one material. This component therefore ideally supplements the product master record, which contains all data for describing and managing a piece of material, but doesn't enable you to differentiate between individual items of that material.

Many logistics and manufacturing processes use serial numbers. The serial number profile defines how and when serial numbers are created and assigned during these processes. The *serial number profile* is a set of data that defines the conditions and business processes involved when assigning serial numbers to items of materials.

The serial number profile is entered in the product master record at the plant level for the material to be managed. This means that an individual profile can be assigned to a piece of material per plant. In this way, a certain material can require serial numbers at one plant and not at others. If you use different profiles for a material in multiple plants, the plants must be logistically independent of one another because it's only possible to transfer stocks from one plant to another if the profiles are the same at both.

12.6.5 Inter-/Intracompany Stock Transport

Logistics uses *stock transport orders* to initiate stock transfers between different plants. There are four major process variants for stock transport orders:

- **Stock transport orders without outbound delivery**
  This process creates stock transports without an outbound delivery between plants of the same company code or enabled for intercompany clearing.
- **Stock transport orders with outbound delivery via shipping**
  This process creates stock transports with outbound delivery and shipping documents between plants of the same company code or enabled for intercompany clearing.
- **Stock transport orders with outbound delivery and billing document/invoice**
  This process creates stock transports with outbound delivery, shipping documents, billing, and invoicing, allowing free calculation of the transfer price.
- **Stock transport orders using dedicated stock in transit**
  This process creates stock transports that allow you to separate the transfer of quantity and the transfer of title.

Which of the process variants is used depends on the organizational assignment of the plants, on the required shipping documents, on the cost assignments, and on the timing of transfer of quantity versus transfer of title.

12.6.6 Value Chain Monitoring Framework

Value chain monitoring allows you to track, visualize, monitor, and orchestrate the following intercompany logistic processes:

- Advanced intercompany sales
- Advanced intercompany stock transfer
- Sell from stock with valuated stock in transit

It comes along with an own configuration to identify the respective processes and persistency to store each process instances progress. The results are visualized as a network diagram per process instance from which the next process step can be initiated.

12.7 Logistics Integration Scenarios

As described earlier in this chapter, logistics functions are integrated with various other functions, both inside SAP S/4HANA and outside. As two important examples,

this section addresses integration with warehouse management and with manufacturing execution systems.

12.7.1 Warehouse Management

The core logistics processes, such as goods receipt, goods issue, physical inventory, quality management, batch management, and stock transfer described in Section 12.1, can be integrated with EWM (see Chapter 13). In addition, it's possible to set up a communication scenario in which an EWM system of a third-party logistics provider is used.

12.7.2 Manufacturing Execution Systems

A *manufacturing execution system* (MES) represents the interface between the production planning system (SAP S/4HANA) and the process control system in manufacturing according to *supervisory control and data acquisition* (SCADA). In real time, an MES translates the outcome of production planning into instructions for shop floor elements of the production process, such as machines, input, workers, and transport devices, and then captures the outcome of each element, sending it back to the production planning system in SAP S/4HANA.

From a business perspective, the production or process order is copied and distributed to the correct destination (MES instance) using filter criteria provided by the business object. After completion of a single production order's operations or of the entire production order, the data is relayed back to SAP S/4HANA as a production confirmation (Section 12.4). While being processed by the MES instance, internal confirmations of the production order in SAP S/4HANA are blocked. In repetitive manufacturing, the planned order is copied to the MES system.

From a technical perspective, asynchronous interfaces can be used to integrate SAP S/4HANA with an MES system using Simple Object Access Protocol (SOAP; recommended) or intermediate documents (IDocs; discouraged as legacy technology). Alternatively, a synchronous interface via Open Data Protocol (OData; recommended) or remote function calls (RFCs; legacy technology) can be established.

12.8 Summary

In this chapter, we gave an overview of the architecture of logistics and manufacturing functions in SAP S/4HANA. We started by covering the main components and data flows. Then, we introduced the organizational units such as plant, storage location, and production supply; the master data, such as BOM, routing, work center, and production version; and the transactional business objects such as production order, material document, outbound delivery, and physical inventory. Next, we covered calculated business objects and engines for logistics. Here we discussed how inventory is calculated on the fly, and we explained how the different flavors of ATP work. We described MRP, with special focus on the optimized MRP Live. We discussed demand-driven MRP, kanban processing, JIT supply, pMRP, and capacity planning. Next, we gave an overview of cross-functions that are used in logistics and manufacturing, as well as in other areas of SAP S/4HANA. Here, we introduced the concepts of batch management, quality management, handling unit management, serial number management, and intercompany stock transport. Finally, we discussed integration with MES and with EWM, which is the topic of the next chapter.

Contents at a Glance

Dear Reader,

Say you're an architect designing a building. What questions would you consider when drawing up a blueprint?

First, there are spatial considerations. What environment are you working in? Are you building wide, or tall, to meet your requirements? Then you need to think about function. How will people flow into and out of the building? How do you map your interior spaces for optimal proximity? And don't forget about the visual components—What style will you choose for the exterior façade?

A similar line of thinking can be applied to software. When you're evaluating or implementing a new enterprise resource planning (ERP) suite like SAP S/4HANA, you need to understand it from the ground up. How is the system environment constructed? What are your options for hosting on-premise or in the cloud? How will data flow through your system, and how will your business processes integrate for optimal efficiency? Not to mention the user experience—What are your GUI options?

The answers to all these questions (and many more!) can be found in these pages, composed by a premier team of SAP executives, experts, product managers, and architects. This book is your complete SAP S/4HANA blueprint.

What did you think about *SAP S/4HANA Architecture*? Your comments and suggestions are the most useful tools to help us make our books the best they can be. Please feel free to contact me and share any praise or criticism you may have.

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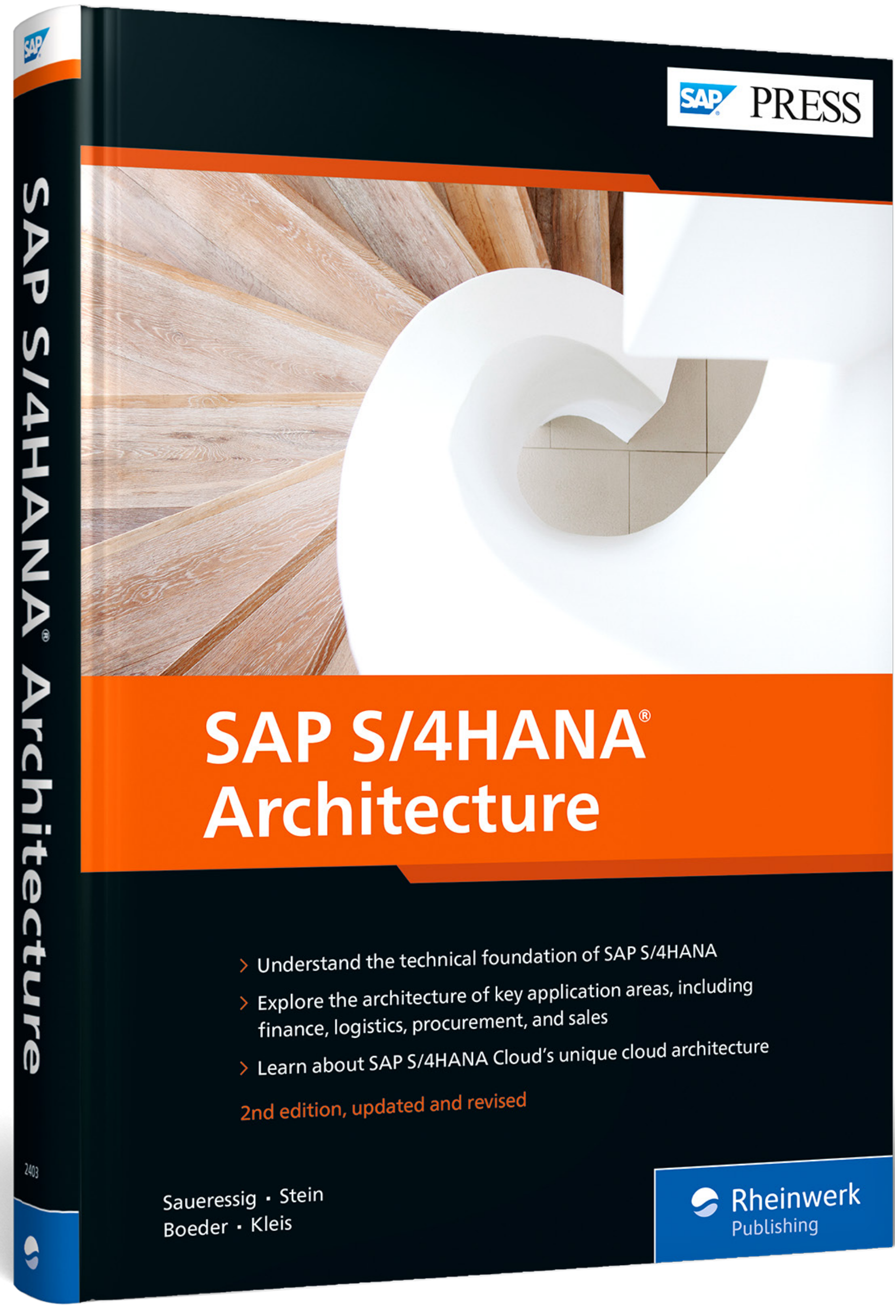

Saueressig, Stein, Boeder, Kleis

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This book is the work of more than 70 software architects and product experts from the engineering organization responsible for SAP S/4HANA development at SAP SE. Together with editors Thomas Saueressig, Tobias Stein, Jochen Boeder, and Wolfram Kleis, this team has extensive experience in engineering at SAP.

Thomas Saueressig has global responsibility for all business software applications, including all functional areas from product strategy and management to product development and innovation, as well as product delivery and support. In addition, he's in charge of all development cross-functions at SAP, comprising the overall quality of SAP software products, its user experience and the underlying global cloud infrastructure.

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