



Reading Sample

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"**
-  **Contents**
-  **Index**
-  **The Authors**

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SAP S/4HANA Architecture

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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.

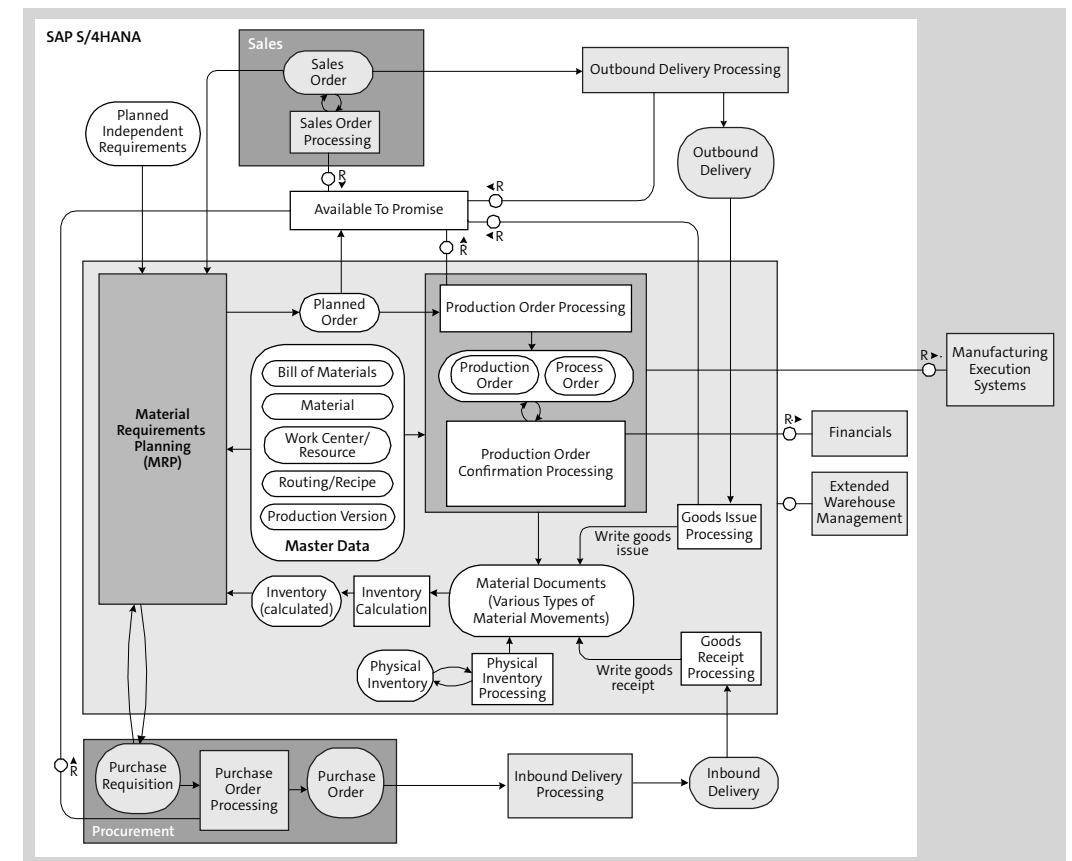


Figure 12.1 Logistics Architecture Overview

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.

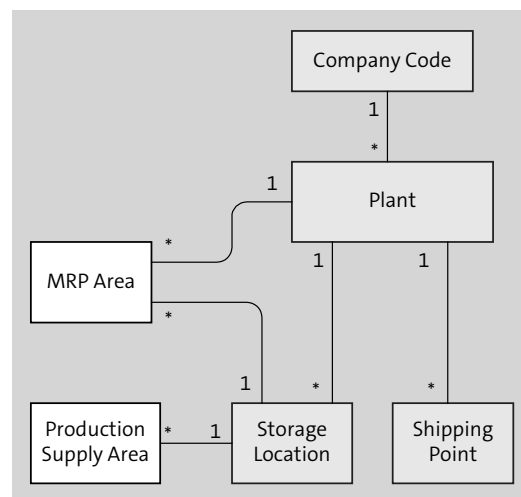


Figure 12.2 Organizational Units in Core Logistics

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.

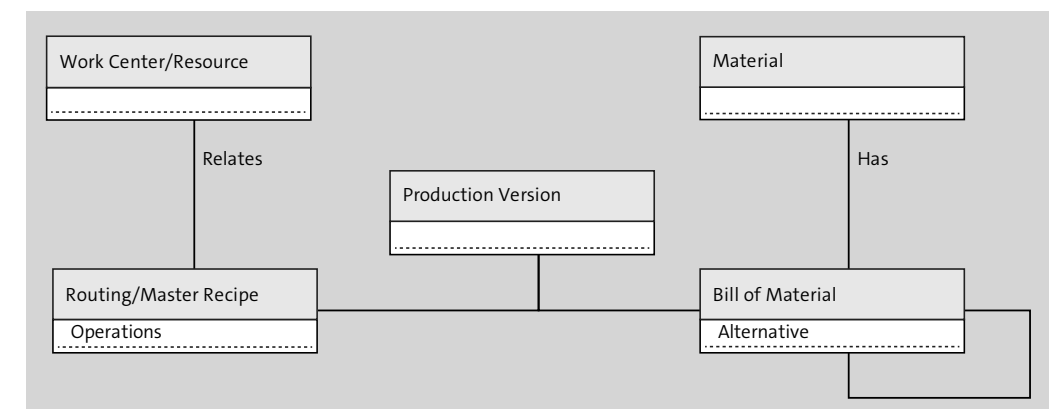


Figure 12.3 Master Data Business Objects with Relationships

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.

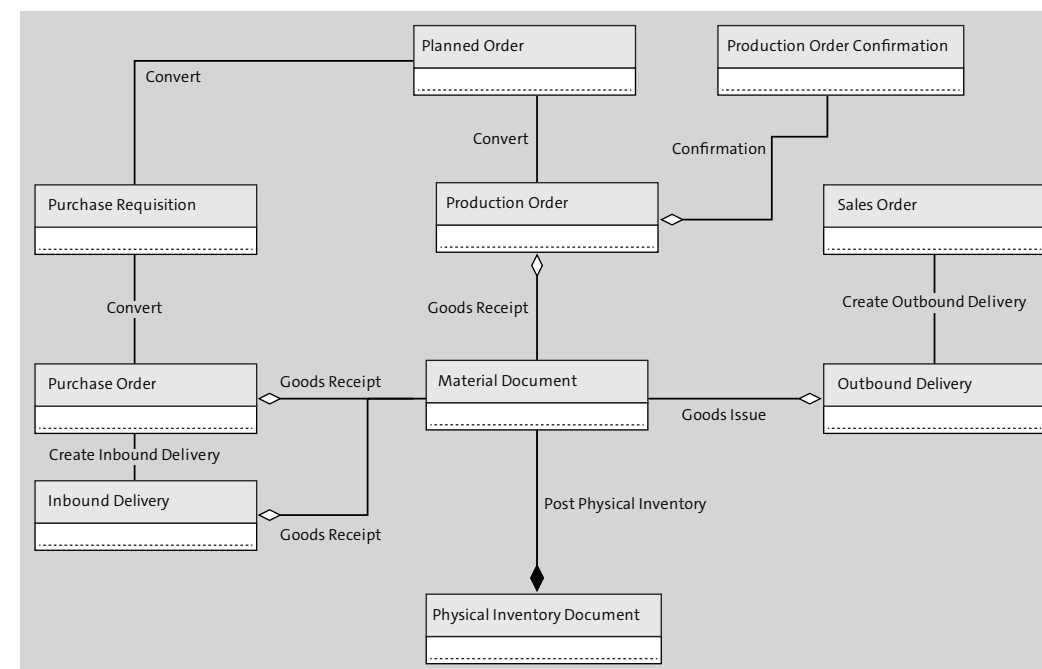


Figure 12.4 Transactional Business Objects and Process Steps

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).

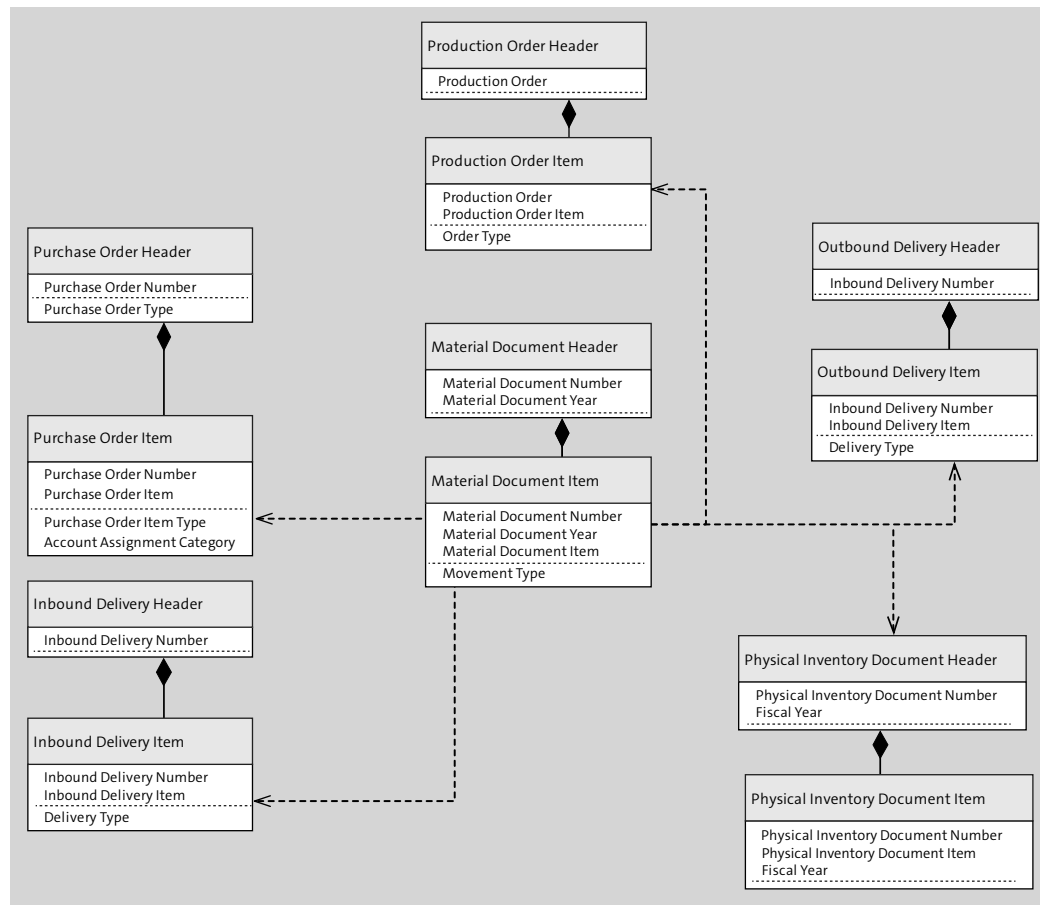


Figure 12.5 Transactional Business Objects with Business Keys and Semantic Attributes

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.

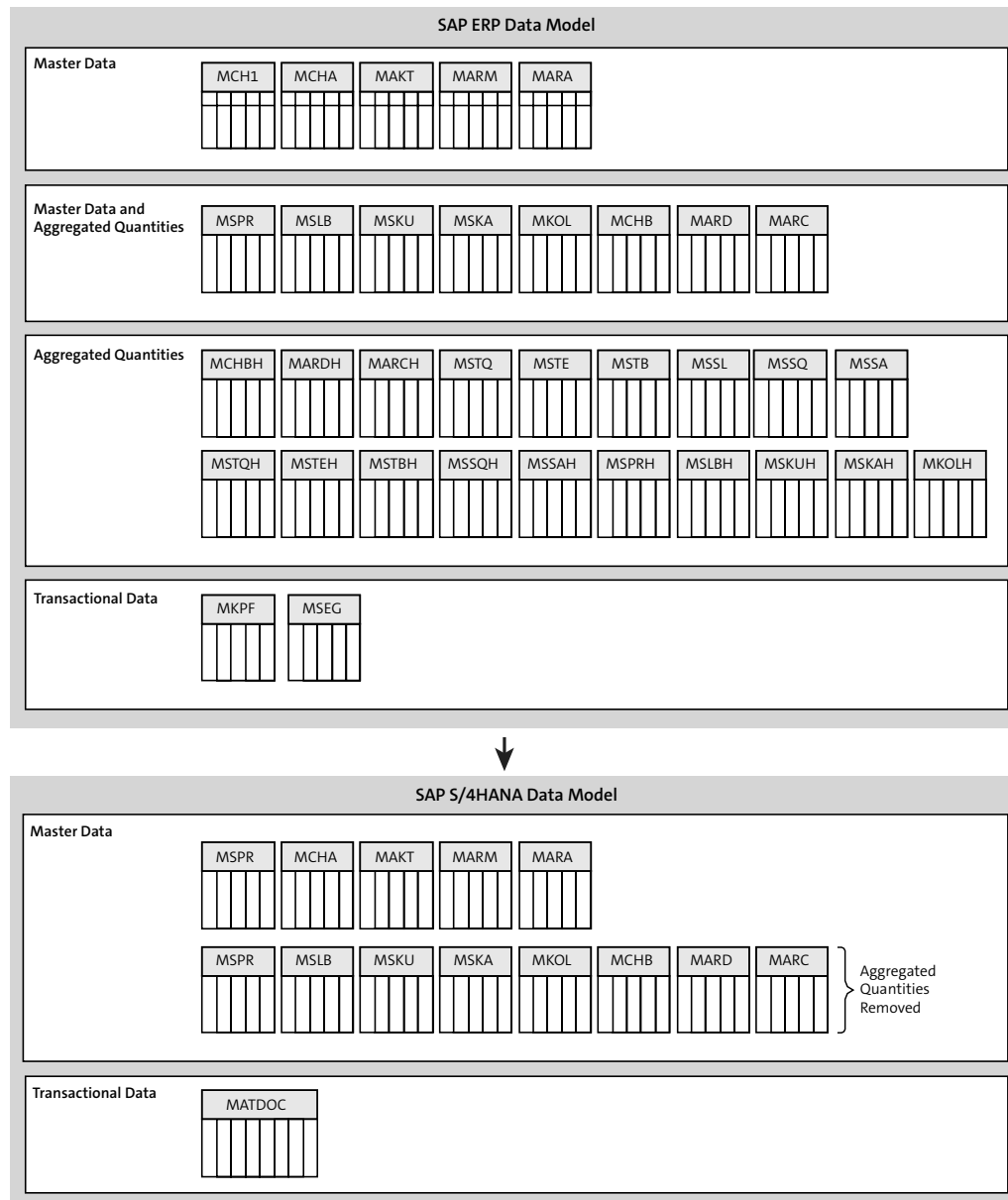


Figure 12.6 Inventory Data Model in SAP ERP and in SAP S/4HANA

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 (MDO1N: 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.

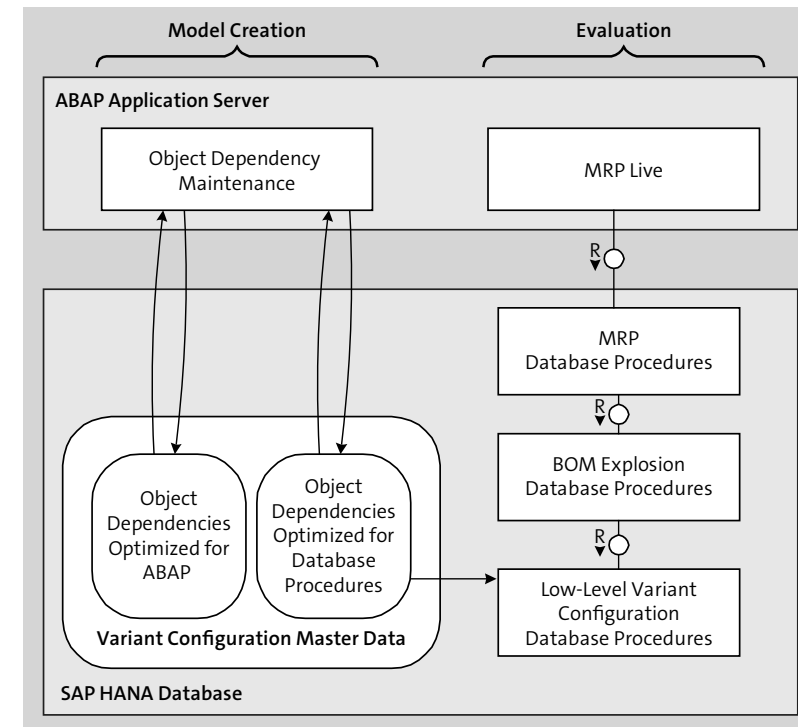


Figure 12.7 Optimized Low-Level Configuration in SAP HANA

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).

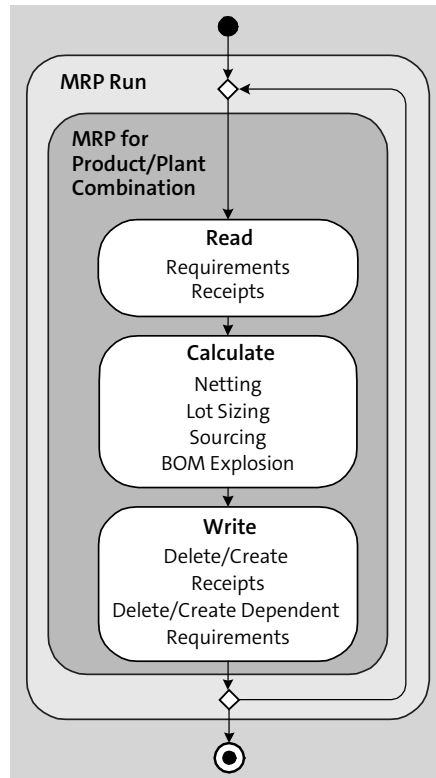


Figure 12.8 MRP Run

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.

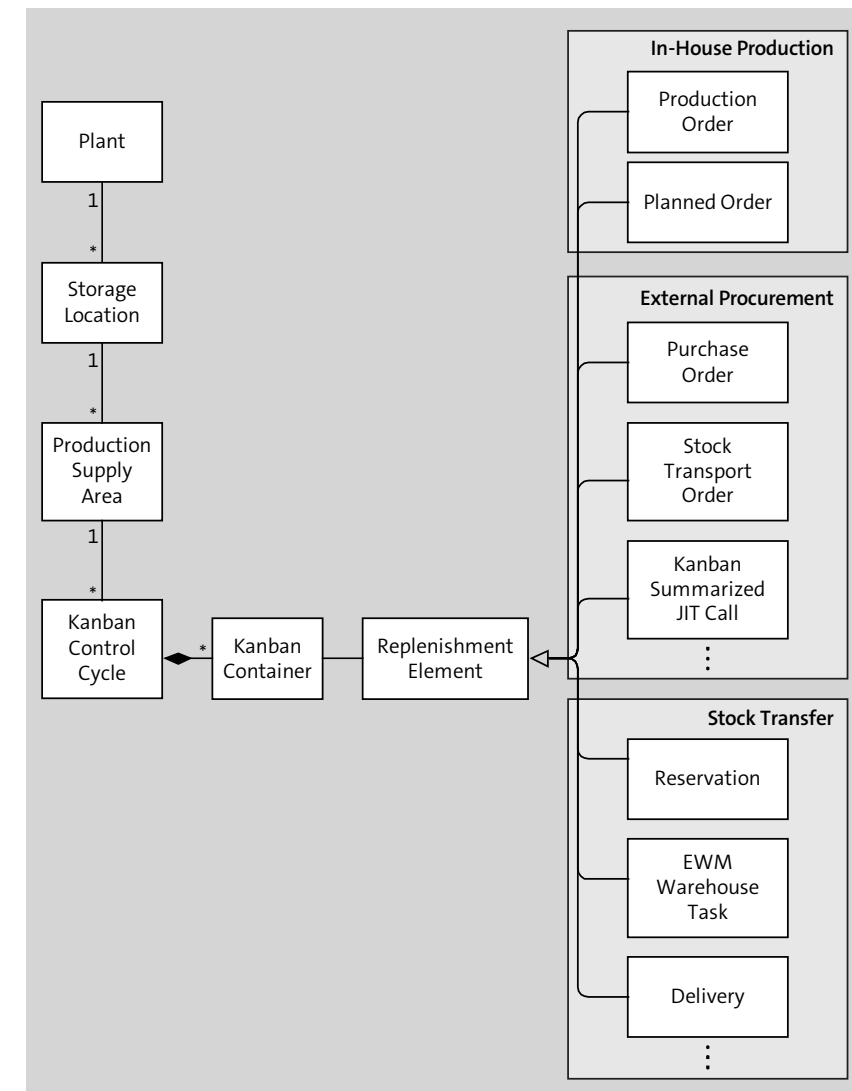


Figure 12.9 Kanban Architecture

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

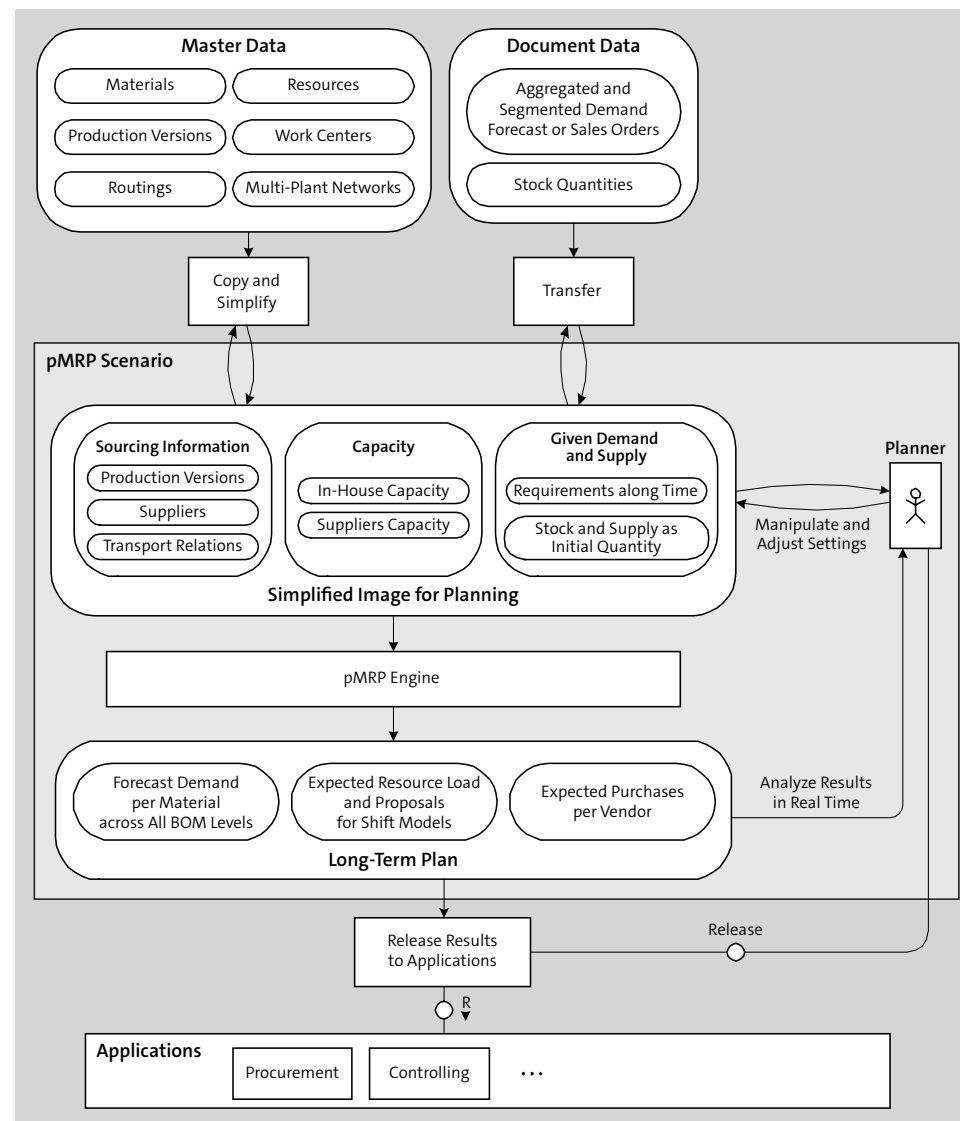


Figure 12.10 Architecture of pMRP: Simplified Image for Planning

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.

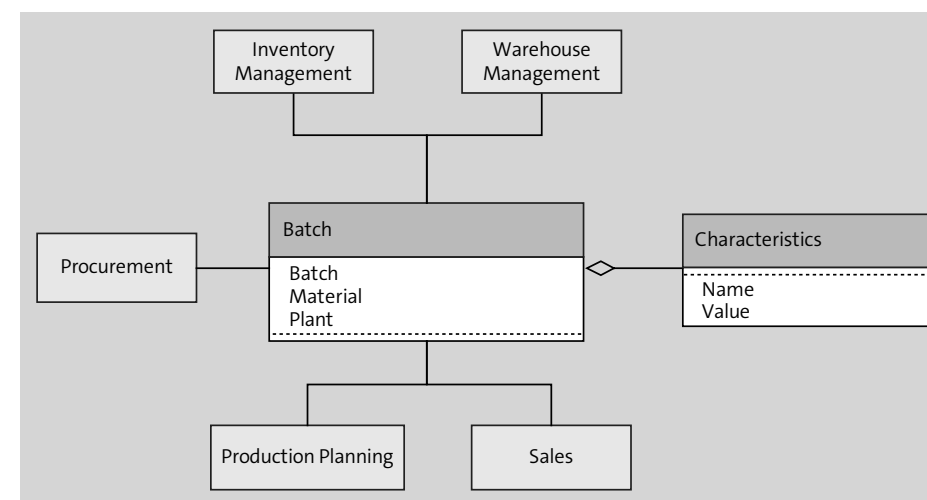


Figure 12.11 Batch Management

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).

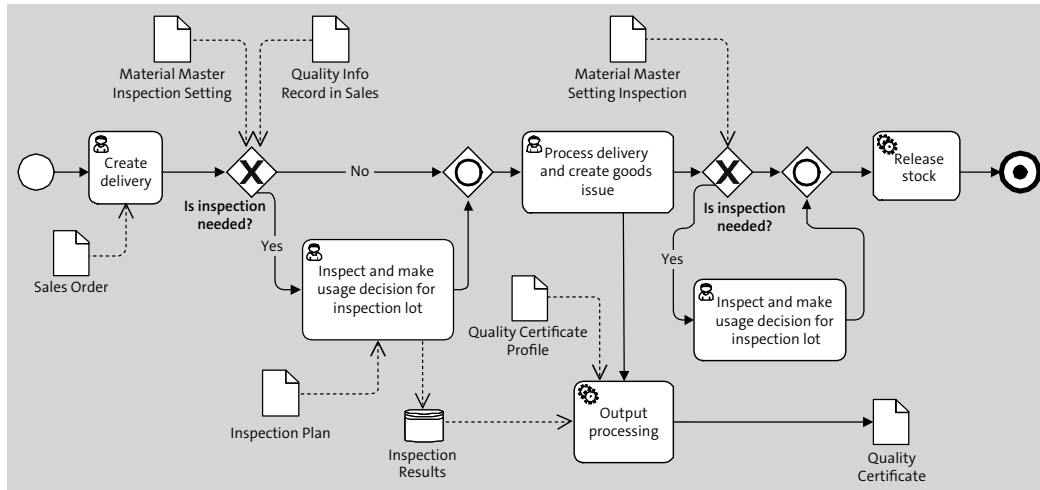


Figure 12.12 Quality Management in Sales

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.

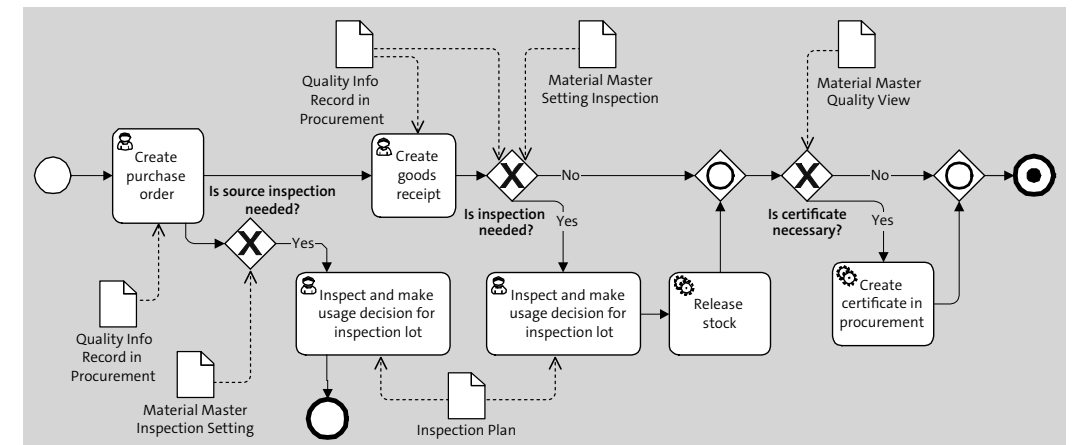


Figure 12.13 Quality Management in Procurement

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

PART I Foundation

1	Architecture Challenges of a Modern ERP Solution	27
2	Technical Architecture Foundation	43
3	Simplified Experience	67
4	Intelligence and Analytics	83
5	Extensibility	113
6	Integration	139
7	Data Protection and Privacy	165

PART II Application Architecture

8	Master Data	177
9	Sales	209
10	Service Operations	225
11	Sourcing and Procurement	239
12	Logistics and Manufacturing	261
13	Extended Warehouse Management	295
14	Finance, Governance, Risk, and Compliance	309
15	Localization in SAP S/4HANA	415

PART III SAP S/4HANA Cloud-Specific Architecture and Operations

16	Scoping and Configuration	427
17	Identity and Access Management	441
18	Output Management	459
19	Cloud Operations	469
20	Sizing and Performance in the Cloud	489
21	Cloud Security and Compliance	503
22	Outlook	511

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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Contents

Foreword	19
SAP S/4HANA: A New ERP Platform	21

Part I Foundation

1 Architecture Challenges of a Modern ERP Solution 27

1.1 Characteristics of a Modern ERP System	28
1.1.1 Even Higher Performance and Scalability	28
1.1.2 Consumer-Grade User Experience	30
1.1.3 Extensible Architecture	31
1.1.4 Intelligent ERP Processes	32
1.1.5 Simplified and Standardized Implementation	32
1.1.6 Cloud and On-Premise Deployment Models	33
1.1.7 Security, Privacy, Compliance, and Data Isolation	35
1.2 SAP S/4HANA Architecture Principles	35
1.2.1 Stable but Flexible Digital Core	36
1.2.2 Simplification with the Principle of One	36
1.2.3 Open for Innovations through Service Orientation	37
1.2.4 Modularization into (Hybrid) Integration Scenarios	38
1.2.5 Cloud First, but Not Cloud Only	39
1.2.6 Semantic Compatibility to Support Evolution with the Least Possible Disruption	40
1.3 Evolving a Cloud ERP System from the Best Possible Origins	40
1.4 Summary	41

2 Technical Architecture Foundation 43

2.1 Virtual Data Model	43
2.1.1 Core Data Services	44
2.1.2 Naming Conventions	44
2.1.3 Structure of the Virtual Data Model	45
2.1.4 Consumption Scenarios	47

2.2	ABAP RESTful Application Programming Model	49
2.2.1	Defining and Developing Business Objects	49
2.2.2	Defining Business Services	56
2.2.3	Runtime Architecture	59
2.3	Summary	66
3	Simplified Experience	67
<hr/>		
3.1	User Experience	67
3.1.1	SAP Fiori	67
3.1.2	User Experience Adoption Strategy	68
3.1.3	SAP Fiori Launchpad	69
3.1.4	SAP Fiori Apps	73
3.1.5	SAP Fiori Elements Apps	74
3.2	Search	77
3.2.1	Search Architecture	78
3.2.2	SAP HANA Search Functionality	79
3.2.3	Enterprise Search Extensibility	80
3.3	Summary	82
4	Intelligence and Analytics	83
<hr/>		
4.1	Analytics	83
4.1.1	Embedded Analytics Architecture	85
4.1.2	Embedded Analytical Applications	87
4.1.3	Modeling Analytical Artifacts	88
4.1.4	Analytics Extensibility	89
4.1.5	Enterprise Analytics Applications	91
4.2	Machine Learning	92
4.2.1	Machine Learning Architecture	93
4.2.2	Embedded Machine Learning	94
4.2.3	Side-by-Side Machine Learning Architecture	95
4.2.4	Machine Learning in SAP S/4HANA Applications	97
4.3	Intelligent Situation Handling	100
4.3.1	Example: Contract Is Ready as Source of Supply	100
4.3.2	Technical Background	102
4.3.3	Custom Use Cases	104

4.3.4	Message-Based Situation Handling	105
4.3.5	Intelligent Situation Automation	105
4.3.6	User Experience	108
4.3.7	Use Cases	111
4.4	Summary	112
5	Extensibility	113
<hr/>		
5.1	Key User Extensibility	113
5.1.1	Stability Criteria for Extensibility	114
5.1.2	Use Cases across the Software Stack	116
5.1.3	Lifecycle Management	122
5.2	In-Stack Developer Extensibility	123
5.3	Side-by-Side Extensions	126
5.3.1	Introduction to Cloud-Native Applications	126
5.3.2	SAP BTP and Programming Models	130
5.3.3	Integrating with SAP S/4HANA Using the SAP Cloud SDK	131
5.3.4	API Consumption with the SAP Cloud SDK	132
5.3.5	Business Event Consumption in Extensions	136
5.4	Summary	136
6	Integration	139
<hr/>		
6.1	SAP S/4HANA Integration Interface Technologies	139
6.1.1	Interface Technologies Overview	139
6.1.2	SAP S/4HANA API Strategy	141
6.2	SAP API Business Hub	141
6.3	Interface Monitoring and Error Handling	142
6.4	Communication Management in SAP S/4HANA Cloud	145
6.4.1	Communication Scenario	147
6.4.2	Communication User	147
6.4.3	Communication System	148
6.4.4	Communication Arrangement	148
6.4.5	Calling Inbound Services with User Propagation	148
6.5	Cloud Connector	149
6.5.1	Cloud Connector Principles	149

6.5.2	RFC Communication with SAP S/4HANA Cloud	151
6.6	Process Integration Technology	151
6.7	Event-Based Integration	154
6.7.1	SAP Event Mesh	154
6.7.2	Business Events Architecture	155
6.7.3	Business Events in SAP S/4HANA	156
6.7.4	Event Channels and Topic Filters	157
6.8	Data Integration	158
6.8.1	CDS-Based Data Extraction	158
6.8.2	Data Replication Framework	161
6.8.3	SAP Master Data Integration	162
6.9	Summary	163
7	Data Protection and Privacy	165
7.1	Compliance Baseline	166
7.2	Definitions and Principles	166
7.2.1	Basics in SAP S/4HANA	168
7.2.2	Data Subject Rights	169
7.2.3	Technical and Organizational Measures	171
7.3	Summary	173

Part II Application Architecture

8	Master Data	177
8.1	Product Master	177
8.1.1	Product Master Data Model	178
8.1.2	Product Hierarchy	182
8.1.3	Data Migration	184
8.1.4	Product SOAP Service API	185
8.1.5	Product Master Extensibility	186
8.1.6	Self-Service Configuration	187
8.2	Bill of Materials, Characteristics, and Configurations	187
8.2.1	Bill of Materials	188
8.2.2	Classification System	189

8.2.3	Variant Configuration	190
8.2.4	Variant Classes	192
8.2.5	Super BOM	192
8.2.6	BOM with Class Items	193
8.2.7	Variant Configuration Profiles	193
8.2.8	Object Dependencies in Variant Configuration	193
8.2.9	User Interface and Grouping	194
8.2.10	Extensibility	194
8.2.11	High-Level and Low-Level Configuration	194
8.2.12	Embedded Analytics for Classification and Configuration Data	195
8.3	Business Partners	197
8.3.1	Architecture of Business Partner Master Data	198
8.3.2	SAP S/4HANA System Conversion Scenarios	203
8.3.3	Data Protection and Policy	205
8.3.4	Extensibility	205
8.3.5	Business Partner APIs	206
8.4	Summary	207
9	Sales	209
9.1	Architecture Overview	209
9.2	Sales Documents Structure	211
9.3	Authorizations	212
9.4	Sales Inquiries and Sales Quotations	213
9.5	Sales Order Processing	214
9.6	Sales Contracts	215
9.7	Sales Scheduling Agreements	216
9.8	Claims, Returns, and Refund Management	217
9.9	Billing	217
9.10	Sales Monitoring and Analytics	219
9.11	Pricing	221
9.12	Integration	223
9.13	Summary	224

10 Service Operations	225
10.1 Architecture Overview	225
10.2 Business Objects and Processes in Service Operations	226
10.2.1 Field Service	227
10.2.2 In-House Repair	228
10.2.3 Service Contracts	228
10.2.4 Solution Business	229
10.2.5 Interaction Center	229
10.3 Master Data and Organizational Model	229
10.4 Data Model and Business Transactions Framework	231
10.4.1 Business Transactions Framework	231
10.4.2 Data Model	231
10.4.3 Transaction Type and Item Category	233
10.4.4 Common Functions for Service Transactions	233
10.4.5 Virtual Data Model	234
10.4.6 Public APIs	234
10.5 Integration	235
10.5.1 Data Exchange Manager	235
10.5.2 Backward Integration	236
10.5.3 Integration with SAP Field Service Management	237
10.5.4 User Interface Technology	237
10.6 Summary	238
11 Sourcing and Procurement	239
11.1 Architecture Overview	240
11.2 Procurement Processes	242
11.2.1 Direct Procurement	243
11.2.2 Indirect Procurement	244
11.3 Business Objects in Procurement	244
11.4 Central Procurement	246
11.5 Product Sourcing	249
11.6 Enterprise Contract Management	250
11.7 APIs and Integration	252
11.8 Analytics	257

11.9 Innovation and Intelligent Procurement	258
11.10 Summary	259
12 Logistics and Manufacturing	261
12.1 Architecture Overview	262
12.2 Organizational Units	264
12.3 Master Data Objects	265
12.4 Transactional Business Objects	266
12.5 Calculated Business Objects, Engines, and Process Controls	269
12.5.1 Inventory	269
12.5.2 Available-to-Promise	271
12.5.3 Material Requirements Planning	276
12.5.4 Demand-Driven Material Requirements Planning	278
12.5.5 Kanban	279
12.5.6 Just-in-Time Processing	280
12.5.7 Predictive Material and Resource Planning	283
12.5.8 Capacity Planning	285
12.5.9 Production Planning and Detailed Scheduling	286
12.6 Cross-Functions in Logistics and Manufacturing	286
12.6.1 Batch Management	287
12.6.2 Quality Management	287
12.6.3 Handling Unit Management	290
12.6.4 Serial Number Management	291
12.6.5 Inter-/Intracompany Stock Transport	292
12.6.6 Value Chain Monitoring Framework	292
12.7 Logistics Integration Scenarios	292
12.7.1 Warehouse Management	293
12.7.2 Manufacturing Execution Systems	293
12.8 Summary	293
13 Extended Warehouse Management	295
13.1 Architecture Overview	295
13.2 Organizational Structure	297

13.3 Master Data	298
13.4 Stock Management	299
13.5 Application Components	301
13.6 Monitoring and Reporting	303
13.7 Process Automation	304
13.8 User Interface	305
13.9 Technical Frameworks	305
13.10 Warehouse Automation	306
13.11 Summary	307
14 Finance, Governance, Risk, and Compliance	309
14.1 Finance Architecture Overview	311
14.2 Accounting	313
14.2.1 General Ledger	316
14.2.2 Fixed Asset Accounting	316
14.2.3 Inventory Accounting	318
14.2.4 Lease Accounting	320
14.2.5 Service and Sales Accounting	321
14.2.6 Group Reporting	325
14.2.7 Financial Closing	331
14.3 Tax and Legal Management	333
14.4 Financial Planning and Analysis	335
14.4.1 Budgetary Accounting	335
14.4.2 Predictive Accounting	337
14.4.3 Financial Planning	341
14.4.4 Margin Analysis	346
14.4.5 Overhead Cost	349
14.4.6 Production Cost	351
14.5 Payables Management	354
14.5.1 Supplier Invoicing	354
14.5.2 Open Payables Management	354
14.5.3 Automatic Payment Processing	354
14.6 Receivables Management	356
14.6.1 Open Receivables Management	357

14.6.2 Credit Evaluation and Management	361
14.6.3 Customer Invoicing	363
14.6.4 Dispute Resolution	365
14.6.5 Collections Management	366
14.6.6 Convergent Invoicing	367
14.6.7 Contract Accounting	372
14.7 Treasury Management	376
14.7.1 Advanced Payment Management	376
14.7.2 Bank Integration Using SAP Multi-Bank Connectivity	380
14.7.3 Connectivity to Payment Service Providers and Payment Gateways	381
14.7.4 Cash Management	382
14.7.5 Treasury and Risk Management	386
14.8 Central Finance	390
14.8.1 Replication	392
14.8.2 Mapping	395
14.8.3 Accounting Views of Logistics Information	396
14.8.4 Temporary Postings	398
14.8.5 Centralized Capabilities	401
14.8.6 Cross-System Process Control	401
14.9 Finance Extensibility	405
14.10 Governance, Risk, and Compliance	405
14.10.1 Overview of SAP GRC Solutions	406
14.10.2 SAP GRC Solutions and SAP S/4HANA Integration	408
14.11 Summary	413
15 Localization in SAP S/4HANA	415
15.1 Document and Reporting Compliance	415
15.1.1 Architecture	416
15.1.2 Outlook	420
15.2 Localization as a Self-Service for SAP S/4HANA Cloud	421
15.2.1 Components of Localization as a Self-Service	421
15.2.2 Extensibility Scenario Guides and the Community	422
15.3 Summary	423

Part III SAP S/4HANA Cloud-Specific Architecture and Operations

16 Scoping and Configuration	427
16.1 Reference Content	427
16.2 SAP Central Business Configuration	429
16.2.1 Organizational Setup	430
16.2.2 Business Processes	431
16.2.3 Business Adaptation Catalog	432
16.2.4 Constraints	435
16.2.5 From Scoping to Deployment	436
16.2.6 Reference Configuration Content Updates	438
16.2.7 Localization of Business Configuration	439
16.2.8 Scope-Dependent Technical Objects	440
16.3 Summary	440
17 Identity and Access Management	441
17.1 Architecture Overview	441
17.1.1 Identity Management	442
17.1.2 Authentication	443
17.1.3 ABAP Authorization Concept	444
17.1.4 Identity and Access Entities and Their Relationships	445
17.1.5 Developer Extensibility	448
17.1.6 Identity and Access Management Tools	449
17.1.7 SAP Fiori Pages and Spaces	451
17.2 Managing Users, Roles, and Catalogs	452
17.2.1 Communication Arrangements	453
17.2.2 PFCG Roles and Business Catalogs	453
17.2.3 Management of Users, Roles, and Catalogs by Customers	454
17.2.4 Lifecycle Changes of SAP-Delivered Roles and Catalogs	455
17.2.5 Auditors	456
17.3 Summary	458

18 Output Management	459
18.1 Architecture Overview	459
18.2 Printing	460
18.3 Email	462
18.4 Electronic Data Interchange	463
18.5 Form Templates	463
18.6 Output Control	464
18.7 Summary	467
19 Cloud Operations	469
19.1 SAP S/4HANA Cloud Landscape	469
19.2 Data Centers	472
19.3 Multitenancy	474
19.3.1 System Architecture of SAP S/4HANA	475
19.3.2 Sharing the SAP HANA Database System	476
19.3.3 Sharing of ABAP System Resources	477
19.3.4 Table Sharing Architecture in Detail	478
19.4 Software Maintenance	480
19.4.1 Maintenance Events	481
19.4.2 Blue-Green Deployment	481
19.5 Built-In Support	483
19.5.1 Support Journey without Built-In Support	483
19.5.2 Built-In Support Architecture	484
19.5.3 Comparison of Support Interactions	486
19.6 Summary	488
20 Sizing and Performance in the Cloud	489
20.1 Performance-Optimized Programming	489
20.1.1 Minimal Number of Network Round Trips and Transferred Data Volume	490
20.1.2 Content Delivery Networks	492

20.1.3	Buffers and Caches	492
20.1.4	Nonerratic Performance	493
20.2	Sizing	493
20.2.1	Sizing SAP S/4HANA Cloud, Public Edition	494
20.2.2	Sizing for SAP S/4HANA Cloud, Private Edition	496
20.3	Elasticity and Fair Resource Sharing for SAP S/4HANA Cloud, Public Edition	497
20.3.1	Elastic Scalability	497
20.3.2	Dynamic Capacity Management	498
20.4	Sustainability	500
20.5	Summary	501

21 Cloud Security and Compliance 503

21.1	Network and Data Security Architecture	503
21.1.1	Access Levels	504
21.1.2	Resource and Data Separation	505
21.1.3	Resource Sharing	506
21.1.4	Data Security and Data Residency	506
21.1.5	Business Continuity and Disaster Recovery	506
21.2	Security Processes	506
21.3	ABAP Application Server Security	508
21.4	Certification and Compliance	508
21.4.1	SAP Operations	509
21.4.2	SAP Software Development	509
21.5	Summary	510

22 Outlook 511

The Authors	513
Index	531

Index

A

- ABAP application server 478, 508
- ABAP authorization concept 171, 444
- ABAP CDS reader operator 159
- ABAP class 116
- ABAP development object 124
- ABAP Development Tools (ADT) 90, 120, 124, 471
- ABAP Dictionary 44, 186, 478, 482
- ABAP for Cloud Development 125
- ABAP RESTful application programming
 - model 49, 140, 155
 - BOPF-managed implementation* 53
 - determination* 53
 - draft feature* 55
 - implementation* 52
 - implementation type* 54
 - managed implementation* 52
 - runtime architecture* 59
 - transaction phases* 61
 - transactional buffer* 53
 - unmanaged implementation* 54
 - validation* 53
- ABAP-Managed Database Procedures (AMDPs) 94, 221
- Access governance 407, 411
- Access level 504
- Access schema 482
- Access sequence 222, 275
- Account assignment 316
- Account assignment category 268
- Accounting 235, 311, 313
 - business transaction interface* 313
 - interface* 339, 348, 395
- Accounting interface 336
- Accounting principle 317
- Accounting View of Logistics
 - Information (AVL) 396
- Accounts receivable 357
- Action controls 281
- Active-active 473
- Activity area 297
- Activity mapping 445, 449
- Activity quantity planning 343
- Actual costing 319
- Adaptation Transport Organizer (ATO) 123, 469
- Advanced Adapter Engine Extended 153
- Advanced compliance reporting 397
- Advanced financial closing 331
- Advanced payment management 376, 378
- Advanced planning and optimization (APO) 178
- Advanced returns management 217
- Advanced shipping notification (ASN) 291
- Advanced variant configurator (AVC) 190, 234
 - configuration architecture* 194
- AI Service Component Predictor 486
- AI Service Incident Solution Matching 486
- Allocated revenue 324
- Alternative-based confirmation 274
- Analytic engine 85, 89
 - runtime object* 86
- Analytical application 48, 87
- Analytical list page 87
- Analytical model 88
 - analytical query view* 89
 - cube view* 88
 - dimension view* 88
 - hierarchy view* 89
- Analytical query 86, 89
- Analytics 83
 - extensibility* 89
 - group reporting* 329
 - sales* 219
 - sourcing and procurement* 257
 - treasury* 388
- Anchor object 102
- API first principle 38
- Application Link Enabling (ALE) 306
- Application programming
 - interface (API) 31, 206
 - consumption* 133
 - custom* 122
 - public versus nonpublic* 142
 - sales* 223
 - service operations* 234
 - sourcing and procurement* 252
 - standard* 122
 - strategy* 141
- Assembly 189
- Asset accounting 317
- Attribution 348
- Audit 290

- Auditing 456
 - Authentication 171, 443
 - Authoring 251
 - Authorization 171, 212, 444
 - Automated Predictive Library (APL) 93
 - Automatic payment processing 354
 - Automation quota 107
 - Availability control 172
 - Availability group 300
 - Availability zone 504
 - Available stock 300
 - Available-to-promise (ATP) 210, 271
 - characteristics* 275
- B**
- Backflushing 290
 - Backorder processing 273, 274
 - Backup 506
 - Backward integration 236
 - Balance sheet valuation 319
 - Bandwidth 491
 - Bank integration 380
 - Bank relationship management 383
 - Bank statement processing 358
 - rules* 359
 - Base unit of measure 179
 - Basic view 46
 - Batch management 287
 - Behavior definition 51
 - model* 48
 - Best practices 427
 - Bill of materials (BOM) 178, 188, 265, 343
 - class items* 193
 - explosion* 189, 276
 - product* 188
 - super* 192
 - Billable item (BIT) 368
 - Billing 211, 217, 236, 368
 - Billing document 217, 236, 368
 - convergent invoicing* 370
 - request* 218, 236
 - Billing due list 218
 - Blue-green deployment 481
 - Budget availability control 335
 - Built-In Support 483, 484, 486
 - features* 486
 - Business adaptation catalog 429, 432
 - principles* 433
 - Business add-in (BAId) 116, 121, 186, 419
 - cloud* 121
 - Business Application Programming Interface (BAPI) 141
 - Business area 432
 - Business catalog 69, 213, 446, 447, 449
 - template* 453
 - Business Communication
 - Services (BCS) 460, 462
 - Business configuration (BC) set 428
 - Business constraint 435
 - Business context 115, 117
 - Business event 140, 154–156
 - architecture* 155
 - consumption* 136
 - framework* 106
 - Business mapping 395
 - Business object 49, 231, 244, 445
 - calculated* 269
 - custom* 119
 - data model* 49
 - design* 49
 - implementation* 49
 - transactional* 266
 - Business Object Processing
 - Framework (BOPF) 53
 - managed provider* 63
 - Business object repository (BOR) 141
 - Business package 432
 - Business partner 177, 197, 210, 298, 320, 361, 442
 - addresses* 200
 - advantages* 198
 - APIs* 206
 - architecture* 200
 - employee role* 201
 - extensibility* 205
 - group* 361
 - master data* 198
 - OData API* 133
 - service operations* 229
 - time dependency* 202
 - types* 197
 - Business Process Model and Notation (BPMN) 152
 - Business process scheduling 275
 - Business role 445, 447
 - template* 213, 447
 - Business Rules Framework (BRF) 465
 - Business scenario 118
 - Business server page (BSP) 69
 - Business service 56
 - implementation* 49
 - Business topic 432

- Business transactions framework 231
 - header* 231
 - item extension* 231
 - root component* 231
 - set* 231
 - Business user 442, 445
- C**
- Capacity management 498
 - Capacity planning 285
 - Capital expense planning 345
 - Cash concentration 385
 - Cash flow 385
 - Cash Flow Analyzer app 385
 - Cash management 374, 382, 384
 - Cash positioning 385
 - CDS-based extraction 158, 159, 258
 - Central asset accounting 401
 - Central budgeting 401
 - Central Finance 390, 392
 - centralized capabilities* 401
 - error handling* 394
 - mapping* 395
 - process control* 401
 - replication* 392
 - temporary postings* 398
 - Central payment 401
 - Central procurement 240, 246
 - analytics* 258
 - architecture* 246
 - integration* 248
 - Change control 172
 - Change data capture 160
 - Characteristic 347, 405
 - catalog* 275
 - combination* 275
 - group* 194
 - value combination* 275
 - Class item 193
 - Classification system 189
 - Cloud access manager 507
 - Cloud BAId 121
 - Cloud connector 149, 326
 - principles* 149
 - Cloud Data Integration (CDI) 92, 159
 - Cloud deployment 33, 39, 469, 489
 - Cloud Foundry 130
 - Cloud Integration 151, 223, 248, 253, 419
 - CloudEvents 155
 - Cloud-native application 126
 - Coding block 405
 - Collaboration 251
 - Collection strategy 366
 - Collections management 366
 - Collections worklist 366
 - Communication arrangement 148, 256, 453
 - Communication management 145
 - Communication scenario 147, 158
 - Communication system 148
 - Communication user 147, 443
 - Company code 446
 - Compatibility 40
 - Complex filter 185
 - Compliance 166, 503, 508
 - cloud* 503
 - Composite view 46
 - Composition 49
 - Condition technique 221, 291
 - Condition type 222
 - Configuration 427, 438
 - Configuration database 194
 - Configuration Localization tool 439
 - Confirmation 271
 - Consent 167
 - Consolidation 326
 - functions* 328
 - of investments* 328
 - plan* 330
 - reports* 329
 - Consumption item (CIT) 368
 - Consumption view 47
 - Consumption-based planning 282
 - Content delivery network (CDN) 70, 492
 - Continuous delivery 128, 129
 - Contract accounting 312, 371, 372, 374
 - Control cycle 280
 - Control object 337
 - Convergent billing 218
 - Convergent invoicing 367, 369, 374
 - integration* 370
 - Copy control 214
 - Core data services (CDS) 44
 - analytical views* 85
 - annotations* 51, 76
 - classification and configuration* 196
 - consumption scenario* 47
 - custom views* 120
 - DCL* 51
 - entities* 45
 - extensibility* 90
 - extension include association* 186
 - models* 49
 - pipeline operator* 96

Core data services (CDS) (Cont.)	
<i>projection view entities</i>	57
<i>service operations</i>	234
<i>views</i>	116
Cost analysis	352
Cost center assessment	348
Cost center planning	342
Cost object controlling	351
<i>event based</i>	352
Costing-based profitability analysis	346
Create, read, update, delete (CRUD)	48, 119
Credit decision support	362
Credit event	362
Credit Management	356
Credit management	356, 361
Credit risk analyzer	389
Credit rules engine	362
Credit scoring	374
Cross-application state	72
Cross-application time sheet (CATS)	323
Cross-system process control	
framework (CSPC)	402
Cube view	48, 88
Currency	350
Custom Analytical Queries app	90
Custom business logic	120
Custom business object	119
Custom CDS Views app	120
Custom Fields and Logic app	119, 186
Custom logic	405
Custom View Builder app	90
Customer returns	217
<i>integration</i>	223
Customer role	199
Customer-vendor integration (CVI)	200, 203
cXML	256
Cycle counting	181
D	
Dashboard	87
Data center	472
Data collection	326
Data control language (DCL)	44
Data exchange manager	235
Data integration	158
Data interface	114
Data lake	95, 106
Data migration	184
Data model	231, 313
Data Monitor app	327, 329
Data preparation	327, 346
Data protection	165
Data protection and privacy (DPP)	92, 166, 205
Data replication	92
Data Replication Framework (DRF)	161, 224
Data residency	506
Data security	506
Data separation	173, 505
Data source extensibility	405
Data subject	166
<i>rights</i>	169
Data type	116
Database table	232
Database view	478
Decentralized EWM	295
Default authorization value	445, 448
Delivery	288
<i>document</i>	215
<i>processing</i>	215
Delta extraction	161
Demand-driven MRP	278
Demand-driven planning	282
Deployment	33
Derivation	348
Determine action	53
Development system	469
Development tenant	471
DevOps	126, 128
Digital core	36
Digital payment	381
Dimension view	88
Direct procurement	242
Direct requirement element	262
Disaster recovery (DR)	473, 506
Disclosure control	171
Display Security Audit Log app	457, 509
Dispute case	365
Dispute management	365, 375
Distribution channel	180
Division	180
Dock appointment scheduling	303
Documented credit decision (DCD)	362
Draft enablement	179
Dunning	357
Dynamic Capacity Management tool	498
E	
Edge Integration Cell	153
eDocument	416–418
<i>cockpit</i>	418
<i>outlook</i>	420

Elasticity	497
Electronic Banking Internet	
Communication Standard (EBICS)	380
Electronic bill presentment and payment (EBPP)	363
Electronic Data Interchange (EDI)	141, 217, 256, 282, 290, 463
Electronic invoicing	416
Email	462
<i>templates</i>	463
Embedded analytical application	87
Embedded analytics	83, 195, 219, 257
<i>architecture</i>	85
Embedded EWM	295
Emergency patch	481
Employee role	201
Encryption	172, 506
Enterprise analytics	83, 91
Enterprise contract management	250
<i>architecture</i>	251
<i>supporting services</i>	251
Enterprise Event Enablement	155, 157
Enterprise resource planning (ERP)	21, 27
Enterprise risk and compliance	406
Enterprise search	47, 77
<i>auxiliary view</i>	79
<i>connectors</i>	79
<i>extensibility</i>	80
<i>framework</i>	78
<i>personalization</i>	81
<i>search scope</i>	80
Entitled to dispose	299
Entity data model (EDM)	140
Entity Manipulation Language (EML)	52, 59
Entity relationship model	46
Entity tag (ETag)	51
Error handling	142
eSignature	252
European Article Number (EAN)	187
Event	106, 140, 154, 321
<i>channel</i>	157
<i>consumption</i>	136
Event bus client	155
Event-based integration	154
Event-based revenue recognition	321
<i>principles</i>	323
Exception management	301
Expense planning	343
Expert Chat	486
Explore Related Situations app	107
Exposure management	386
Extended services for user account and authentication (XSUAA)	132
Extended warehouse management (EWM)	178, 293, 295
<i>architecture</i>	295
<i>components</i>	301
<i>master data</i>	298
<i>monitoring</i>	303
<i>process automation</i>	304
<i>reporting</i>	303
<i>technical frameworks</i>	305
<i>user interface</i>	305
<i>warehouse automation</i>	306
Extensibility	31, 113
<i>analytics</i>	89
<i>business partners</i>	205
<i>CDS-based</i>	90
<i>finance</i>	405
<i>in-app</i>	113
<i>in-stack developer</i>	123, 448
<i>integration</i>	122
<i>key user</i>	113
<i>localization</i>	422
<i>product master</i>	186
<i>side-by-side</i>	126
<i>stability criteria</i>	114
<i>variant configuration</i>	194
Extension field	118
Extension include	186
Extension ledger	316
F	
Failover SAP HANA instance	473
Failure mode and effect analysis (FMEA)	290
Feature control	52
<i>global</i>	52
<i>instance</i>	52
<i>static</i>	52
Field extensibility	117
Field mapping	118
Field service	227
Filter object	185
Finance	309
<i>architecture</i>	311
<i>extensibility</i>	405
<i>interface</i>	311, 315
Financial accounting	313
Financial closing	311, 331
<i>advanced</i>	331
Financial planning	341
Financial planning and analysis	330, 335

- Financial statement planning 344
 First in, first out (FIFO) 266
 Fixed asset 316
 Foreign currency valuation 331
 Form template 463
 Forms processing 463
 FX hedge management 387
 FX risk management 386
- G**
- Gain confirmation strategy 274
 General Data Protection Regulation
 (GDPR) 165, 407
 technical measures 171
 General ledger 313, 316
 Generic lock handling 403
 Goods issue 182, 323, 338, 352
 Goods receipt 182, 242, 266, 269, 288,
 290, 405
 Governance, risk, and compliance (GRC) ... 309,
 405
 Green IT strategy 489
 Group Financial Statements Review
 Booklet app 329
 Group reporting 325
 analysis 329
 functions 328
 Guided buying 244, 252
- H**
- Hacking 508
 Handling unit 300
 management 290, 301
 Hardware sizing 493
 Health check framework 507
 High availability (HA) 506
 High-level configuration 194
 Hotfix collection (HFC) 481
 Hybrid analytical application 87
 Hyperscale provider 473
- I**
- Identity and Access Management (IAM) 441
 architecture 441
 entities 445
 tools 449
 Identity Authentication service 171, 442,
 444, 456, 470
 Identity management 442
- Identity Provisioning service 470
 IDoc 141, 207
 Import Financial Plan Data app 336
 In-app extensibility 113
 lifecycle management 122
 use cases 116
 In-application search 77
 Inbound delivery 268
 Indirect procurement 243, 244
 Inference 93
 Information Access (InA) 86, 91
 Information retrieval framework (IRF) 169
 Infrastructure vulnerability scanning 507
 In-house bank 380
 In-house repair 227, 228
 Initial load 394, 492
 group 395
 Inspection lot 288
 Inspection rule 299
 In-stack developer extensibility 123, 448
 Integration 139
 banking 380
 central procurement 248
 convergent invoicing 370
 extensibility 122
 financial planning 346
 logistics 292
 middleware 151
 sales 223
 SAP GRC solutions 408
 service operations 235
 sourcing and procurement 252
 Integration flow (iFlow) 152
 Intelligent ERP 32
 Intelligent procurement 258
 Intelligent Situation Automation 105, 106
 Intelligent situation handling 100
 Intent-based navigation 71
 Interaction center 229
 Interaction phase 61
 Interface monitoring 142
 Intermediate Data Retention (IDR) 395
 International Bank Account Number
 (IBAN) 200
 International Financial Reporting
 Standards (IFRS) 314
 International Standard on Assurance
 Engagements (ISAE) 3000 447
 International trade management 407, 410
 Inventory 269
 accounting 318
 management 181, 318

- Inventory (Cont.)
 valuation methods 319
 Invoicing 363, 369
 convergent 367
 electronic 416
 Item category 215, 233
- J**
- Job control 172
 Jupyter Notebook 95
 Just-in-sequence (JIS) supply 281
 Just-in-time (JIT) processing 280
- K**
- Kanban 279
 containers 280
 control cycles 280
 Key performance indicator (KPI) 69, 88, 91
 performance 491
 sizing 493
 Key user 89, 114
 tools 117
 Key user extensibility 113
 lifecycle management 122
 margin analysis 347
 use cases 116
 Kubernetes 130
- L**
- Latency 473, 491
 Lease accounting 320
 Lease agreement 320
 Lease contract 320
 Ledger 314, 349
 layering 337
 parallel 349
 Legal contract 250
 Legal transaction 250
 Lifecycle compatibility 428
 Lifecycle management 122
 Liquidity item 385
 Liquidity management 383
 Liquidity Planning app 386
 Local area network (LAN) 490
 Localization 415
 business configuration 439
 self-service for SAP S/4HANA Cloud 421
 toolkit 421
 Locking 320
- Logical unit of work (LUW) 61
 Logistics 261
 architecture 262
 cross-functions 286
 organizational units 264
 Loose coupling 116, 119
 Low-level configuration 195, 276
- M**
- Machine learning 92, 107
 architecture 93
 categorization 97
 conversational UX 98
 embedded 94
 matching 97
 prediction 97
 ranking 97
 recommendation 97
 sales 220
 side-by-side 95
 sourcing and procurement 258
 Maintain Business Roles app 450, 452
 Maintenance event 481
 Malware 507
 Manage Document Compliance 418
 Manage KPIs and Reports app 91
 Manage Launchpad Pages tool 452
 Manage Product Hierarchies app 183, 187
 Manage Product Master Data app 178
 Manage Purchase Requisition
 Centrally app 247
 Manage Temporary Postings app 398
 Managed provider 63
 Management accounting 350
 Managing Pending Journal Entries app 394
 Manufacturing 261
 architecture 262
 cross-functions 286
 organizational units 264
 Manufacturing execution system (MES) ... 293
 Mapping 121
 action 396
 entity 396
 Margin analysis 346, 374
 Margin reporting 348
 Market risk analyzer 389
 Market segment 347, 405
 management 347
 Mass Data Framework (MDF) 394
 Mass data processing 105

Master data 177, 261, 265
scripts 428
 Master recipe 265
 Material 262
document 262, 267, 268
postings 300
reservation 267
 Material flow system (MFS) 301, 307
 Material Ledger 318, 319
 Material master 177, 277
 Material requirements planning (MRP) 215,
 244, 262, 276, 285
area 264
logic 277
run 277
type 276
 Memory 499
 Microservice 126
 Migration object 184
 Modularization 38
 Moving average price 182, 319
 MRP Live 276
cockpit 278
 Multidimensional reporting 87
 Multitenancy 474, 482
 My Situations app 213

O

Object and value determination 275
 Object dependency 193
 Object node type 117
 Object type 117, 156
 OData API 139, 142, 206, 223, 254
 OData model 73
 OData service 56, 73, 76, 136
consumption 66
define 58
extension 117
V2 versus V4 140
 One Exposure from Operations 383
 One order model 231
 Online analytical processing (OLAP) 29, 86
 Online transaction processing (OLTP) 29
 On-premise deployment 33, 475
 Open Connectors 152
 Open payables management 354
 Open receivables management 357
 Operating expense planning 342
 Operation 61
 Operational data provider (ODP) 159
 Operational procurement 240

Outbound delivery 210, 266, 269, 301
document 215
 Output control 464
 Output management 459
architecture 459
 Output management system (OMS) 461
 Overhead cost 349

P

Packaging specification 299
 Packing instruction 290, 299
 Parallel accounting 314
 Parallel ledger 349
 Partner connector 419
 Partner determination procedure 233
 Payables management 354
 Payment enqueue processing 355
 Payment handling 373
 Payment medium workbench (PMW) 421
 Payment proposal 355
 Payment run 354
 Payment service provider (PSP) 374
connectivity 381
 Payment-medium workbench (PMW) 356
 Pegging 284
 Peppol 416
 Performance 28, 94, 489
nonerratic 493
 Personal data 166
deletion 170
 PFCG role 69, 444, 452, 453
 Phantom assembly 189
 Physical access control 171
 Physical inventory document 269
 Physical inventory management 301
 Picking 215
 Pipeline operator 96
 Plan data 331
line items 331
 Planned independent requirement (PIR) 262
 Planned order 263, 266, 285, 293
 Planning 341
table 342
 Plant 264
 Portability 169
 Post Processing Framework (PPF) 304
 Posting level 327
 Preconfiguration 427
 Prediction ledger 339
 Predictive accounting 331, 337
journal entries 339

Predictive Analysis Library (PAL) 93
 Predictive Analytics Integrator (PAI) 220
 Predictive Delivery Delay app 220
 Predictive material and resource
 planning (pMRP) 283
 Price control indicator 182
 Pricing 221
 Pricing procedure 222
 Principle of one 36, 178
 Print queue 460
 Printing 460
user 443
 Privacy 165
 Process anchor 338
 Process order 263, 352
 Process Receivables app 367
 Procurement 239, 241
architecture 240
business objects 244
central 246
embedded analytics 257
intelligent 258
planning 250
processes 242
 Product allocation check 272
 Product availability check 271
 Product bundle 230
 Product cost planning 343
 Product hierarchy 182
migration 184
nodes 187
 Product master 177, 178, 210, 265, 288,
 291, 298
data model 178
data replication 185
extensibility 186
 Product sourcing 249
 Product type 187
 Production cost 351
 Production order 263, 266, 268, 293, 352
confirmation 266
 Production planning 263
 Production planning and detailed
 scheduling (PP/DS) 273, 286
 Production supply area 264, 279
 Production supply planning 282
 Production system 469
 Production version 266
 Profit and loss (P&L) 344
 Profit center 316
 Profitability analysis 346, 348, 352
 Progressive disclosure 109

Project 129
 Project planning 343
 Projection view entity 57
 Provider contract 373
 Provider implementation 63
 Pseudonymization 172
 Public extension model 115
 Purchase order 236, 240, 266, 405
item type 268
type 267
 Purchase requisition 240, 244, 247, 263,
 266, 276
 Purchasing contract 240
 Purchasing group 181
 Purchasing info record 240
 Purchasing value key 181
 Putaway 182
 Python 95

Q

Quality certificate profile 288
 Quality info record in procurement 288
 Quality info record in sales 287
 Quality inspection 288, 302
 Quality management 287
 Quant 300
 Quick Sizer 494
 Quota arrangement 241
 Quotation 209, 213, 250

R

Radio frequency (RF) framework 305
 Rapid content activation 69
 Rapid deployment 427
 Rating 368
 Read access logging (RAL) 171
 Receivables management 356
 Reclassification 328
 Reduction posting 340
 Reference configuration 438
 Reference content 427
 Release for delivery 273
 Release for Delivery app 274
 Release order 216
 Remote API view 47
 Remote function call (RFC) 140
communication 151
connection 392
queued 141
synchronous 141

Remote function call (RFC) (Cont.)
transactional 141
 Repair order 228
 Replenishment element 280
 Request for quotation (RFQ) 242
 Reservation 267
 Resource 265, 304
sharing 497, 506
warehouse 299
 Response time 490
 Responsibility management 100, 230, 246
 REST service 96
 Restricted reuse view 47
 Restriction field 446
 Restriction type 446, 453
 Returns 217
 Revenue recognition 323
 Right of use (RoU) asset 321
 Root-cause analysis 365
 Routing 265
 Run Statutory Reports app 419
 Runtime architecture 59

S

Sales 209
 Sales and profitability planning 344
 Sales area 180
 Sales contract 209, 215
master contract 215
quantity contract 215
value contract 215
 Sales document 211
category 212
type 212, 215
 Sales inquiry 209, 213
 Sales order 50, 209, 214, 222, 290, 323, 338, 348, 361
header 50
integration 223
item 222
processing 214
requests 210
 Sales Order Fulfillment Issues app 220
 Sales organization 180
 Sales overview 220
 Sales quotation 213
 Sales scheduling agreement 216
 SAML bearer assertion 149
 SAP Analysis for Microsoft Office 329
 SAP Analytics Cloud 74, 86, 91, 251, 329, 336, 341, 470
embedded edition 86
story designer 91
 SAP API Business Hub 38, 133, 136, 141, 142, 153, 234, 419
 SAP Application Interface Framework 142, 223, 256, 393, 394, 400
architecture 143
 SAP Ariba 252, 253
 SAP Ariba Buying 244, 252
 SAP Ariba Sourcing 252
 SAP Ariba Supplier Management 254
 SAP Billing and Revenue Innovation
 Management 370
 SAP BTP, ABAP environment 130, 250
 SAP BTP, Cloud Foundry
 environment 130, 133
 SAP BTP, Kubernetes environment 95
 SAP BTP, Kyma runtime 130
 SAP Business Application Studio 73
 SAP Business Client 71
 SAP Business Integrity Screening 409
 SAP Business Network 253, 256
 SAP Business Network for Procurement 223, 252, 253, 255, 256
 SAP Business Suite 29
 SAP Business Suite powered by SAP HANA ... 29
 SAP Business Technology Platform
 (SAP BTP) 72, 95, 122, 130, 131, 408, 472, 506
authentication 133
connectivity 132
 SAP Business Workflow 304, 365, 460
 SAP BW/4HANA 304
 SAP Cash Application 99, 357, 360, 372
 SAP Cash Management 382
 SAP Central Business Configuration .. 429, 471
business processes 431
implementation 436
localization 439
organizational setup 431
scoping to deployment 436
 SAP Cloud Application Programming
 Model 136
 SAP Cloud Identity Access
 Governance 408, 411
 SAP Cloud Identity Services 442, 443
 SAP Cloud Print Manager 460, 461
 SAP Cloud SDK 131, 326
API consumption 132, 133
authentication 133

SAP Cloud SDK (Cont.)
destination service 132
integration 131
resilience 134
 SAP Collections and Dispute
 Management 357
 SAP Commerce Cloud 224
 SAP Contract and Lease Management 320
 SAP Convergent Charging 368, 371
 SAP Convergent Mediation by
 DigitalRoute 371
 SAP CPQ 226
 SAP Customer Relationship
 Management (SAP CRM) 231
 SAP Data Custodian 172
 SAP Data Intelligence 94, 223
 SAP Data Privacy Governance 407
 SAP Destination service 132, 134
 SAP digital payments add-on 364, 374, 381
 SAP Disclosure Management 330
 SAP Document and Reporting
 Compliance 415, 416, 418, 421
cloud edition 420
 SAP Enterprise Threat Detection 172
 SAP Event Mesh 136, 140, 144, 154, 156, 158
 SAP Excise Tax Management 470
 SAP Field Service Management 226, 237
 SAP Fieldglass 252, 254
 SAP Financial Compliance
 Management 408, 409
 SAP Fiori 30, 67, 451, 492
apps and tiles 71, 73
apps reference library 74
library 73
personalize 118
role 71
transactional apps 74
UI 45
 SAP Fiori elements 73, 74
analytical list page 75
list report 75
object page 75
overview page 75
worklist 75
 SAP Fiori launchpad 69, 71, 451, 485
pages and spaces 451
 SAP for Retail 178
 SAP Forms service by Adobe 464, 470
 SAP Global Trade Services (SAP GTS) 375
 SAP GRC solutions 168, 309, 406
integration 408
 SAP GTS, edition for SAP HANA 410

SAP GUI 68, 119
 SAP HANA 29, 37, 94, 231, 313, 475, 478, 499
enterprise search 78
failover 473
search 79
sharing 476
sizing 204
 SAP HANA Cloud 475
 SAP Information Lifecycle
 Management (SAP ILM) 170, 205
 SAP Integration Package for SWIFT 389
 SAP Integration Suite 151
 SAP Integration Suite, managed gateway
 for spend management 223, 253, 256
 SAP Intelligent Robotic Process
 Automation 396
 SAP Landscape Transformation
 Replication Server 392
 SAP liveCache 286
 SAP Master Data Governance 249, 395
 SAP Master Data Integration 162, 201, 254
 SAP Mobile Cards 72
 SAP Multi-Bank Connectivity 358, 378, 380
 SAP ONE Support Launchpad 484–486
 SAP Privacy Governance 412
 SAP Process Control 409
 SAP Process Integration 153, 361
 SAP R/2 21
 SAP R/3 21
 SAP Readiness Check 204
 SAP Risk Management 409
 SAP S/4HANA 21, 74, 252, 475
API strategy 141
architecture 35
GDPR 168
integration 139
integration with GRC 408
logistics 261
machine learning 97
output control 459, 465
search 77
search models 81
service 225
system conversion 203
transport extensions 123
 SAP S/4HANA Cloud 39, 86, 132, 141, 142, 213, 223, 248, 255, 256, 317, 469
ABAP stack 508
access levels 504
audits 456
authentication 443
communication management 145

SAP S/4HANA Cloud (Cont.)

- configuraton architecture* 437
- constraints* 435
- data centers* 472
- data security* 506
- data separation* 505
- elasticity* 497
- extensibility* 115
- identity and access management* 441
- implementation* 436
- international trade* 410
- landscape* 469
- lifecycle management* 123
- localization* 421
- maintenance* 480
- multitenancy* 474, 476
- network* 503
- operations* 509
- output management* 459
- performance* 489
- product hierarchy* 183
- RFC communication* 151
- scoping and configuration* 427
- security and compliance* 503
- sizing* 489, 494
- SSCUI* 325
- user propagation* 149
- user provisioning* 443
- user type* 442

SAP S/4HANA Cloud for advanced financial closing 331

SAP S/4HANA Cloud for credit integration 356

SAP S/4HANA Cloud for customer payments 357, 363

SAP S/4HANA Cloud, ABAP environment 123

SAP S/4HANA Cloud, private edition 34

- sizing* 496

SAP S/4HANA Cloud, public edition 34, 469

SAP S/4HANA Finance 37, 309, 311, 313, 325, 333, 335, 337, 342, 354, 358, 376, 405

SAP S/4HANA for central finance 390

SAP S/4HANA for international trade 410

SAP S/4HANA Sales 209, 211, 220, 371

SAP S/4HANA Sourcing and Procurement 239, 245, 252, 257

SAP Smart Business 68, 88, 220

- apps* 73

SAP SuccessFactors Employee Central 201

SAP Supply Chain Management (SAP SCM) 178

SAP Treasury and Risk Management 386

SAP Trust Center 473

SAP Warehouse Robotics 307

SAPUI5 70, 73, 492

- freestyle application* 73
- runtime* 77

Save phase 61

- operation flow* 62

Save sequence 62

Scalability 28, 497

Schedule line 214, 217

Scheduling agreement 209, 216, 242, 266

scikit-learn 94

Scoping 427, 430, 436, 454

Search service 486

Security 35, 503

- ABAP application server* 508
- cloud* 503
- data* 506
- event management* 507
- group* 505
- patch management* 507
- processes* 506

Security Assertion Markup Language (SAML) 442–444

Segment 316

- filter* 186

Segmentation 374

Segregation of duty 447, 454, 455

Self-service configuration 187

Self-service configuration user interface (SSCUI) 325, 428

Semantic check 403

Semantic object 71

Separation of concerns 36

Serial number 291

Service adaptation definition language (SADL) 78, 85

Service and sales accounting 321

Service binding 59

Service confirmation 225, 227

Service contract 225, 227, 229, 323

Service definition 59

Service entry sheet 242

Service operations 225

- architecture* 225
- business object* 226
- business partner* 229
- master data* 229
- organization unit* 230
- process* 226
- service product* 230
- service teams* 230

Service operations (Cont.)

- technical object* 230

Service order 225, 227, 236

Service quotation 227

Service request 227

Service transaction 233

- advanced variant configuration* 234
- backward integration* 236
- integration* 235
- notes* 233
- partner functions* 233
- pricing* 233
- status management* 233

Service-specific data model 57

Shared database 477

Shipping and receiving 303

Shipping point 215, 264

Side-by-side extensibility 126

- custom backend application* 126
- custom UI* 126

Simple filter 185

Simple item 189

Simple Mail Transfer Protocol (SMTP) 463

Simplification 36

Simulation 339

- cockpit* 345

Situation handling 100, 105, 107, 213

- message-based* 105
- use cases* 111
- UX* 108

Situation indication 108

Situation knowledge graph 107

Situation notification 108

Situation object 104

Situation page 110

Situation scenario 104

Situation template 101, 102, 104, 105, 213

Situation type 103

Sizing 489, 493

- guidelines* 494
- report* 496

SOAP API 142, 206, 223, 254

SOAP services 140

Software development 509

Solution business 227, 229

Solution constraint 435

Solution order 225, 229

Source list 241

Source of supply 240, 282

Sourcing and procurement 239

- architecture* 240

Sourcing bundle 249

Sourcing project 250

Spool system 460

SQL interface 479

SQLScript 94

Staging area 298

Standalone selling price (SSP) 324

Standard costing 342

Standard price 182, 319

Standardization 32

Static resource 492

Statutory consolidation 328

Statutory reporting 416, 419

Stock identifying fields (SIDs) 270

Stock management 299, 301

Stock transfer 209

Stock transport order 292

Stock type 271, 300

Storage bin 297

Storage control 304

Storage location 264

Storage type 297

Story 341

Strategic procurement 242

Structured Query Language (SQL) 44

Subledger 313

Subscription billing 236

Subscription order management 371

Super BOM 192

Supervisory control and data acquisition (SCADA) 293

Supplier invoicing 354

Supplier quotation management 250

Supplier role 199

Supply assignment (ARun) 274

Supply protection 273

S-user ID 484, 494

Sustainability 500

System conversion 203

T

Target setting 345

Tax 333

Tax and legal management 333

Tax calculation 334

Technical architecture foundation 43

Technical catalog 69

Technical constraint 436

Telegram 301, 307

Tenant 470

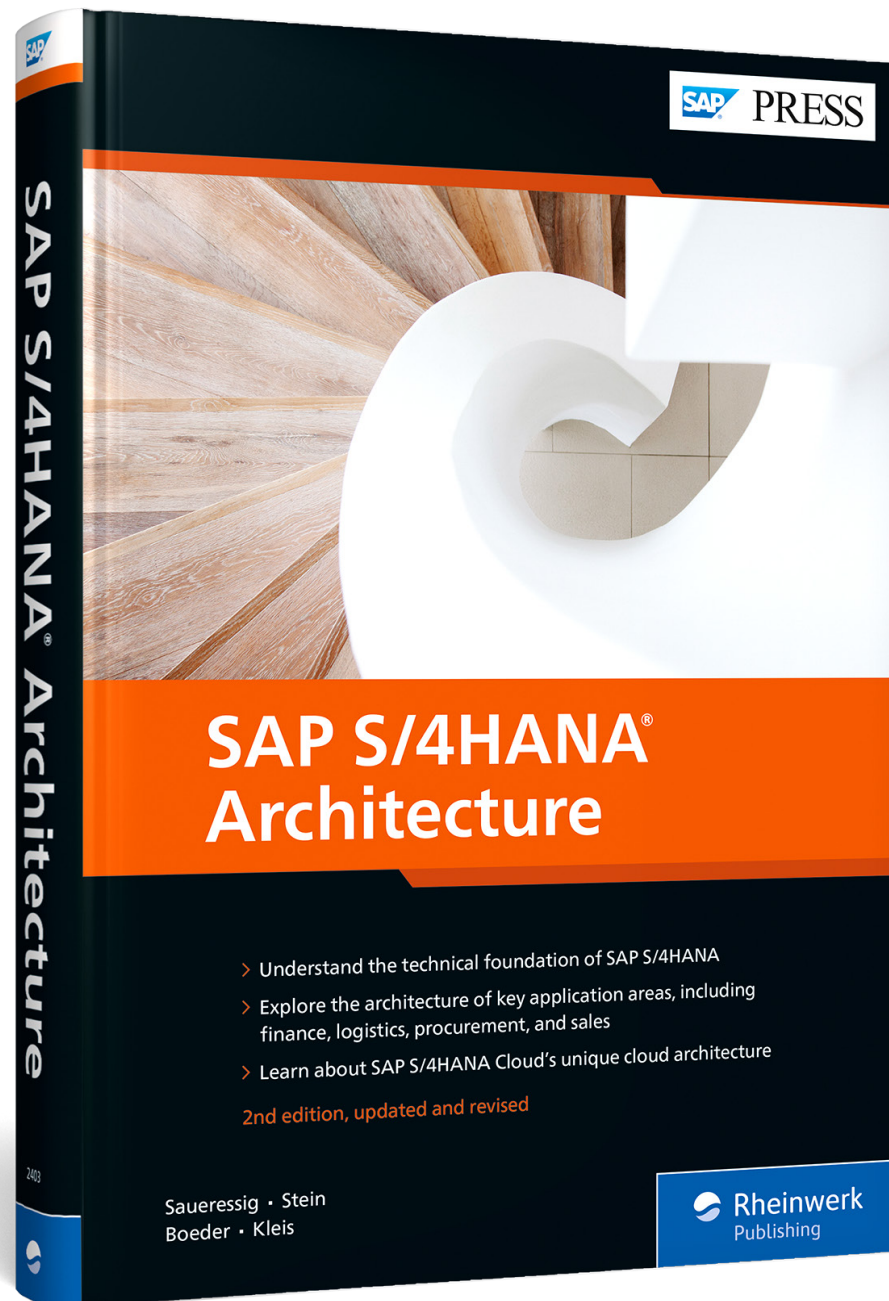
- database* 474, 482

TensorFlow 94

Test system 469

Theme 72

- Time dependency 202
 Time sheet 236
 Token concept 402
 Top-down distribution 348
 Topic filter 157
 Total cost of implementation (TCI) 427
 Trade request 388
 Trading platform integration 388, 470
 Transaction
 /SAPAPO/MATI 178
 /SCWM/MATI 178
 BP_CVI_IMG_CHK 204
 CVI_COCKPIT 204
 CVI_PRECHK 204
 DRFIMG 185
 MDS_LOAD_COCKPIT 204
 MMO1 178
 MMO2 178
 MMO3 178
 MM41 178
 MM42 178
 MM43 178
 PFCG 444
 Transaction type 233
 Transactional processing-enabled
 application 48
 Transactional view 46, 49
 Transmission control 172
 Transportation unit 299
 Treasury and risk management 386
 Treasury Executive Dashboard app 386, 388
 Treasury management 312, 376
 Treasury Workstation 312
 Trigger object 102
- U**
- UI runtime adaptation 118
 Unit of measure (UoM) 180
 Universal Journal 309, 312, 313, 316, 318,
 337, 346, 349, 351, 405
 Universal key mapping service 249
 Universal parallel accounting 314, 349
 Universal unique identifier (UUID) 51
 Unmanaged provider 63
 Update 480
 Upgrade 480
 US Generally Accepted Accounting
 Principles (US GAAP) 314, 338
 User account and authentication (UAA) 133
 User experience (UX) 30, 67
 conversational 98
 situation handling 108
- User management 507
 User propagation 148
- V**
- Validation 120
 Valuation area 182
 Valuation class 187
 Valuation rule 321
 Value chain monitoring 292
 Value mapping 145
 Value-added service 303
 Value-added tax (VAT) 333
 Variant class 192
 Variant configuration 190, 192
 object dependency 193
 profiles 193
 View Browser app 90
 Virtual data model (VDM) 37, 43, 120, 159,
 195, 199, 219, 234
 analytical artifacts 88
 embedded analytics 85
 naming conventions 44
 search architecture 78
 structure 45
 Virtual element 58
 Virtual private cloud (VPC) 504
 Virtual private network (VPN) 39, 504
 Vulnerability announcement service
 (VAS) 507
- W**
- Warehouse automation 306
 Warehouse billing 303
 Warehouse control unit (WCU) 306
 Warehouse management 293
 Warehouse monitor 306
 Warehouse number 297
 Warehouse request processing 301
 Wave management 302
 Web Client UI 68, 226, 237
 Web Dynpro 68, 119, 245, 305
 Web Services Reliable Messaging (WSRM) ... 361
 Wide area network (WAN) 490
 Work breakdown structure (WBS) 336, 343
 Work center 265, 298
 Work in progress (WIP) 325, 352
- Y**
- Yard 298



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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.



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