Microsoft Dynamics NAV

Supply Planning in Microsoft Dynamics NAV 2009 SP1

Technical White Paper

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Microsoft Dynamics

Contents

Introduction

This document is intended for internal and external planning experts who are involved in the implementation or support of supply planning functionality in Microsoft Dynamics NAV installations and for those who need to make modifications within the area. It gives an overview of the concepts and principles that are used within the supply planning area of Microsoft Dynamics NAV 2009, including the enhancements released with version 2009 SP1.

The aim of this document is to explain how the planning system works and how to adjust the algorithms to meet planning requirements in different environments. It first introduces central solution concepts and then describes the logic of the central mechanism, supply balancing, before proceeding to explain how inventory planning is performed with the use of reordering policies – as presented in the following main sections:

- Central Concepts of the Planning System
- Balancing Supply and Demand
- Handling Reordering Policies

This is a technical document and is not intended to describe general aspects of planning methodologies or theories. A variety of related documentation is available on PartnerSource under the topics of Planning and Supply Planning. In addition, the Microsoft Dynamics NAV Manufacturing II course material offers a number of planning scenarios that describe the effect of different reordering policies.

Changes in Service Pack 1 for Version 2009

The following issue has been addressed:

When using reorder policies Maximum Qty and Fixed Reorder Qty, the planning system focuses on the projected inventory in the given time-bucket only. This means that the planning system may suggest superfluous supply when negative demand or positive supply changes occur outside of the given time bucket.

The issue is fixed as follows:

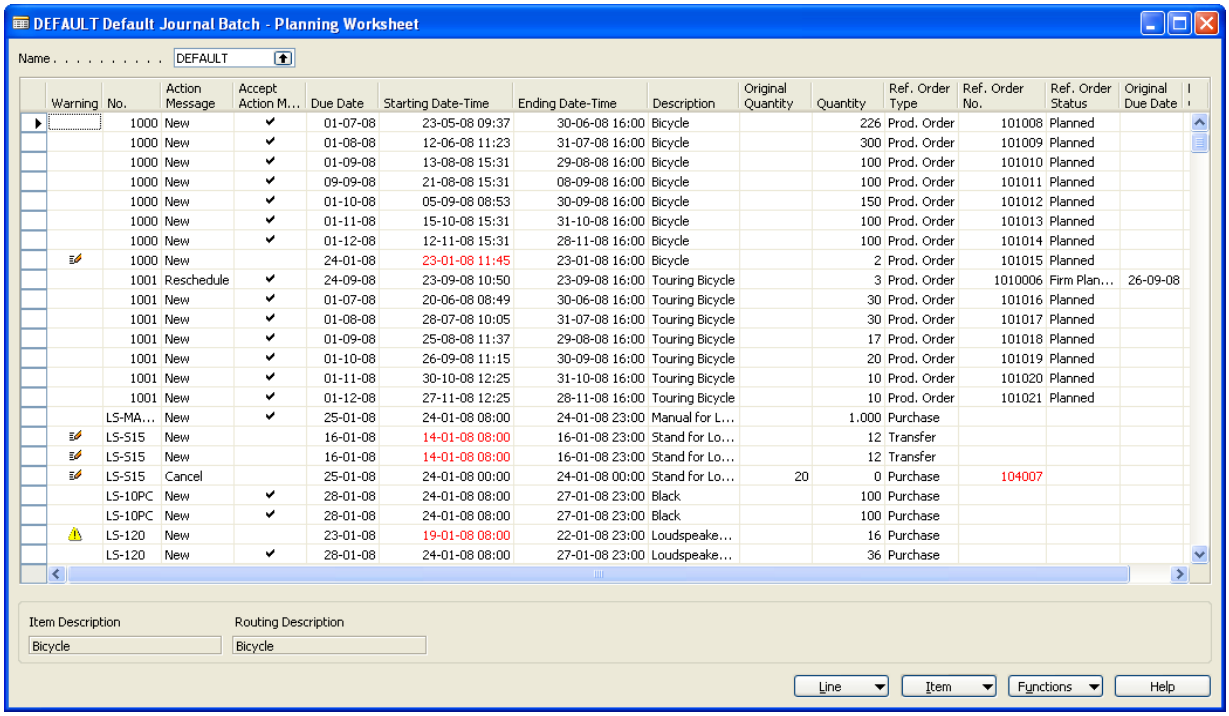
A warning is displayed when superfluous supply causes the projected inventory to exceed the highest projected inventory in an ideal supply plan, defined as the “overflow level”. The warning message displays the overflow level that the planner must adjust to if he wants to avoid the superfluous supply.

For more information, see Staying under the Overflow Level.

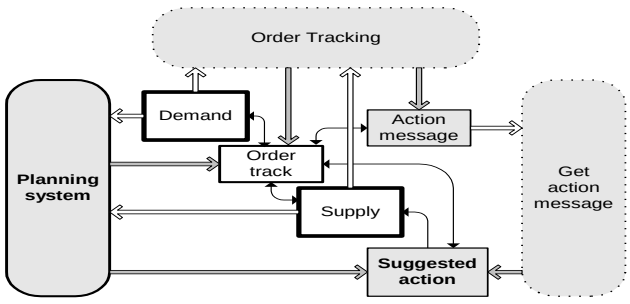
> **Note** The code that fixes this issue is released in version 2009 SP1 and it is also provided as a roll-up update for version 5.0 SP1.

Central Concepts of the Planning System

The planning functions are contained in a batch job that first selects the relevant items and period to plan for. Then, according to each item's low-level code (BOM position), the batch job calls a code unit, which calculates a supply plan by balancing supply-demand sets and suggesting possible actions for the user to take. The suggested actions appear as lines in the planning worksheet or the requisition worksheet.



The planner of a company, such as a purchaser or a production planner, is presumed to be the user of the planning system. The planning system assists the user by performing the extensive but rather straightforward calculations of a plan. The user can then concentrate on solving the more difficult problems, such as when things differ from normal.



The planning system is driven by anticipated and actual customer demand, such as forecast and sales orders. Running the planning calculation will result in the program suggesting specific actions for the user to take concerning possible supply from vendors, transfers between warehouses, or production. These suggested actions could be to create new supply orders, such as purchase orders.

If supply orders already exist, the suggested actions could be to increase or expedite the orders to meet the changes in demand.

Another goal of the planning system is to ensure that the inventory does not grow unnecessarily. If demand decreases, the planning system will suggest that the user postpone, decrease in quantity, or cancel existing supply orders.

MRP and MPS, Calculate Net Change Plan, and Calculate Regenerative Plan are all functions within one code unit that contains the planning logic. However, the supply plan calculation involves different sub systems.

Note that the planning system includes no dedicated logic for capacity leveling or fine scheduling. Therefore, such scheduling work is performed as a separate discipline. The lack of direct integration between the two areas also means that substantial capacity or schedule changes will require that the planning is rerun.

Planning Parameters

Planning parameters that the user sets for an item or a group of items control which actions the planning system will suggest in the various situations. The planning parameters are defined on each item card to control when, how much, and how to replenish.

Planning parameters can also be defined for any combination of item, variant, and location by setting up a stockkeeping unit (SKU) for each needed combination, and then specifying individual parameters.

For more information, see Handling Reordering Policies and Appendix A: Planning Parameters.

Planning Starting Date

To avoid a supply plan that incorporates open orders in the past and suggests potentially impossible actions, the planning system treats all dates before the planning starting date as a frozen zone where the following special rule applies:

All supply and demand before the starting date of the planning period will be considered a part of inventory or shipped.

In other words, it assumes that the plan for the past is executed according to the given plan.

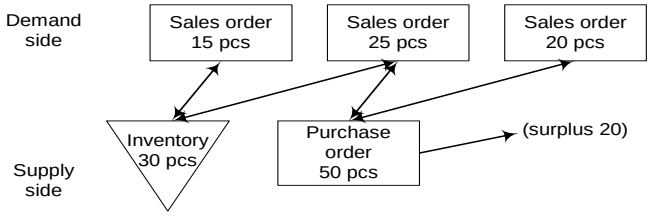
For more information, see Dealing with Dates before the Planning Starting Date.

Dynamic Order Tracking (Pegging)

Dynamic Order Tracking, with its simultaneous creation of action messages in the planning worksheet, is not a part of the supply planning system in Microsoft Dynamics NAV. This feature links, in real-time, the demand and the quantities that could cover them, whenever a new demand or supply is created or changed.

For example, if the user enters or changes a sales order, the dynamic order tracking system will instantly and search for an appropriate supply to cover the demand. This could be from inventory or from an expected supply order (such as a purchase order or a production order). When a supply source is found, the system creates a link between the demand and the supply and displays it in view-only windows that are accessed from the involved document lines. When appropriate supply cannot be found, the dynamic order tracking system creates action messages in the planning worksheet with supply plan suggestions reflecting the dynamic balancing. Accordingly, the dynamic order tracking system offers a very basic planning system that can be of help both to the planner and other roles in the internal supply chain.

Accordingly, Dynamic Order Tracking can be considered a tool that assists the user in assessing whether to accept supply order suggestions. From the supply side, a user can see which demand has created the supply, and from the demand side, which supply should cover the demand.



Order Tracking

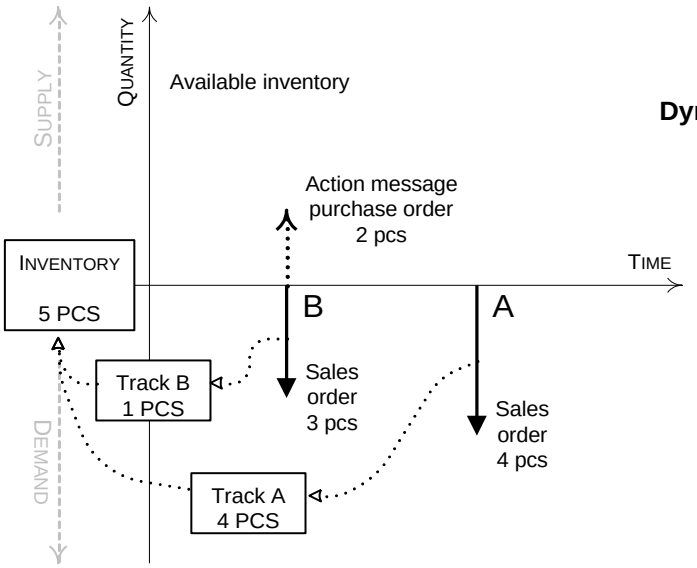
In companies with a low item flow and less advanced product structures, it may be adequate to use the Dynamic Order Tracking as the main means of supply planning. However, in busier environments, the planning system should be used to ensure a properly balanced supply plan at all times.

Dynamic Order Tracking versus the Planning System

At a quick glance, it may be difficult to differentiate between the planning system and Dynamic Order Tracking. Both features display output in the planning worksheet by suggesting actions that the planner should take. However, the way this output is produced differs.

The planning system deals with the entire supply-demand pattern of an item through all levels of the BOM hierarchy along the time line, whereas Dynamic Order Tracking only addresses the situation of the order that activated it. When balancing demand and supply, the planning system creates links in a user-activated batch mode, whereas Dynamic Order Tracking creates the links automatically and on the fly, whenever the user enters a demand or a supply in the program, such as a sales order or purchase order.

Dynamic Order Tracking establishes links between demand and supply when data is entered, on a first-come/first-served basis. This may lead to some disorder in priorities. For example, a sales order entered first, with a due date next month, may be linked to the supply in inventory, while the next sales order due tomorrow may cause an action message to create a new purchase order to cover it – as illustrated below.

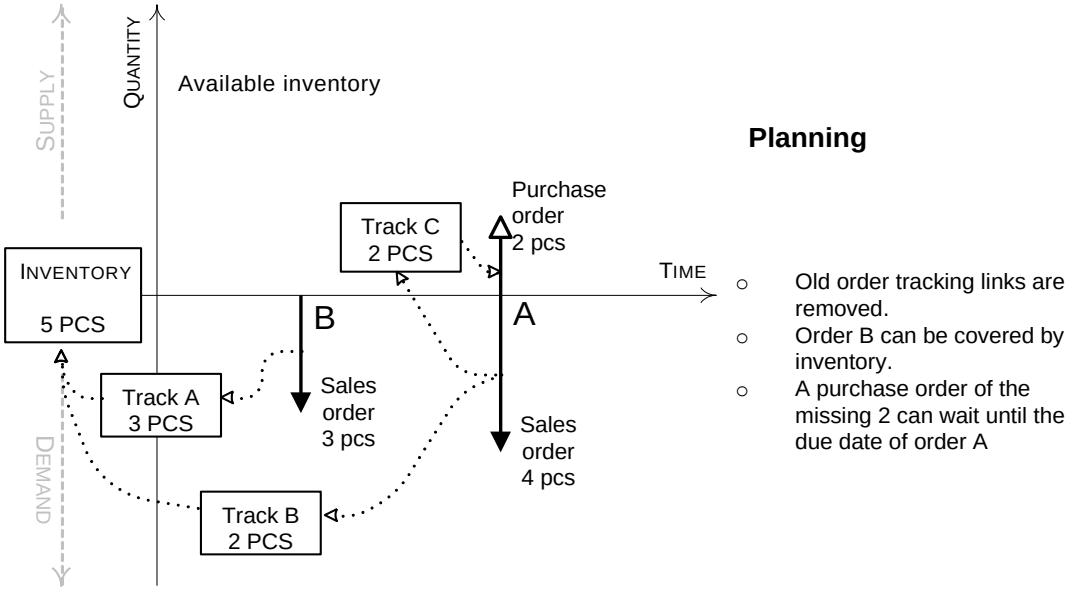


Dynamic Order Tracking

- Order A comes first and is covered by inventory.
- Order B can take 1 from inventory, then an action message will suggest a purchase order to cover the missing 2.

Notice that Dynamic Order tracking does not consider replenishment lead times.

In contrast, the planning system deals with all demand and supply for a particular item, in prioritized order according to due dates and order types, that is, on a first-needed/first-served basis. It deletes all order tracking links that were created dynamically and reestablishes them according to due date priority. When the planning system has run, it has solved all imbalances between demand and supply, as illustrated below for the same data.



After the planning run, no action messages remain in the Action Message Entry table, because they have been replaced by the suggested actions in the planning worksheet

For more information, see Order Tracking Links during Planning.

Sequence and Priority in Planning

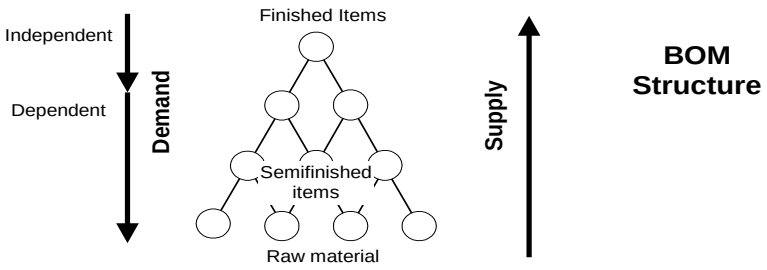
When establishing a plan, the sequence of the calculations is important to get the job done within a reasonable timeframe. In addition, the prioritization of requirements and resources play an important role in obtaining the best results.

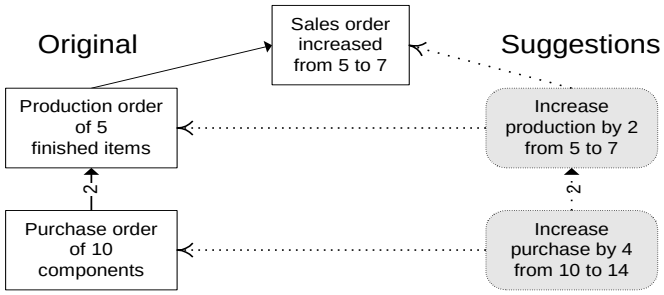
The planning system in Microsoft Dynamics NAV is demand-driven. High-level items should be planned before low-level items, because the plan for high-level items might generate additional demand for the lower-level items. This means, for example, that retail locations should be planned before distribution centers are planned, because the plan for a retail location may include additional demand from the distribution center. On a detailed balancing level, this also means that a sales order should not trigger a new supply order if an already released supply order is can cover the sales order. Likewise, a supply carrying a specific lot number should not be allocated to cover a generic demand if another demand requires this specific lot.

Item Priority / Low-Level Code

In a manufacturing environment, the demand for a finished, saleable item will result in derived demand for components that comprise the finished item. The bill-of-material structure controls the component structure and can cover several levels of semi-finished items. Planning an item at one level will cause derived demand for components at the next level, and so on. Eventually, this will result in derived demand for purchased items.

Consequently, the planning system plans for items in order of their ranking in the total BOM hierarchy, starting with finished saleable items at the top level and continuing down through the product structure to the lower level items (according to the low-level code).





The figures illustrates in which sequence the system makes suggestions for supply orders at the top level and, assuming that the user will accept these suggestions, for any lower-level items as well.

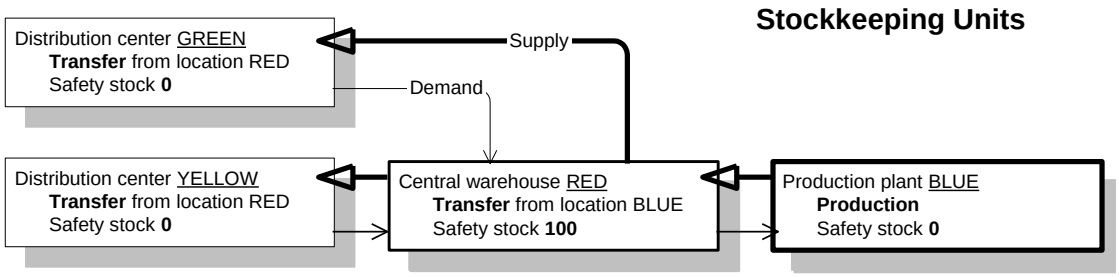
For more information about manufacturing considerations, see Component Need is Loaded according to Production Order Changes.

Locations / Transfer-Level Priority

Companies that operate at more than one location may need to plan for each location individually. For example, an item's safety stock level and its reordering policy may differ from one location to another. In this case, the planning parameters must be specified per item and also per location.

This is supported with the use of SKUs, where individual planning parameters can be specified at the SKU level. An SKU can be regarded as an item at a specific location. If the user has not defined a SKU for that location, the program will default to the parameters that have been set on the item card. The program calculates a plan for active locations only, which is where there is existing demand or supply for the given item.

In principle, any item can be handled at any location, but the program's approach to the location concept is quite strict. For example, a sales order at one location cannot be fulfilled by some quantity on stock at another location. The quantity on stock must first be transferred to the location specified on the sales order.



For more information, see Appendix E: Transfers in Planning.

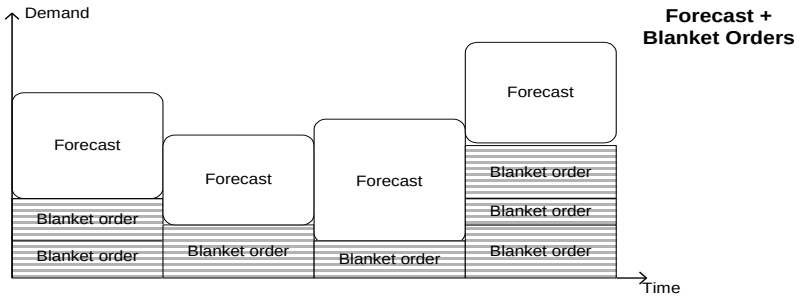
Order Priority

Within a given SKU, the requested or available date represents the highest priority; the demand of today should be dealt with before the demand of the coming days. But apart from this some kind of priority, the different demand and supply types are sorted according to business importance to decide which demand should be satisfied before satisfying another demand. On the supply side, the order priority will tell what source of supply should be applied before applying other sources of supply.

For more information, see Prioritizing Orders.

Production Forecasts and Blanket Orders

Forecasts and blanket orders both represent anticipated demand. The blanket order, which covers a customer's intended purchases over a specific period of time, acts to lessen the uncertainty of the overall forecast. The blanket order is a customer-specific forecast on top of the unspecified forecast as illustrated below.



For more information, see Forecast Demand is Reduced by Sales Orders.

Planning Assignment

All items should be planned for, however, there is no reason to calculate a plan for an item unless there has been a change in the demand or supply pattern since the last time a plan was calculated.

If the user has entered a new sales order or changed an existing one, there is reason to recalculate the plan. Other reasons include a change in forecast or the desired safety stock quantity. Changing a bill-of-material by adding or removing a component would most likely indicate a change, but for the component item only.

The planning system monitors such events and assigns the appropriate items for planning.

For multiple locations, the assignment takes place at the level of item per location combination. If, for example, a sales order has been created at only one location, the program will assign the item at that specific location for planning.

The reason for selecting items for planning is a matter of system performance. If no change in an item's demand-supply pattern has occurred, the planning system will not suggest any actions to be taken. Without the planning assignment, the system would have to perform the calculations for all items in order to find out what to plan for, and that would drain system resources.

The full list of reasons for assigning an item for planning is provided in Appendix C: Planning Assignment Table.

The planning options in Microsoft Dynamics NAV are:

- Calculate Regenerative Plan – Calculates all selected items, whether it is necessary or not.
- Calculate Net Change Plan – Calculates only those selected items that have had some change in their demand-supply pattern and, therefore, have been assigned for planning.

Some users believe that net change planning should be performed on the fly, for example, when sales orders are entered. However, this could be confusing because dynamic order tracking and action messaging are also calculated on the fly. Besides, Microsoft Dynamics NAV offers real-time available-to-promise control, which provides pop–up warnings when entering sales orders if the demand cannot be fulfilled under the present supply plan.

In addition to these considerations, the planning system only plans for those items that the user has prepared with appropriate planning parameters. Otherwise, it is assumed that the user will plan the items manually or semi-automatically by using the Order Planning feature.

For more information about the automatic planning procedures, see Balancing Demand and Supply.

Item Dimensions

Demand and supply can carry variant codes and location codes that must be respected when the planning system balances demand and supply.

The system treats variant and location codes as item dimensions on a sales order line, inventory ledger entry, and so on. Accordingly, it calculates a plan for each combination of variant and location as if the combination were a separate item number.

Instead of calculating any theoretical combination of variant and location, the program calculates only those combinations that actually exist in the database.

For more information on how the planning system deals with location codes on demand, see Appendix D: Demand at Blank Location.

Item Attributes

Apart from general item dimensions, such as item number, variant code, location code, and type of order, each demand and supply event can carry additional specifications in the form of serial/lot numbers. The planning system plans these attributes in certain ways depending on their level of specification.

An order-to-order link between demand and supply is another type of attribute that affects the planning system.

Specific Attributes

Certain attributes on demand are specific and must be matched exactly by a corresponding supply. The following two specific attributes exist:

- Demanded serial/lot numbers that require specific application (specific tracking setup).
- Links to supply orders created manually or automatically for a specific demand (order-to-order links).

For these attributes, the planning system applies the following rules:

- Demand with specific attributes can only be fulfilled by supply with matching attributes.
- Supply with specific attributes can also satisfy demand that does not ask specifically for those attributes.

Accordingly, if a demand for specific attributes cannot be met by inventory or projected supplies, the planning system will suggest a new supply order to cover this specific demand with no regard of planning parameters.

Non-Specific Attributes

Serial/lot-numbered items without specific item tracking setup may carry serial/lot numbers that do not need to be applied to the exact same serial/lot number, but can be applied to any serial/lot number. This gives the planning system more freedom to match, for example, a serialized demand with a serialized supply, typically in inventory.

Demand-supply with serial/lot numbers, specific or non-specific, are considered high priority and are therefore exempt from the frozen zone, meaning that they will be part of planning even if they are due before the planning starting date.

For more information about how the planning system balances attributes, see Serial/Lot Numbers and Order-to-Order Links are Exempt from the Frozen Zone.

Order-to-Order Links

Order-to-order procurement means that an item is purchased or produced to exclusively cover a specific demand. Typically it relates to A-items and the motivation for choosing this policy can be that the demand is infrequent, the lead-time is insignificant, or the required attributes vary.

Order-to-order links are applied between demand and supply in four ways:

- When the planned item uses the reordering policy Order.
- When using the manufacturing policy Make-to-Order to create multi-level or project-type production orders (producing needed components on the same production order).
- When creating production orders for sales orders with the Sales Order Planning feature.

In these instances, the planning system will only suggest to order the required quantity. Once created, the purchase, production, or transfer order will continue to match the corresponding demand. For example, if a sales order is changed in time or quantity, the planning system will suggest that the corresponding supply order is changed accordingly.

When order-to-order links exist, the planning system does not involve linked supply or inventory in the balancing procedure. It is up to the user to evaluate if the linked supply should be used to cover other or new demand and, in that case, delete the supply order or reserve the linked supply manually.

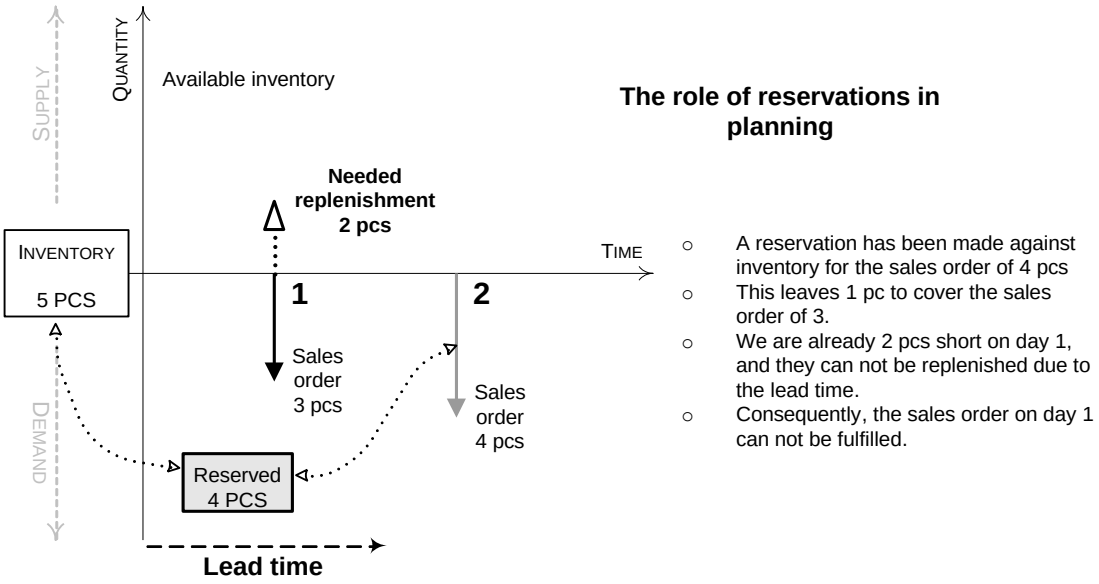
Reservations and order tracking links will break if a situation becomes impossible, such as moving the demand to a date earlier than the supply. However, the order-to-order link adapts to any changes in the respective demand or supply and thereby the link is never broken.

Reservations

The planning system does not include any reserved quantities in the calculation. For example, if a sales order has been totally or partially reserved against the quantity in inventory, the reserved quantity in inventory cannot be used to cover other demand. The planning system does not include this demand-supply set in its calculation.

However, the planning system will still include reserved quantities in the projected inventory profile because all quantities must be considered when determining both when the reorder point has been passed and how many to reorder to reach and not exceed the maximum inventory level. Consequently, unnecessary reservations will lead to increased risks that inventory levels run low because the planning logic does not detect reserved quantities.

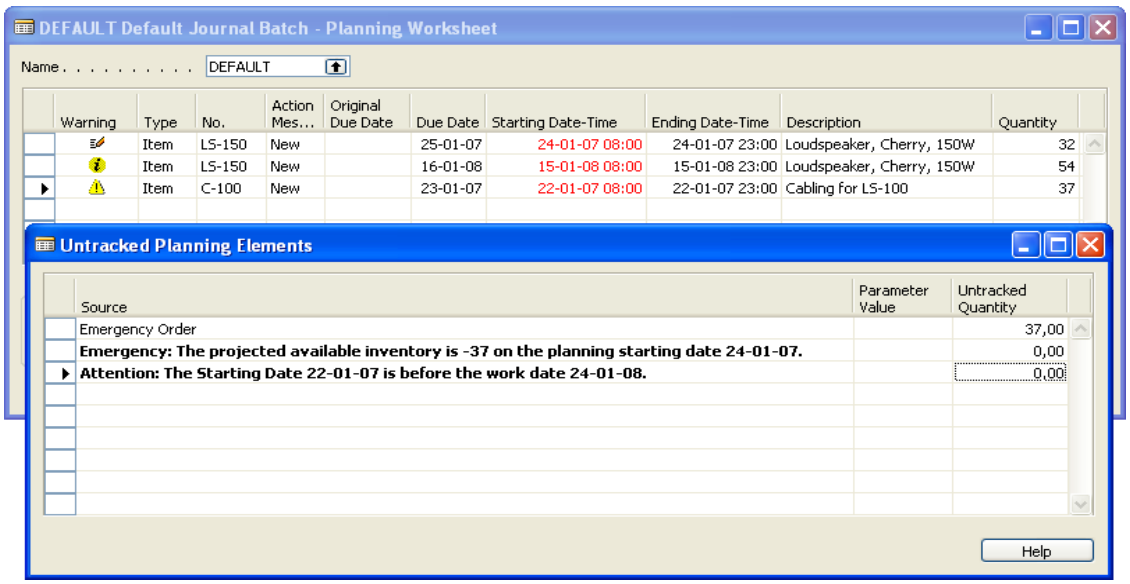
The following illustration shows how reservations can hinder the most feasible plan.



Warnings

The first column in the planning worksheet is for the Warning fields. Any planning line created for an unusual situation will display a warning icon in this field, which the user can click for additional information. The warning information is shown in the Untracked Planning Elements window, which is also used to show order tracking links to non-order network entities. The following warning types exist:

- Emergency
- Exception
- Attention



Emergency (warning icon = yellow triangle)

The emergency warning is displayed in two situations:

- When the inventory is negative on the planning starting date.
- When back-dated supply or demand events exist.

If an item's inventory is negative on the planning starting date, the planning system suggests an emergency supply for the negative quantity to arrive on the planning starting date. The warning text states the starting date and the quantity of the emergency order. For more information, see Handling Negative Inventory.

Any document lines with due dates before the planning starting date are consolidated into one emergency supply order for the item to arrive on the planning starting date.

Exception (warning icon = yellow circle)

The exception warning is displayed if the projected available inventory drops below the safety stock quantity. The planning system will suggest a supply order to meet the demand on its due date. The warning text states the item's safety stock quantity and the date on which it is violated.

Violating the safety stock level is considered an exception because it should not occur if the reorder point has been set correctly. For more information, see The Role of the Reorder Point.

> **Note** The planning system may have consumed the safety stock intentionally and will then replenish it straight away. For more information, see Safety Stock is Demand but May also be Consumed as Supply.

Attention (warning icon = pencil point)

The attention warning is displayed in three situations:

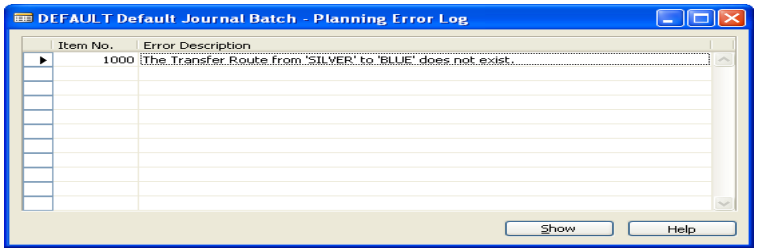
- The planning starting date is earlier than the work date. In that case, the value in the Starting Date-Time field is in red text.
- The planning line suggests changing a released purchase or production order. In that case, the value in Ref. Order No. field is in red text.
- The projected inventory exceeds the overflow level on the due date. For more information, see Staying within the Overflow Level.

> **Note** In planning lines with warnings, the Accept Action Message field is not selected, because the planner is expected to further investigate these lines before carrying out the plan.

Error Logs

In the Calculate Plan request form, the user can select the Stop and Show First Error field to have the planning run stop when it encounters the first error. At the same time, a message is displayed with information about the error. If an error exists, only the successful planning lines that were made before the error was encountered will be presented in the planning worksheet.

If the field is not selected, the Calculate Plan batch job will continue until it has completed. Errors will not interrupt the batch job. If one or more errors exist, the program will display a message after completion saying how many items are affected by errors. The Planning Error Log window then opens to provide more details about the error and to provide links to the affected documents or setup cards.



Planning Flexibility

It is not always practical to plan an existing supply order, such as when production has started or extra people are hired on a specific day to do the job. To indicate whether an existing order can be changed by the planning system, all supply order lines have a Planning Flexibility field with two options: Unlimited or None. If the field is set to None, the planning system will not try to change the supply order line.

The field can be manually set by the user, however, in some cases it will be set automatically by the system. The fact that planning flexibility can be manually set by the user is important, because it makes it easy to adapt the usage of the feature to different workflows and business cases.

For more information about how this field is used, see Appendix E: Transfers in Planning.

This completes the outline of central concepts relating to supply planning in Microsoft Dynamics NAV. The following sections investigate these concepts deeper and place them in the context of the core planning procedures, balancing demand and supply as well as the use of reordering policies.

Order Planning

The basic supply planning tool represented by the Order Planning window is designed for manual decision making. It does not consider any planning parameters and is therefore not discussed further in this document. For more information on the Order Planning feature, refer to Help in Microsoft Dynamics NAV.

> **Note** It is not advisable to use Order Planning if the company already uses the planning or requisition worksheets. Supply orders created through the Order Planning window may be changed or deleted during the automated planning runs. This is because the automated planning run uses planning parameters and these may not be considered by the user who made the manual plan in the Order Planning window.

Balancing Demand and Supply

To understand how the planning system works, it is necessary to understand the prioritized goals of the planning system, the most important of which are to ensure that:

- Any demand will be met by sufficient supply.
- Any supply serves a purpose.

Generally, these goals are achieved by the balancing of demand and supply.

Demand and Supply

Demand is the common term used for any kind of gross demand, such as a sales order and component need from a production order. In addition, the program allows more technical types of demand, such as negative inventory and purchase returns.

Supply is the common term used for any kind of positive or inbound quantity, such as inventory, production order, or inbound transfer. In addition, a sales return may also represent supply.

To sort out the many sources of demand and supply, the planning system organizes them on two time lines called inventory profiles. One profile holds demand events, and the other holds the corresponding supply events. Each event represents one order network entity, such as a sales order line, an item ledger entry, or a production order line.

When inventory profiles are loaded, the different demand-supply sets are balanced to output a supply plan that fulfills the listed goals.

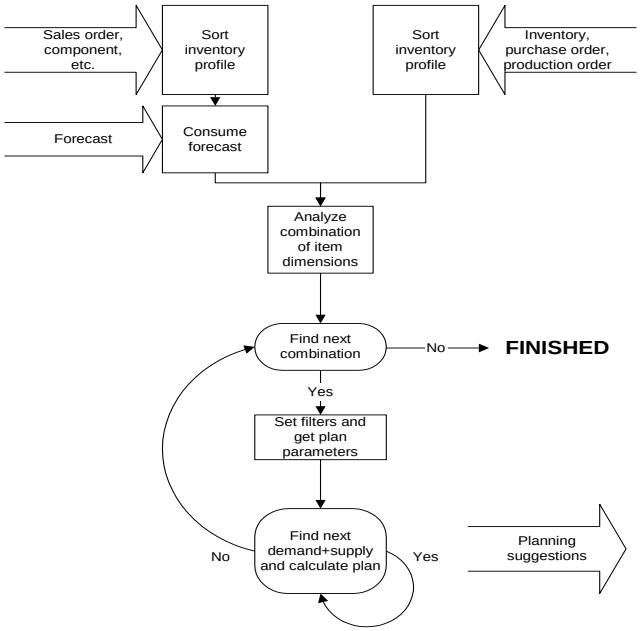
Planning parameters and inventory levels are other types of demand and supply respectively, which undergo integrated balancing to replenish stock items. For more information, see Handling Reordering Policies.

The Concept of Balancing in Brief

Demand is given by a company's customers. Supply is what the company can create and remove to establish balance. The planning system starts with the independent demand and then tracks backwards to the supply.

The inventory profiles are used to contain information about the demands and supplies, quantities, and timing. These profiles essentially make up the two sides of the balancing scale.

The objective of the planning mechanism is to counterbalance the demand and supply of an item to ensure that supply will match demand in a feasible way as defined by the planning parameters and rules.



Dealing with Orders before the Planning Starting Date

To avoid that a supply plan shows impossible and therefore useless suggestions, the planning system regards the period up until the planning starting date a frozen zone where nothing is planned for. The following rule applies to the frozen zone:

All supply and demand before the starting date of the planning period will be considered a part of inventory or shipped.

Accordingly, the planning system will not, with a few exceptions, suggest any changes to supply orders in the frozen zone, and no order tracking links are created or maintained for that period.

The exceptions to this rule are as follows:

- If the projected available inventory, including the sum of supply and demand in the frozen zone, is below zero.
- If serial/lot numbers are required on the backdated order(s).
- If the supply-demand set is linked by an order-to-order policy.

If the initial available inventory is below zero, the planning system suggests an emergency supply order on the day before the planning period to cover the missing quantity. Consequently, the projected and available inventory will always be at least zero when planning for the future period begins. The planning line for this supply order will display an Emergency warning icon and additional information is provided upon lookup.

Serial/Lot Numbers and Order-to-Order Links are Exempt from the Frozen Zone

If serial/lot numbers are required or an order-to-order link exists, the planning system will disregard the frozen zone and incorporate such quantities that are back-dated from the starting date and potentially suggest corrective actions if demand and supply is not synchronized. The business reason for this principle is that such specific demand-supply sets must match to ensure that this specific demand is fulfilled.

Loading the Inventory Profiles

To sort out the many sources of demand and supply, the planning system organizes them on two time-lines called inventory profiles.

The normal types of demand and supply with due dates on or after the planning starting date are loaded into each inventory profile. When loaded, the different demand and supply types are sorted according to overall priorities, such as due date, low-level codes, location, and variant. In addition, order priorities are applied to the different types to ensure that the most important demand is fulfilled first. For more information, see Prioritizing Orders.

As previously mentioned, demand could also be negative. This means that it should be treated as supply; however, unlike the normal types of supply, negative demand is considered fixed supply. The planning system can take it into account, but will not suggest any changes to it.

In general, the planning system considers all supply orders, after the planning starting date, as subject to change in order to fulfill demand. The planning system does not analyze which orders can be changed and which should be protected, except when quantities have been posted, that is:

- A released production order that has started.
- A transfer order where shipment has been posted.
- A purchase order where receipt has been posted.

Apart from loading demand and supply types, certain types are loaded with attention to special rules and dependencies that are described in the following.

Item Dimensions are Separated

The supply plan must be calculated per combination of the item dimensions, such as variant and location. However, there is no reason to calculate any theoretical combination. Only those combinations that carry a demand and/or supply need to be calculated.

The planning system controls this by running through the inventory profile. When a new combination is found, the program creates an internal control record that holds the actual combination information. The program inserts the SKU as the control record, or outer loop. As a result, the proper planning parameters based on a combination of variant and location are in place, and the program can proceed to the inner loop.

> **Note** The program does not require the user to enter a SKU record when entering demand and/or supply for a particular combination of variant and location. Therefore, if a SKU does not exist for a given combination, the program creates its own temporary SKU record based on the item card data. If Location Mandatory is set to Yes in the Inventory Setup window, then either a SKU must be created or Components at Location must be set to Yes. For more information, see Appendix D: Demand at Blank Location.

Serial/Lot Numbers are Loaded by Specification Level

Attributes in the form of serial/lot numbers are loaded into the inventory profiles along with the demand and supply that they are assigned to.

Demand and supply attributes are arranged by order priority as well as by their level of specification. Because serial/lot number matches reflect the level of specification, the more specific demand, such as a lot number selected specifically for a sale line, will seek a match before less specific demand, such as a sale from any lot number selected.

> **Note** There are no dedicated prioritization rules for serial/lot-numbered demand and supply, other than the level of specification defined by their combinations of serial and lot numbers and the item tracking setup of the involved items.

During balancing, the planning system regards supply that carries serial/lot numbers as inflexible and will not try to increase or reschedule such supply orders (unless they are used in an order-to-order relation. See below). This protects the supply from receiving several, possibly conflicting, action messages, when a supply carries varying attributes, such as a collection of different serial numbers.

Another reason that serial/lot numbered supply is inflexible is that serial/lot numbers are generally assigned so late in the process that it would be confusing if changes are suggested.

The matching of serial/lot numbers does not respect the frozen zone. If demand and supply is not synchronized, the planning system will suggest changes or suggest new orders, regardless of the planning starting date.

Order-to-Order Links are Never Broken

When planning an order-to-order item, the linked supply must not be used for any demand other than what it was originally intended for. The linked demand should not be covered by any other random supply, even if, in its present situation, it is available in time and quantity.

Order-to-order demand and supply must balance precisely. The planning system will ensure the supply under all circumstances without regarding order sizing parameters, modifiers, and quantities in inventory (other than quantities relating to the linked orders). For the same reason, the system will suggest decreasing excess supplies if the linked demand has decreased.

This balancing also affects the timing. The limited horizon that is given by the reorder cycle is not regarded; the supply will be rescheduled if the timing of the demand has changed. However, dampener time will be respected and will prevent order-to-order supplies from being scheduled out, except for the internal supplies of a multi-level production order (project order).

> **Note** Serial/lot numbers can also be specified on order-to-order demand. In that case, the supply is not regarded inflexible by default, as is normally the case for serial/lot numbers. In this case, the system will increase/decrease according to changes in demand. Furthermore, if one demand carries varying serial/lot numbers, such as more than one lot number, one supply order will be suggested per lot.
>
> **Note** Forecasts should not lead to creating supply orders that are bound by an order-to-order link. If the forecast is used, it should only be used as a generator of dependent demand in a manufacturing environment.

Component Need is Loaded According to Production Order Changes

When handling production orders, the planning system must monitor the needed components before loading them into the demand profile. Component lines that result from an amended production order will replace those of the original order. This ensures that the planning system ensures that planning lines for component need are never duplicated.

Safety Stock May Be Consumed

The safety stock quantity is primarily a demand type and is therefore loaded into the inventory profile on the planning starting date.

Safety stock is an inventory quantity set aside to compensate for uncertainties in demand during the replenishment lead time. However, it may be consumed If it is necessary to take from it to fulfill a demand. In that case, the planning system will ensure that the safety stock is quickly replaced by suggesting a supply order to replenish the safety stock quantity on the date it is consumed. This planning line will display an Exception warning icon explaining to the planner that the safety stock has been partly or fully consumed by means of an exception order for the missing quantity.

Forecast Demand is Reduced by Sales Orders

The production forecast expresses anticipated future demand. While actual demand is entered, typically as sales orders for produced items, it consumes the forecast.

The forecast itself is not actually reduced by sales orders; it remains the same. However, the forecast quantities used in the planning calculation are reduced (by the sales order quantities) before the remaining quantity, if any, enters the demand inventory profile. When the planning system examines actual sales during a period, both open sales orders and item ledger entries from shipped sales are included, unless they are derived from a blanket order.

A user is required to define a valid forecast period. The date on the forecasted quantity defines the start of the period, and the date on the next forecast defines the end of the period.

The forecast for periods prior to the planning period is not used, regardless of whether it was consumed or not. The first forecast figure of interest is either the date on or the closest date prior to the planning starting date.

The forecast can be for independent demand, such as sales orders, or dependent demand, like production order components (module-forecast). An item can have both types of forecast. During planning, the consumption takes place separately, first for independent demand and then for dependent demand.

Blanket Order Demand is Reduced by Sales Orders

Forecasting is supplemented by the blanket sales order as a means of specifying future demand from a specific customer. As with the (unspecified) forecast, actual sales should consume the anticipated demand, and the remaining quantity should enter the demand inventory profile. Again, the consumption does not actually reduce the blanket order.

The planning calculation considers open sales orders linked to the specific blanket order line, but it does not consider any valid time period. Nor does it consider posted orders, since the posting procedure has already reduced the outstanding blanket order quantity.

Prioritizing Orders

Within a given SKU, the requested or available date represents the highest priority; the demand of today should be dealt with before the demand of next week. But in addition to this overall priority, the planning system will also suggest which type of demand should be fulfilled before fulfilling another demand. Likewise, it will suggest what source of supply should be applied before applying other sources of supply. This is done according to order priorities.

Loaded demand and supply contribute to a profile for the projected inventory according to the following priorities.

Priorities on the Demand Side:

1. Already shipped: Item Ledger Entry
2. Purchase Return Order [1]
3. Sales Order
4. Service Order
5. Component need
6. Outbound Transfer Order
7. Blanket Order (that has not already been consumed by related sales orders)

[1] Purchase returns are usually not involved in supply planning; they should always be reserved from the lot that is going to be returned. If not reserved, purchase returns play a role in the availability and are highly prioritized to avoid that the planning system suggests a supply order just to serve a purchase return

8. Forecast (that has not already been consumed by other sales orders)

Priorities on the Supply Side:

1. Already in inventory: Item Ledger Entry (Planning Flexibility = None)
2. Sales Return Order (Planning Flexibility = None)
3. Inbound Transfer Order
4. Production Order
5. Purchase Order

Priority Related to the State of Demand and Supply

Apart from priorities given by the type of demand and supply, the present state of the orders in the execution process also defines a priority. For example, warehouse activities have an impact, and the status of sales, purchase, transfer, and production orders is taken into account:

1. Partly handled (Planning Flexibility = None)
2. Already in process in the warehouse (Planning Flexibility = None)
3. Released – all order types (Planning Flexibility = Unlimited)
4. Firm Planned Production Order (Planning Flexibility = Unlimited)
5. Planned/Open – all order types (Planning Flexibility = Unlimited)

Balancing Demand and Supply

The core of the planning system involves balancing demand and supply by means of suggesting user actions to revise the supply orders in case of imbalance. This takes place per combination of variant and location.

Imagine that each inventory profile contains a string of demand events (sorted by date and priority) and a corresponding string of supply events. Each event refers back to its source type and identification. The rules for counterbalancing the item are straightforward. Four instances of matching demand and supply can occur at any point of time in the process:

1. No demand or supply exists for the item => the planning has finished (or should not start).
2. Demand exists but there is no supply => supply should be suggested.
3. Supply exists but there is no demand for it => supply should be canceled.
4. Both demand and supply exist => questions should be asked and answered before the system can ensure that demand will be met and supply is sufficient.

   If the timing of the supply is not suitable, perhaps the supply can be rescheduled:

   a. If the supply is placed earlier than the demand, perhaps the supply can be rescheduled out so that inventory is as low as possible.
   b. If the supply is placed later than the demand, perhaps the supply can be rescheduled in. Otherwise, the system will suggest new supply.
   c. If the supply meets the demand on the date, the planning system can proceed to investigate whether the quantity of the supply can cover the demand.

   Once the timing is in place, the adequate quantity to be supplied can be calculated:

   a. If the supply quantity is less than the demand, it is possible that the supply quantity could be increased (or not, if limited by a maximum quantity policy).

b. If the supply quantity is greater than the demand, it is possible that the supply quantity can be decreased (or not, if limited by a minimum quantity policy).

At this point, either of two situations exists:

a. The current demand can be covered, in which case it can be closed and planning for the next demand can start.

b. The supply has reached its maximum, leaving some of the demand quantity uncovered. In this case, the planning system can close the current supply and proceed to the next one.

The procedure starts all over with the next demand and the current supply or vice versa. The current supply might be able to cover this next demand as well, or the current demand has not yet been fully covered.

Rules Concerning Actions for Supply Events

When the planning system performs a top-down calculation in which supply must fulfill demand, the demand is taken as a given, that is, it lies outside the control of the planning system. However, the supply side can be managed. Therefore, the planning system will suggest creating new supply orders, rescheduling existing ones, and/or changing the order quantity. If an existing supply order becoming superfluous, the planning system will suggest that the user cancels it.

If the user wants to exclude an existing supply order from the planning suggestions, he can state that it has no planning flexibility (Planning Flexibility = None). Then, excess supply from that order will be used to cover demand, but no action will be suggested.

In general, all supply has a planning flexibility that is limited by the conditions of each of the suggested actions.

1. Reschedule Out: The date of an existing supply order can be scheduled out to meet the demand due date unless:

   - It represents inventory (always on day zero).
   - It has an order-to-order linked to another demand.
   - It lies outside the reschedule window defined by the reorder cycle.
   - There is a closer supply that could be used.

   In addition, rescheduling could be ruled out because:

   - The supply order has already been tied to another demand on a previous date.
   - The rescheduling is so minimal that the user has defined it as negligible.

2. Reschedule In: The date of an existing supply order can be scheduled in unless:

   - It is linked directly to some other demand.
   - It lies outside the reschedule window defined by the reorder cycle.

   Note When planning an item using a reorder point, the supply order can always be scheduled in if necessary. This is common in forward-scheduled supply orders triggered by a reorder point.

3. Increase Quantity: The quantity of an existing supply order can be increased to meet the demand unless the supply order is linked directly to a demand by an order-to-order link.

   Note Even though it is possible to increase the supply order, it may be limited due to a defined maximum order quantity.

4. Decrease Quantity: An existing supply order with a surplus compared to an existing demand can be decreased to meet the demand.

Note Even though the quantity could be decreased, there may still be some surplus compared to the demand due to a defined minimum order quantity or order multiple.

5. Cancel: As a special incident of the decrease quantity action, the supply order could be canceled if it has been decreased to zero.
6. New: If no supply order already exists, or an existing one cannot be changed to meet the necessary quantity on the demanded due date, a new supply order is suggested.

Determining the Supply Quantity

Planning parameters defined by the user control the suggested quantity of each supply order.

When the planning system calculates the quantity of a new supply order or the quantity change on an existing one, the suggested quantity may be different from what is actually demanded.

If a maximum inventory or fixed order quantity are selected, the suggested quantity may be increased to meet that fixed quantity or the maximum inventory. If a reordering policy uses a reorder point, the quantity may be increased at least to meet the reorder point.

The suggested quantity may be modified in this sequence:

1. Down to the maximum order quantity (if any).
2. Up to the minimum order quantity.
3. Up to meet the nearest order multiple. (In case of erroneous settings, this may violate the maximum order quantity.)

Order Tracking Links during Planning

Concerning order tracking during planning, it is important to mention that the planning system rearranges the dynamically created order tracking links for the item/variant/location combinations.

There are two reasons for this:

- The planning system must be able to justify its suggestions; that all demand has been covered, and that no supply orders are superfluous.
- Dynamically created order tracking links need to be rebalanced regularly.

Over time, dynamic order tracking links become out of balance since the entire order tracking network is not rearranged until a demand or supply event is actually closed.

Before balancing supply by demand, the program deletes all existing order tracking links. Then during the balancing procedure, when a demand or supply event is closed, it establishes new order tracking links between the demand and supply.

Note Even if the item is not set up for dynamic order tracking, the planned system will create balanced order tracking links as explained above.

Closing Demand and Supply

When the supply balancing procedures have been performed, there are three possible ending situations:

1. The required quantity and date of the demand events have been met and the planning for them can be closed. The supply event is still open and may be able to cover the next demand, so the balancing procedure can start over with the current supply event and the next demand.
2. The supply order cannot be revised to cover all of the demand. The demand event is still open, with some uncovered quantity that may be covered by the next supply event. Thus the current supply event is closed, so the balancing act can start over with the current demand and the next supply event.
3. All of the demand has been covered; there is no subsequent demand (or there has been no demand at all). If there is any surplus supply, it may be decreased (or canceled) and then closed. It is possible that additional supply events exist further along in the chain, and they should also be canceled.

Lastly, the planning system will create an order tracking link between the supply and the demand.

Creating the Planning Line (Suggested Action)

If any action – New, Change Quantity, Reschedule, Reschedule and Change Quantity, or Cancel – is suggested to revise the supply order, the planning system creates a planning line in the planning worksheet. Due to order tracking, the planning line is created not only when the supply event is closed, but also if the demand event is closed, even though the supply event is still open and may be subject to additional changes when the next demand event is processed. This means that when first created, the planning line may be changed again.

To minimize database access when handling production orders, the planning line can be maintained in three levels, while aiming to perform the least demanding maintenance level:

1. Create only the planning line with the current due date and quantity but without the routing and components.
2. Include routing: the planned routing is laid out including calculation of starting and ending dates and times. This is demanding in terms of database accesses. To determine the ending and due dates, it may be necessary to calculate this even if the supply event has not been closed (in the case of forward scheduling).
3. Include BOM explosion: this can wait until just before the supply event is closed.

This concludes the descriptions of how demand and supply is loaded, prioritized, and balanced by the planning system. In integration with this supply planning activity, the system must ensure that the required inventory level of each planned item is maintained according to its reordering policies.

Handling Reordering Policies

For an item to participate in supply planning, a reorder policy must be defined. The following four reordering policies exist:

- Fixed Reorder Qty.
- Maximum Qty.
- Order
- Lot-for-Lot

In the following, the characteristics of each reordering policy are covered after descriptions of central related concepts and principles below.

Fixed Reorder Qty. and Maximum Qty. policies relate to inventory planning. Although inventory planning is technically simpler than the balancing procedure, these policies must coexist with the step-by-step balancing of supply and order tracking. To control the integration between the two and to provide visibility into the involved planning logic, principles apply concerning the following:

- The role of the reorder point
- Monitoring the projected inventory level and the reorder point
- The role of the reorder cycle
- Staying within the overflow level
- Handling negative inventory

The Role of the Reorder Point

In addition to the general balancing of supply and demand, the planning system must also monitor inventory levels for the affected items to respect the defined reordering policies:

A reorder point represents demand during lead time. When the projected inventory passes below the inventory level defined by the reorder point, it is time to order more quantity. Meanwhile, the inventory is expected to decrease gradually and possibly reach zero (or the safety stock level), until the replenishment arrives.

Accordingly, the planning system will suggest a forward-scheduled supply order at the point when the projected inventory passes below the reorder point.

The reorder point reflects a certain inventory level. However, inventory levels can move significantly during the reorder cycle and, therefore, the planning system must constantly monitor the projected available inventory.

Monitoring the Projected Inventory Level and the Reorder Point

Inventory is a type of supply, but for inventory planning, the planning system distinguishes between two inventory levels:

- Projected inventory
- Projected available inventory

Projected Inventory

Initially, projected inventory is the quantity of gross inventory, including supply and demand in the past even if not posted, when starting the planning process. In the future, this becomes a moving projected inventory level that is maintained by gross quantities from future supply and demand because those

are introduced along the time line (whether reserved or in other ways allocated).

The projected inventory is used by the planning system to monitor the reorder point and to determine the reorder quantity when using the Maximum Qty. reordering policy.

Projected Available Inventory

The projected available inventory is the part of the projected inventory that at a given point in time is available to fulfill demand. The projected available inventory is used by the planning engine when monitoring the safety stock level.

The projected available inventory is used by the planning system to monitor the safety stock level, since the safety stock must always be available to serve unexpected demand.

Time Buckets

Having a tight control of the projected inventory is crucial to detect when the reorder point is being crossed and to calculate the right order quantity when using the Maximum Qty. reordering policy.

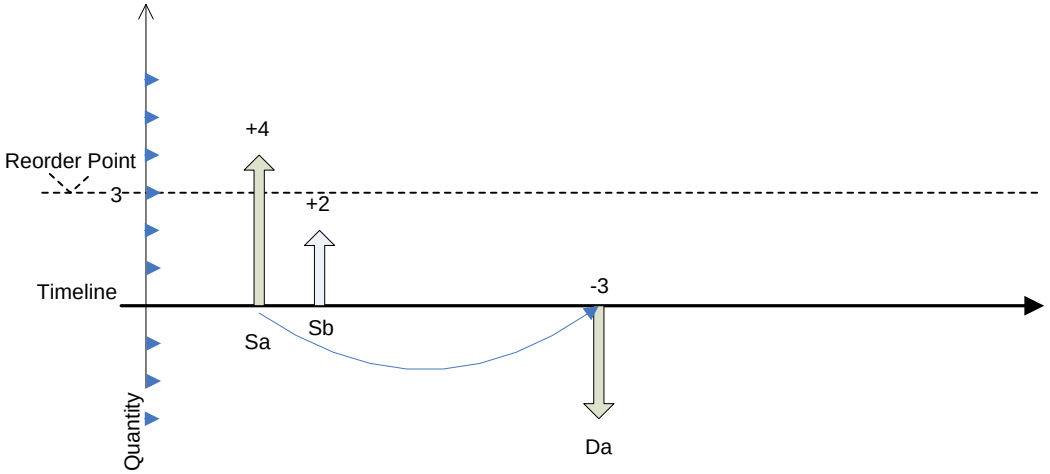
As stated earlier, the projected inventory level is calculated at the start of the planning period. It is a gross level that does not consider reservations and similar allocations. To monitor this inventory level during the planning sequence, the system monitors the aggregated changes over a period of time, a time bucket. The time bucket is defined by the reorder cycle of the item. The system ensures that the time bucket is at least one day since it is the most precise unit of time for a demand or supply event (except for production orders and component need in manufacturing).

Determining the Projected Inventory Level

The following sequence describes how the projected inventory level is determined:

- When a supply event, such as a purchase order has been totally planned, it will increase the projected inventory on its due date.
- When a demand event has been fully satisfied, it will not decrease the projected inventory right away. Instead, it posts a decrease reminder, which is an internal record that holds the date and quantity of the contribution to the projected inventory.
- When a subsequent supply event is planned and placed on the time line, the posted decrease reminders are investigated one by one up until the planned date of the supply while updating the projected inventory. During this process, the reorder point level of the internal increase reminder may be passed.
- If a new supply order is introduced, the system checks if it is entered before the current supply. If it is, the new supply becomes current supply and the balancing procedure starts over.

The following shows a graphical illustration of this principle:



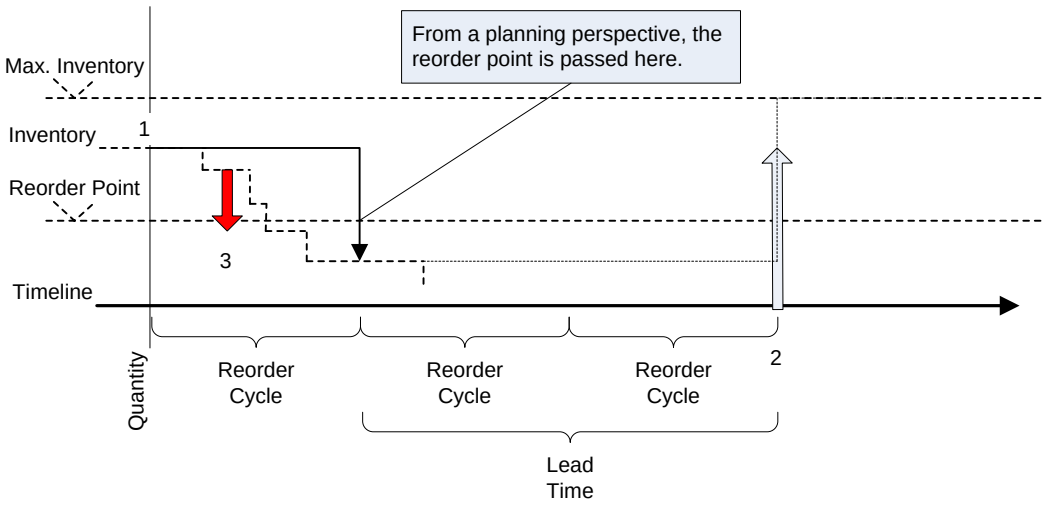
1) Supply **Sa** of 4 (fixed) closes Demand **Da** of -3.
2) CloseDemand: Create a decrease reminder of -3 (not shown).
3) Supply **Sa** is closed with a surplus of 1 (no more demand exists).
   This increases the projected inventory level to +4, while the projected available inventory becomes -1.
4) The next supply **Sb** of 2 (another order) has already been placed on the timeline.
5) System checks if there is any decrease reminder preceding **Sb** (there is not, so no action is taken).
6) System closes supply **Sb** (no more demand exists) – either A: by reducing it to 0 (cancel) or B: by leaving as is.
   This increases the projected inventory level (A: +0 => +4 or B: +2 => +6).
7) System makes a final check: Is there any decrease reminder? Yes, there is one on the date of **Da**.
8) System adds the decrease reminder of -3 reminder to the projected inventory level, either A: +4 -3 => 1 or
   B: +6 -3 => +3.
9) In case of A, the system creates a forward-scheduled order starting on date **Da.**
   in case of B, the reorder point is not crossed and no new order is created.

The Role of the Reorder Cycle

The purpose of the reorder cycle is to collect demand events within the time window in order to make a joint supply order.

For reordering policies that use a reorder point, the reorder cycle concept is expanded slightly to include a time bucket principle. This ensures that demand within the same reorder cycle is accumulated before checking the impact on the projected inventory and whether the reorder point has been passed. If the reorder point is passed, a new supply order is scheduled forward from the end of the period defined by the reorder cycle. The reorder cycle buckets begin on the planning starting date.

The time-bucketed concept reflects the manual process of checking the inventory level on a frequent basis rather than for each transaction. The user needs to define the frequency (the reorder cycle). For example, the user gathers all item needs from one vendor to place a weekly order.



1. Initially, the inventory is above the reorder point.
   The system checks projected inventory and accumulates demand within the reorder cycle.
   The system detects that the reorder point has been passed.
2. A new forward-scheduled supply is created.

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3. Next time the planning is run, a new demand has arrived.
   Although it seems that demand would displace the time when the reorder point is passed, it has no influence on planning.

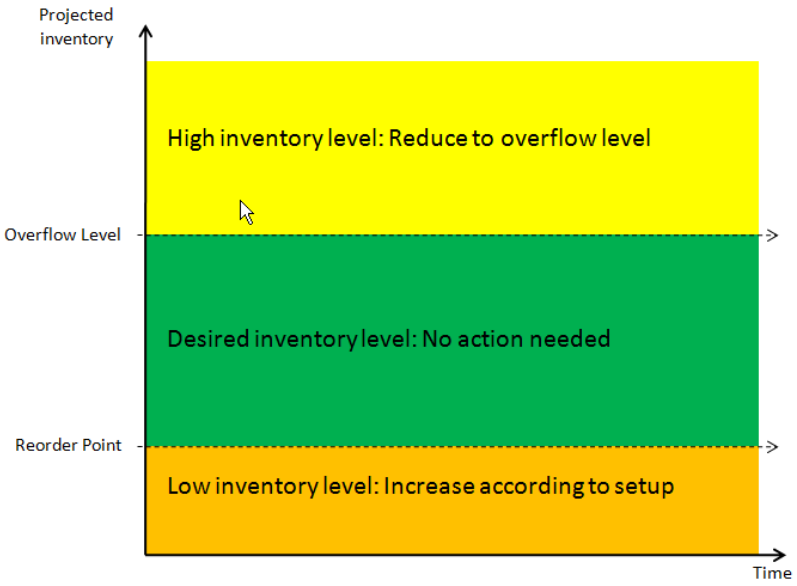
   Note: Without the time bucket principle, the planning system would suggest that supply 2 be scheduled in.

The reorder cycle is generally used to avoid a cascade effect. For example, a balanced row of demand and supply where an early demand is canceled, or a new one is created. The result would be that every supply order (except the last one) is rescheduled.

Staying under the Overflow Level

When using Maximum Qty. and Fixed Reorder Qty., the planning system focuses on the projected inventory in the given time-bucket only. This means that the planning system may suggest superfluous supply when negative demand or positive supply changes occur outside of the given time bucket. If, for this reason, a superfluous supply is suggested, the planning system calculates which quantity the supply should be decreased to (or deleted) to avoid the superfluous supply. This quantity is called the “overflow level”. The overflow is communicated as a planning line with a *Change Qty.* (decrease) or *Cancel* action and the following warning message:

Attention: The projected inventory [xx] is higher than the overflow level [xx] on the Due Date [xx].



Calculating the Overflow Level

The overflow level is calculated in different ways depending on planning setup.

Maximum Qty. reordering policy

Overflow level = Maximum Inventory

Note: If a minimum order quantity exists, then it will be added as follows:
Overflow level = Maximum Inventory + Minimum Order Quantity

Fixed Reorder Qty. reordering policy

Overflow level = Reorder Quantity + Reorder Point

Note: If the minimum order quantity is higher than the reorder point, then it will replace as follows:

Overflow Level = Reorder Quantity + Minimum Order Quantity

Order Multiple

If an order multiple exists, then it will adjust the overflow level for both Maximum Qty. and Fixed Reorder Qty. reordering policies.

Creating the Planning Line with Overflow Warning

When an existing supply causes the projected inventory to be higher than the overflow level at the end of a time bucket, a planning line is created. To warn about the potential superfluous supply, the planning line has a warning message, the Accept Action Message field is not selected, and the action message is either *Cancel* or *Change Qty.*

Calculating the Planning Line Quantity

Planning Line Quantity = Current Supply Quantity – (Projected Inventory – Overflow Level)

Note: As with all warning lines, any maximum/minimum order quantity or order multiple will be ignored.

Defining the Action Message Type
If the planning line quantity is higher than 0, then the action message is *Change Qty.*.
If the planning line quantity is equal to or lower than 0, then the action message is *Cancel*

Composing the Warning Message
In case of overflow, the **Untracked Planning Elements** window displays a warning message with the following information:

- The projected inventory level that triggered the warning
- The calculated overflow level
- The due date of the supply event.

Example: "The projected inventory 120 is higher than the overflow level 60 on 28-01-11"

Scenario:

In this scenario, a customer changes a sales order from 70 to 40 pieces between two planning runs. The overflow feature sets in to reduce the purchase that was suggested for the initial sales quantity.

Item setup

Reordering Policy	Maximum Qty.
Maximum Order Quantity	100
Reorder Point	50
Inventory	80

Situation before sales decrease

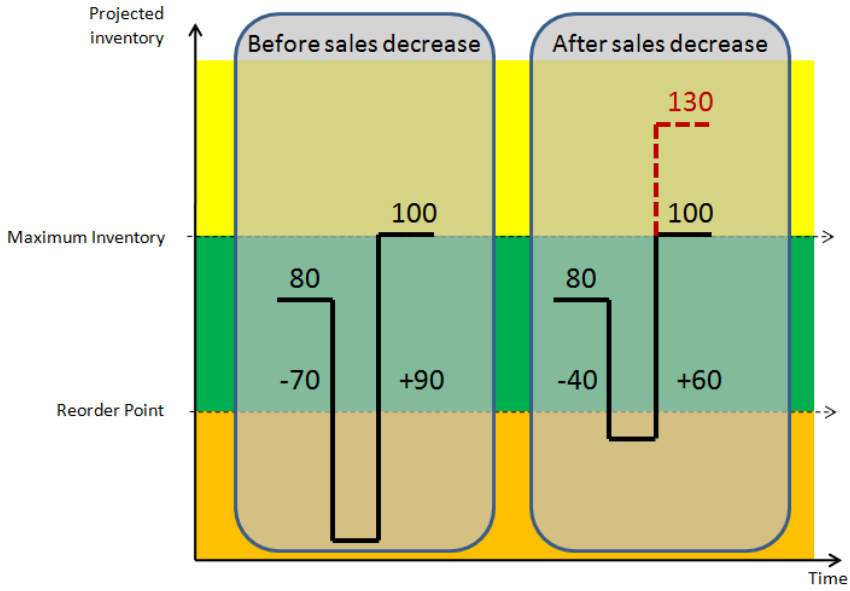
Event	Change Qty.	Projected Inventory
Day one		80
Sale	-70	10
End of time bucket		10
Suggest new purchase order	+90	100

Situation after sales decrease

Change	Change Qty.	Projected Inventory
Day one		80
Sale	-40	40
Purchase	+90	130
End of time bucket		130
Suggest to decrease purchase order	90 → 60 = -30	100

Resulting Planning Lines

One planning line (warning) is created to reduce the purchase with 30 from 90 to 60 to keep the projected inventory on 100 according to the overflow level.



Note: Without the Overflow feature, no warning is created if the projected inventory level is above maximum inventory. This could cause a superfluous supply of 30.

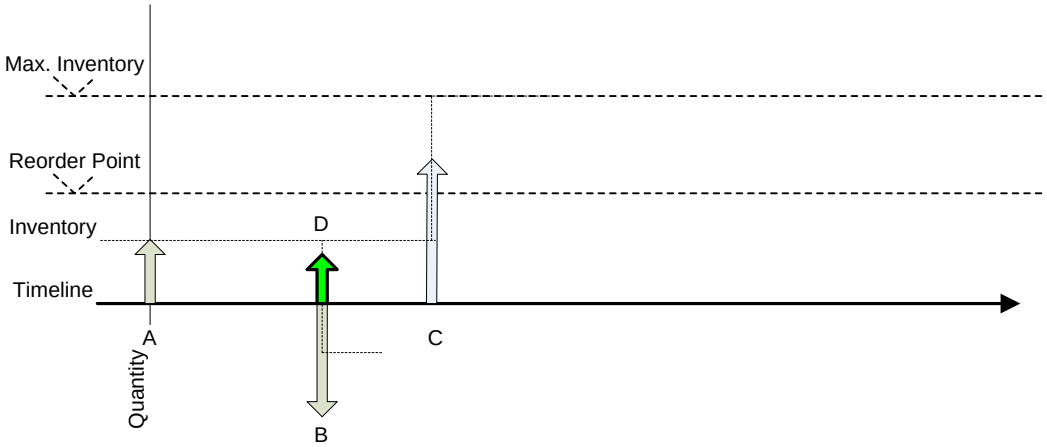
Handling Projected Negative Inventory

The reorder point expresses the anticipated demand during the lead time of the item. When the reorder point is passed, it is time to order more. But the projected inventory must be large enough to cover the demand until the new order is received. Meanwhile, the safety stock should take care of fluctuations in demand up to a targeted service level.

Consequently, the planning system considers it an emergency if a future demand cannot be served from the projected inventory, or expressed in another way, that the projected inventory goes negative. The system deals with such an exception by suggesting a new supply order to meet the part of the demand that cannot be met by inventory or other supply. The order size of the new supply order will not take the maximum inventory or the reorder quantity into consideration, nor will it take into consideration the order modifiers Maximum Order Quantity, Minimum Order Quantity, and Order Multiple. In stead, it will reflect the exact deficiency.

The planning line for this type of supply order will display an Emergency warning icon, and additional information will be provided upon lookup to inform the user of the situation.

In the following illustration, supply D represents an emergency order to adjust for negative inventory.



1. Supply **A,** initial projected inventory, is below reorder point
2. A new forward-scheduled supply is created (**C**)
   (Quantity = Maximum Inventory – Projected Inventory level)
3. Supply **A** is closed by demand **B**, which is not fully covered.
   (Demand **B** could try to schedule Supply **C** in but that will not happen according to the time-bucket concept.)
4. New supply (**D**) is created to cover the remaining quantity on Demand **B.**
5. Demand **B** is closed (creating a reminder to the projected inventory).
6. The new supply **D** is closed.
7. Projected Inventory is checked; reorder point has not been crossed.
8. Supply **C** is closed (no more demand exists).
9. Final check: No outstanding inventory level reminders exist.

Step 4 reflects how the system reacts in versions earlier than 2009 SP1.

This concludes the description of central principles relating to inventory planning based on reordering policies. The following section describes the characteristics of the four supported reordering policies.

Fixed Reorder Qty.

The Fixed Reorder Qty. policy is related to inventory planning of typical C-items (low inventory cost, low risk of obsolescence, and/or many items). This policy is usually used in connection with a reorder point reflecting the anticipated demand during the lead time of the item.

Calculated per Time Bucket

If the planning system detects that the reorder point has been passed in a given time bucket (reorder cycle) – above or at the reorder point at the start of the period, and below at the end – it will suggest to create a new supply order of the specified reorder quantity and forward schedule it from the first date after the end of the time bucket.

The bucketed reorder point concept reduces the number of supply suggestions. This reflects a manual process of frequently walking through the warehouse to check the actual contents in the various bins.

Creates only Necessary Supply

Before suggesting a new supply order to meet a reorder point, the planning system checks if supply has already been ordered to be received within the item's lead time. If an existing supply order will solve the problem by bringing the projected inventory to or above the reorder point within the lead time, the system will not suggest a new supply order.

Supply orders that are created specifically to meet a reorder point is excluded from ordinary supply balancing, and will not in any way be changed afterwards. Consequently, if an item using reorder

point is to be phased out (not replenished), it is advisable to review outstanding supply orders manually or change the reordering policy to Lot-for-Lot, whereby the system will reduce or cancel superfluous supply.

Combines with Order Modifiers

The order modifiers, Minimum Order Quantity, Maximum Order Quantity, and Order Multiple, should not play a big role when the fixed reorder quantity policy is used. However, the planning system still takes these modifiers into account and will decrease the quantity to the specified maximum order quantity (and create two or more supplies in order to reach the total order quantity), increase the order to the specified minimum order quantity, or round the order quantity up to meet a specified order multiple.

Should Not be Used with Forecast

Because the anticipated demand is already expressed in the reorder point level it is not necessary to include a forecast in the planning of an item using a reorder point. If it is relevant to base the plan on a forecast, use the lot-for-lot policy.

Must Not be Used with Reservations

If the user has reserved a quantity, for instance a quantity in inventory, for some distant demand, the planning foundation will be disturbed. Even if the projected inventory level is acceptable in relation to the reorder point, the quantities might not be available. The system may try to compensate for that by creating exception orders; however, it is recommended that the Reserve field is set to Never on items that are planned using a reorder point.

Maximum Qty.

The Maximum Quantity policy is way to maintain inventory using a reorder point.

Everything regarding the Fixed Reorder Qty. policy also applies to this policy. The only difference is the quantity of the suggested supply. When using the maximum quantity policy, the reorder quantity will be defined dynamically based on the projected inventory level and will therefore usually differ from order to order.

Calculated per Time Bucket

The reorder quantity is determined at the point of time (the end of a time bucket) when the planning system detects that the reorder point has been crossed. At this time, the system measures the gap from the current projected inventory level up to the specified maximum inventory. This constitutes the quantity that should be reordered. The system then checks if supply has already been ordered elsewhere to be received within the lead time and, if so, reduces the quantity of the new supply order by already ordered quantities.

The system will ensure that the projected inventory at least reaches the reorder point level – in case the user has forgotten to specify a maximum inventory quantity.

Combines with Order Modifiers

Depending on the setup, it may be best to combine the Maximum Quantity policy with order modifiers to ensure a minimum order quantity or round it to an integer number of purchase units of measure, or split it into more lots as defined by the maximum order quantity.

Order

In a make-to-order environment, an item is purchased or produced to exclusively cover a specific demand. Typically it relates to A-items, and the motivation for choosing the Order reordering policy can be that the demand is infrequent, the lead-time is insignificant, or the required attributes vary.

The program creates an order-to-order link, which acts as a preliminary connection between the supply, a supply order or inventory, and the demand that it is going to fulfill.

Apart from using the Order policy, the order-to-order link can be applied during planning in the following ways:

- When using the Make-to-Order manufacturing policy to create multi-level or project type production orders (producing needed components on the same production order).
- When using the Sales Order Planning feature to create a production order from a sales order.

Even if a manufacturing company considers itself as a make-to-order environment, it might be best to use a Lot-for-Lot reordering policy if the items are pure standard without variation in attributes. As a result, the system will use unplanned inventory and only accumulates sales orders with the same shipment date or within a defined reorder cycle.

Order-to-Order Links and Past Due Dates

Unlike most supply-demand sets, linked orders with due dates before the planning starting date are fully planned for by the system. The business reason for this exception is that specific demand-supply sets must be synchronized through to execution. For more information about the frozen zone that applies to most demand-supply types, see Dealing with Dates before the Planning Starting Date.

Lot-for-Lot

The lot-for-lot policy is the most flexible because the system only reacts on actual demand, plus it acts on anticipated demand from forecast and blanket orders and then settles the order quantity based on the demand. The lot-for-lot policy is aimed at A- and B-items where inventory can be accepted but should be avoided.

In some ways, the lot-for-lot policy looks like the Order policy, but it has a generic approach to items; it can accept quantities in inventory, and it bundles demand and corresponding supply in time buckets defined by the user.

The time bucket is defined by the reorder cycle. The system works with a minimum time bucket of one day, since this is the smallest time unit of measure on demand and supply events in the system (although, in practice, the time unit of measure on production orders and component needs can be seconds).

The reorder cycle also sets limits on when an existing supply order should be rescheduled to meet a given demand. If the supply lies within the reorder cycle, it will be rescheduled in or out to meet the demand. Otherwise, if it lies earlier, it will cause unnecessary build-up of inventory and should be canceled. If it lies later, a new supply order will be created instead.

With this policy, it is also possible to define a safety stock in order to compensate for possible fluctuations in supply, or to meet sudden demand.

Because the supply order quantity is based on the actual demand it can make sense to use the order modifiers: round the order quantity up to meet a specified order multiple (or purchase unit of measure), increase the order to a specified minimum order quantity, or decrease the quantity to the specified maximum quantity (and thus create two or more supplies to reach the total needed quantity).

This concludes the description of selected planning parameters and principles that govern the inventory planning part of the system. For more information about these planning parameters, see Appendix A: Planning Parameters.

Appendix A: Planning Parameters

This appendix describes the effect of the purpose and effect of the different planning parameters.

The way the planning system controls item supply is governed by various settings on the item card (or SKU), plus the manufacturing setup. The following table shows these parameters, formulated as planning purposes to meet.

Define if the item is to be planned	Reordering Policy = Blank
Define when to reorder	Reorder Cycle
	Reorder Point
	Safety Stock Quantity
	Safety Lead Time
Define how much to reorder	Reordering Policy:
	1. Fixed Reorder Qty. plus Reorder Quantity
	2. Maximum Qty. plus Maximum Inventory
	3. Order
	4. Lot-for-Lot
Modify the supply orders	Minimum Order Quantity
	Maximum Order Quantity
	Order Multiple
Delimit the planned item	Manufacturing Policy:
	1. Make-to-Stock
	2. Make-to-Order

Define If the Item Will Be Planned

To include an item/SKU in the planning process, it must have a reordering policy otherwise it must be planned manually, for example, with the Order Planning feature.

Define When to Reorder

Reorder proposals are generally released only when the projected available quantity has fallen below a given quantity. This quantity is defined by the reorder point. Otherwise, it will be zero. Zero can be adjusted by entering a safety stock quantity. If the user has defined a safety lead time, it will cause the proposal to be delivered in the period prior to the required due date.

The default safety lead time (in the Manufacturing Setup) should be set to at least one day. The due date of the demand may be known, but not the due time. The planning schedules backward to meet gross demand, and, if no Safety Lead Time is defined, the goods may arrive too late to meet the demand.

Define How Much to Reorder

When the planning system detects the need to reorder, it refers to the selected reordering policy to determine when and how much to order.

Generally, and independent of the reordering policy, the planning system follows this logic:

1. The quantity of the order proposal is calculated to meet the specified minimum inventory level of the item, usually the safety stock quantity. If nothing is specified, the minimum inventory level is zero.
2. If the projected available inventory is below the safety stock quantity, a backward-scheduled supply order is suggested. The order quantity will at least fill the safety stock quantity, and can be increased by gross demand within the reorder cycle, by the reordering policy, and by the order modifiers.

3. If the projected inventory is below the reorder point (calculated from aggregated changes within the reorder cycle) and above the safety stock quantity**,** a forward-scheduled exception order is suggested. Both the gross demand to be met and the reordering policy will determine the order quantity. At minimum, the order quantity will meet the reorder point.
4. If there is more gross demand due before the ending date of the forward-scheduled order proposal, and this demand brings the currently calculated projected available inventory below the safety stock quantity, the order quantity is increased to make up the deficit. The suggested supply order is then scheduled backwards from the due date of the gross demand that would have violated the safety stock quantity.
5. If the reorder cycle field is not filled in, only the gross demand on the same due date will be added.

Effects of the Four Reordering Policies

The four reordering policies have the following effect on the quantity being reordered:

- Fixed Reorder Qty.
  The order quantity will, at minimum, be equal to the reorder quantity. It can be increased to meet the demand or the desired inventory level. This reordering policy is usually used with a reorder point.
- Maximum Qty.
  The order quantity will be calculated to meet the maximum inventory. If quantity modifiers are used, then maximum inventory can be violated. It is not recommended to use reorder cycle together with maximum qty., and in most cases the reorder cycle will be overruled. This reordering policy is usually used with a reorder point.
- Order
  The order quantity will be calculated to meet each single demand event and the demand-supply set will remain linked until execution. No planning parameters are considered.
- Lot-for-Lot
  The quantity is calculated to meet the sum of the demand that comes due within the reorder cycle.

Modify the Supply Orders

When the quantity of the order proposal has been calculated, one or more of the order modifiers can adjust it: Maximum Order Quantity ≥ Minimum Order Quantity ≥ Order Multiple.

The quantity is decreased if it exceeds the maximum order quantity. Then, it is increased if it is below the minimum order quantity. Finally, it is rounded up so that it conforms to a specified order multiple. Any remaining quantity would go through the same adjustments until the total demand has been converted into order proposals.

Delimit the Item

The Manufacturing Policy option defines which additional orders the MRP calculation will propose.

- If the Make-to-Stock option is used, the orders concern only the item in question.
- If the Make-to-Order option is used, the planning system will analyze the production BOM of the item and create additional linked order proposals for those lower-level items that are also defined as Make-to-Order. This continues as long as there are Make-to-Order items in the descending BOM structures.

Appendix B: Examples of Planning Parameters Use

This appendix provides examples of planning parameter combinations for the following common inventory planning methods:

- Maximum/Minimum method
- Variable Reorder Quantity method

Maximum/Minimum Method

In this example, you have an item that you store in a box or on a shelf at a store and you want to reorder this item when the inventory drops below a defined reorder point. The reorder point represents your expectations of the general need for the item during the lead time. If you order as soon as you discover that the item is at or below the reorder point, the inventory will decrease to +zero (or safety stock quantity) when you receive the next shipment.

You have decided that when you reorder the item, you want the stock filled to a certain level – the maximum inventory – or you may use a fixed reorder quantity.

To allow for uncertainty regarding the anticipated need, you can define a safety stock quantity. To allow for uncertainty regarding the lead time, you can define a safety lead time on the item or SKU card.

Parameter Setup

- Replenishment System = Purchase
- Reordering Policy = Maximum Qty.
- Reorder Point = 100
- Lead Time Calculation = 3w
- Safety Stock Quantity = 10
- Manufacturing Policy = Make-to-Stock
- Maximum Inventory = 300
- Inventory = 90

With this parameter setup, it is not necessary to use the order modifiers; Maximum Order Quantity and Minimum Order Quantity because you have defined a reorder quantity or a maximum inventory to be met.

Planning Actions

The following planning actions will result from the above parameter setup.

The planning system will suggest an order of 210 to be delivered three weeks after the planning starting date.

This will not change if a gross demand of 70 units, for example, is due two weeks after the planning starting date. However, if a gross demand of 110 units occurs one week after the planning starting date, the planning system will treat it as an exceptional situation. In this case, the inventory will pass below the safety stock and a new supply order labeled Exception is suggested to replenish the safety stock.

Variable Reorder Quantity Method

In this example, you simply want to order the actual required quantity of a particular item, but you also want to keep the number of replenishment orders at a reasonable level. You want to reorder this item when you expect the inventory to pass below zero or the safety stock quantity. When you have to reorder, you want to include additional demands within the nearest future to optimize setup time and order handling. You define the nearest future time period in the reorder cycle on the item card.

Parameter Setup

- Replenishment System = Prod. Order
- Safety Stock Quantity = 10
- Manufacturing Policy = Make-to-Stock
- Reordering Policy = Lot-for-Lot
- Reorder Cycle = 3w
- Inventory = 90

Gross Demand

- 20 units due 3 days after the planning starting date
- 70 units due 2 weeks after the planning starting date
- 25 units due 3 weeks after the planning starting date

Planning Actions

The following planning actions will result from the above parameter setup and demand.

The planning system calculates that the first demand can be met by the projected inventory (70 left, including 10 as safety stock).

The second demand can be partially covered by inventory, but there is a shortage of 10 units.

Now that there is a need to reorder, the planning system investigates the reorder cycle for additional demand and finds the third demand of 25 units. The order is calculated as 35 units, and it is scheduled backwards from the day of the second demand, when the first 10 units are due.

Appendix C: Planning Assignment Table

The Planning Assignment table controls the planning process.

The table is arranged according to the low-level code and number of the item. It shows a planning imbalance, which can be caused by any of the following:

- A new sales order, forecast, component, purchase order, production order, transfer order.
- Change of item, quantity, location, variant, or date on a sales order, forecast, component, purchase order, production order, transfer order.
- Cancellation of a sales order, forecast, component, purchase order, production order, or transfer order.
- Consuming other items or quantities than planned.
- Output other than planned (when finishing a production order).
- Unplanned changes in inventory.

For these direct supply-demand displacements, the order tracking and action messaging system maintains the Planning Assignment table and states a planning reason as an action message.

The following changes in master data can also cause a planning imbalance:

- Change of status to Certified in the production BOM header (for all items using that header).
- Deleted line (child item).
- Change of status to Certified in the routing header (for all items using that routing).
- Changes in the following item card fields.
- Safety Stock Quantity or Safety Lead Time.
- Lead Time Calculation.
- Reorder Point.
- Production BOM No. (and all children of old BOM reference).
- Routing No.
- Reordering Policy.

In these cases, a new function, Planning Assignment Management, maintains the table and states the planning reason as Net Change.

The following changes do not cause a planning assignment:

- Calendars
- Other planning parameters on the item card

When calculating an MPS or an MRP, the following restrictions apply:

- MPS: The planning system checks that the item carries a production forecast or a sales order. If not, the item is not included in the plan.
- MRP: If the planning system detects that the item is being replenished by an MPS planning line or MPS supply order, the item will be left out of the planning. However, any demand from relevant components is included.

Appendix D: Demand at Blank Location

When a user creates a demand event, such as a sales order line, the program allows the user to sometimes specify a location code and other times not, that is, use blank location.

For demand with or without location codes, the planning system operates in a straight forward way when:

- Demand lines always carry location codes and the system fully uses SKUs, including the relevant location setup.
- Demand lines never carry location codes, and the system does not use SKUs or any location setup (see the last scenario in the following section).

However, if demand events sometimes have location codes and other times do not, the planning system will follow certain rules depending on setup.

Demand at Location

When the planning system detects demand at a location, it will behave in different ways depending on three critical setup values. During a planning run, the system checks for three setup values in sequence and plans accordingly.

1. Is there a check mark in the Location Mandatory field?
   If yes, then:
2. Does SKU exist for the item?
   If yes, then:
   The item is planned according to planning parameters on the SKU card.
   If no, then:
3. Does the Components at Location field contain the demanded location code?
   If yes, then:
   The item is planned according to planning parameters on the item card.
   If no, then:
   The item is planned according to: Reordering Policy = Lot-for-Lot, Include Inventory = Yes, all other planning parameters = Empty, items using Reordering Policy = Order will remain using Order along with the other settings.)

   Note The exceptional planning setup that is output as the last reaction in step 3 above is referred to in the following as the “minimal alternative”. This planning setup only covers the exact demand, and all other planning parameters are ignored.

For information about variations of this planning logic, see the Scenarios section below.

Demand at Blank Location

Even if the Location Mandatory field is selected, the program will allow demand lines to be created without a location code, also referred to as blank location. This is a deviation for the system because it has various setup values tuned to dealing with locations (see above) and as a result, the planning engine will not create a planning line for such a demand line.

If the Location Mandatory field is not selected but any of the location setup values exist, it is also considered a deviation, and the planning system will react by using the “minimal alternative”: The item is planned according to: Reordering Policy = Lot-for-Lot (Order remains Order), Include Inventory = Yes, all other planning parameters = Empty.

The following scenarios describe variations of demand at blank location and how the planning system resolves to the “minimal alternative”.

Scenarios

Setup 1:

- Location Mandatory = Yes
- SKU is set up for RED
- Component at Location = BLUE

Case 1.1: Demand is at RED location

The item is planned according to planning parameters on the SKU card.

Case 1.2: Demand is at BLUE location

The item is planned according to: Reordering Policy = Lot-for-Lot (Order remains Order), Include Inventory = Yes, all other planning parameters = Empty.

Case 1.3: Demand is at GREEN location

The item is planned according to: Reordering Policy = Lot-for-Lot (Order remains Order), Include Inventory = Yes, all other planning parameters = Empty.

Case 1.4: Demand is at BLANK location

The item is not planned because no location is defined on the demand line.

Setup 2:

- Location Mandatory = Yes
- No SKU exists
- Component at Location = BLUE

Case 2.1: Demand is at RED location

The item is planned according to: Reordering Policy = Lot-for-Lot (Order remains Order), Include Inventory = Yes, all other planning parameters = Empty.

Case 2.2: Demand is at BLUE location

The item is planned according to planning parameters on the item card.

Setup 3:

- Location Mandatory = No
- No SKU exists
- Component at Location = BLUE

Case 3.1: Demand is at RED location

The item is planned according to: Reordering Policy = Lot-for-Lot (Order remains Order), Include Inventory = Yes, all other planning parameters = Empty.

Case 3.2: Demand is at BLUE location

The item is planned according to planning parameters on the item card.

Case 3.3: Demand is at BLANK location

The item is planned according to: Reordering Policy = Lot-for-Lot (Order remains Order), Include Inventory = Yes, all other planning parameters = Empty.

Setup 4:

- Location Mandatory = No
- No SKU exists
- Component at Location = BLANK

Case 4.1: Demand is at BLUE location

The item is planned according to: Reordering Policy = Lot-for-Lot (Order remains Order), Include Inventory = Yes, all other planning parameters = Empty.

Case 4.2: Demand is at BLANK location

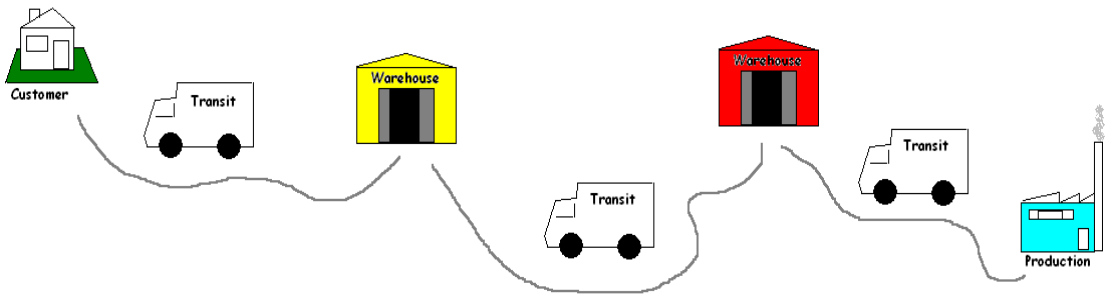
The item is planned according to planning parameters on the item card.

As illustrated in the last scenario, the only way to get a correct result for a demand line without a location code is to disable all setup values relating to locations. Similarly, the only way to get stable planning results for demand at locations is to use SKUs. Therefore, if companies often plan for demand at locations, they are strongly advised to use the Stockkeeping Units granule.

Appendix E: Transfers in Planning

Transfer Orders in Planning

Transfer orders are also a source of supply when working at the SKU level. When using multiple locations (warehouses), the SKU replenishment system can be set to Transfer, implying that the location is replenished by transferring goods from another location. In a situation with more warehouses, companies might have a chain of transfers where supply to GREEN location is transferred from YELLOW, and supply to YELLOW is transferred from RED and so on. In the beginning of the chain, there is a replenishment system of Prod. Order or Purchase.

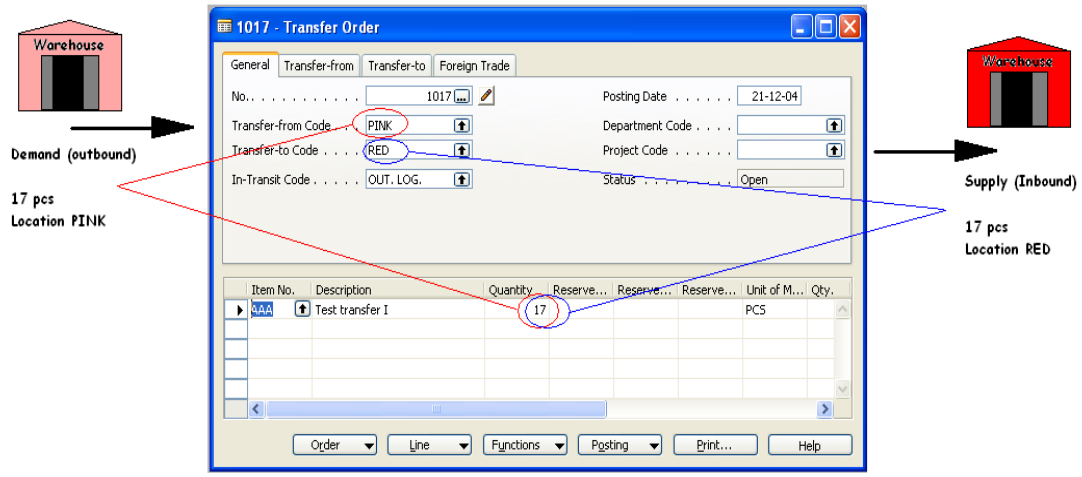


When comparing the situation where a supply order is directly facing a demand order to a situation where the sales order is supplied through a chain of SKU transfers, it is obvious that the planning task in the latter situation can become very complex. If demand changes, it might cause a ripple effect through the chain, because all transfer orders plus the purchase/production order in the opposite end of the chain will have to be manipulated to reestablish balance between demand and supply.

Why is Transfer a Special Case?

A transfer order looks much like any other order in the program. However, behind the scene it is very different.

One fundamental aspect that makes transfers in planning different from purchase and production orders is that a transfer line represents demand and supply at the same time. The outbound part, which is shipped from the old location, is demand. The inbound part, which is to be received at the new location, is supply at that location.



This means that when the system manipulates the supply side of the transfer, it must make a similar change on the demand side.

Transfers are Dependent Demand

The related demand and supply has some resemblance with components of a production order line, but the difference is that components will be on the next planning level and with a different item, whereas the two parts of the transfer is situated on the same level, for the same item.

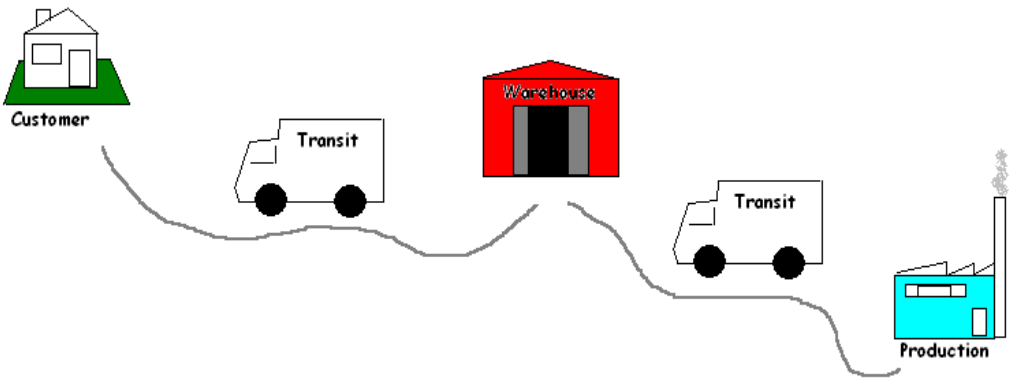
An important similarity is that just as components are dependent demand, so is the transfer demand. The demand from a transfer line is dictated by the supply side of the transfer in the sense that if the supply is changed, the demand is directly affected.

Unless the planning flexibility is None, a transfer line should never be treated as independent demand in planning.

In the planning procedure, the transfer demand should only be taken into account *after* the supply side has been processed by the planning system. Before this, the actual demand is not known. The sequence of the changes made is therefore very important when it comes to transfer orders.

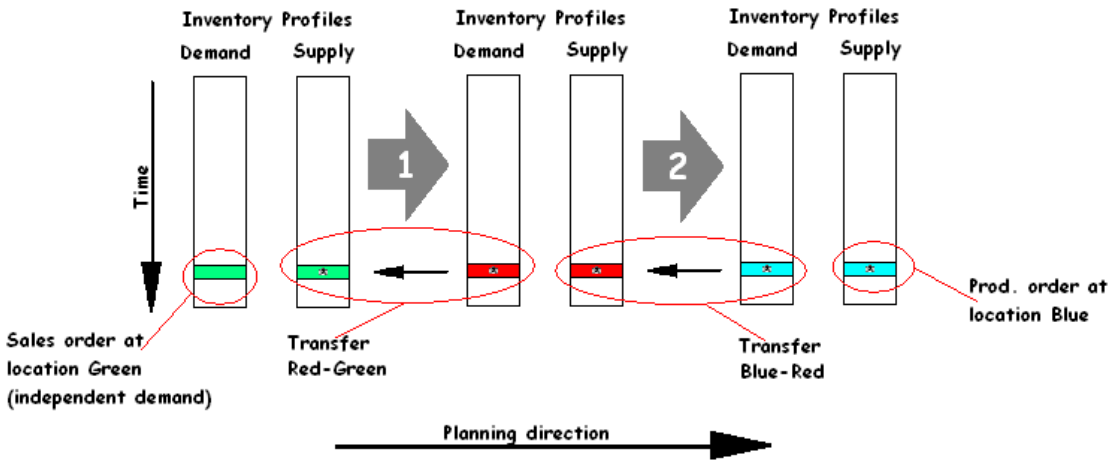
Planning Sequence

The following illustration shows what a string of transfers could look like.



In this example, a customer orders the item at location GREEN. Location GREEN is supplied through transfer from the central warehouse RED. The central warehouse RED is supplied by transfer from production on location BLUE.

In this example, the planning system will start at the customer demand and work its way backwards through the chain. The demands and supplies will be processed one location at a time.

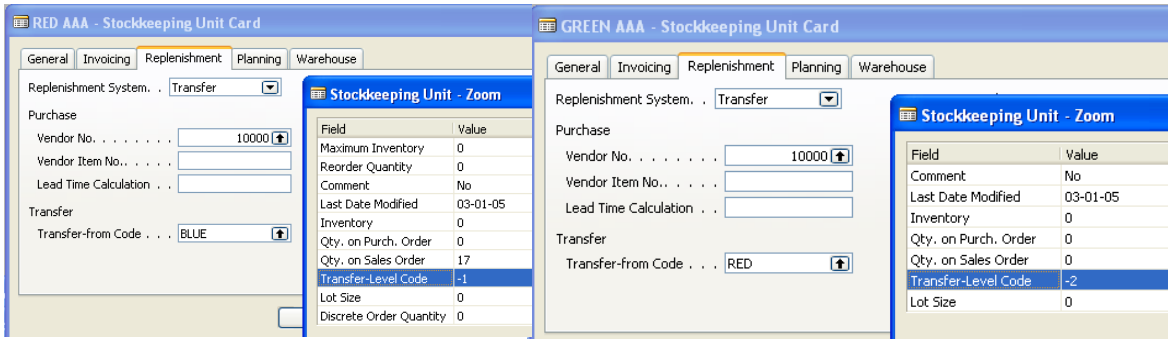


Transfer Level Code

The sequence in which the locations are processed in the planning system is determined by the transfer level code of the SKU.

The transfer level code is an internal field which is automatically calculated and stored on the SKU when SKU is created or modified. The calculation runs across all SKUs for a given combination of Item/Variant and uses the location code and the transfer-from code to determine the route the planning will have to use when traversing through the SKUs to ensure that all demands are processed.

The transfer level code will be 0 for SKUs with replenishment system Purchase or Prod. Order and will be -1 for the first transfer level, -2 for the second and so on. In the transfer chain described above, the levels would therefore be -1 for RED and -2 for GREEN, as shown in the following illustration.

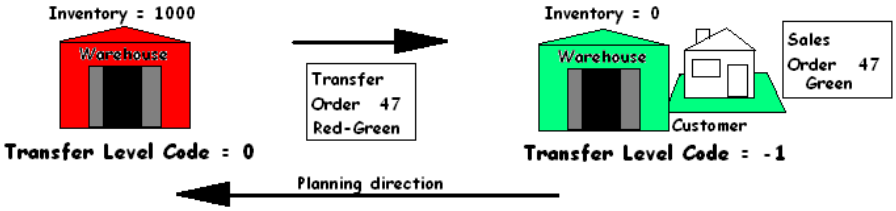


When updating a SKU, the planning system will detect if SKUs with replenishment system Transfer are set up with circular references.

Planning Transfers without SKU

Even if the SKU feature is not used, it is possible to use locations and make manual transfers between locations. For companies with less advanced warehouse setup, the planning system supports scenarios where existing inventory is transferred manually to another location, for example to cover a sales order at that location. At the same time, the planning system should react to changes in the demand.

To support manual transfers, the planning will analyze existing transfer orders and then plan the order in which the locations should be processed. Internally, the planning system will operate with temporary SKUs carrying transfer level codes.



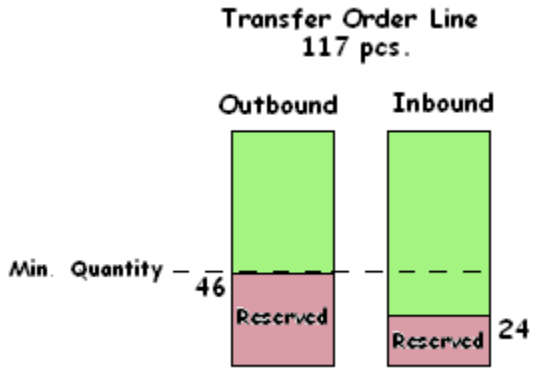
If more transfers to a given location exist, the first transfer order will define the planning direction. Transfers running in the opposite direction will be canceled.

Changing Quantity with Reservations

When changing quantities on existing supply, the planning system takes reservations into account in the sense that the reserved quantity represents the lower limit for how much the supply can be reduced.

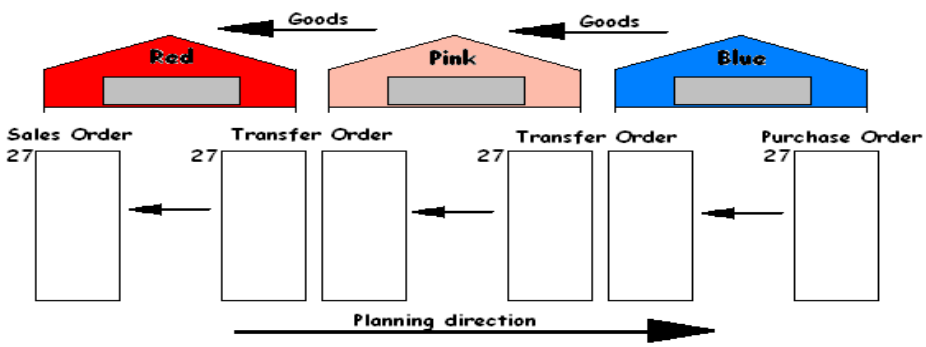
When changing the quantity on an existing transfer order line, keep in mind that the lower limit will be defined as the highest reserved quantity of the outbound and inbound transfer line.

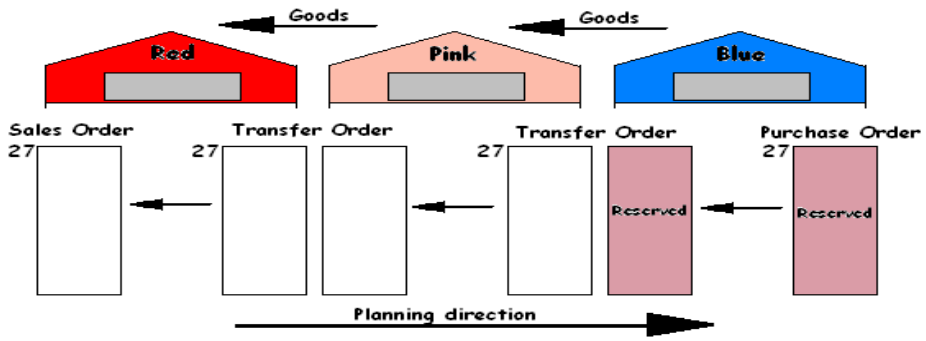
For example, if a transfer order line of 117 pieces is reserved against a sales line of 46 and a purchase line of 24, it is not possible to reduce the transfer line below 46 pieces even though this might represent excess supply on the inbound side.



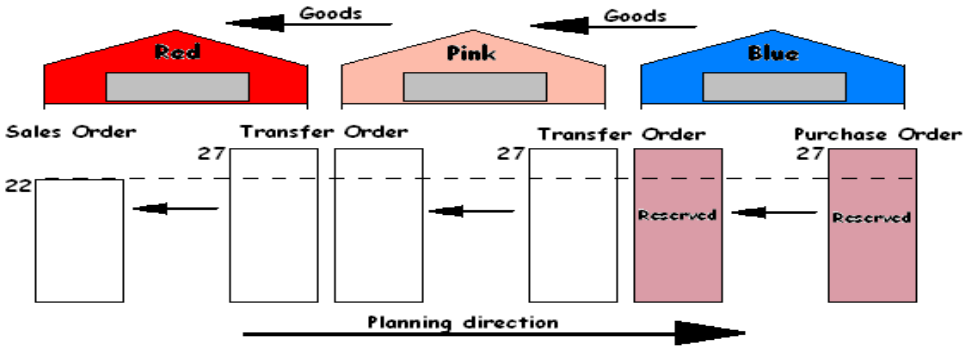
Changing Quantity in a Transfer Chain

In the following example, the starting point is a balanced situation with a transfer chain supplying a sales order of 27 on location RED with a corresponding purchase order on location BLUE, transferred via location PINK. Therefore, apart from sales and purchase, there are two transfer orders: BLUE-PINK and PINK-RED.

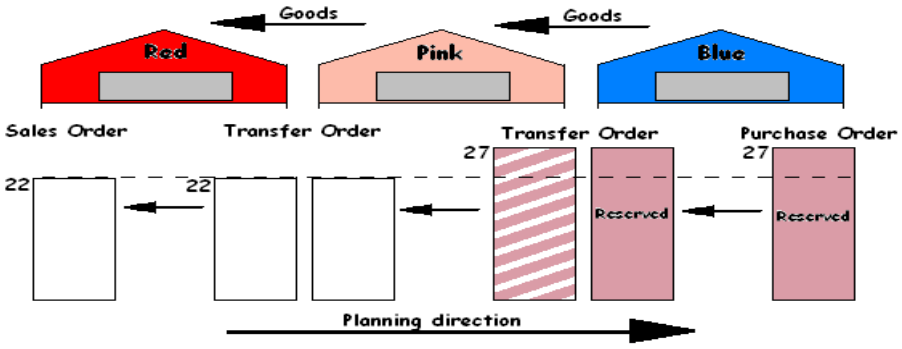




This usually means that the planning system will ignore the purchase order and the transfer demand. As long as there is balance, there is no problem. But what happens when the customer at RED location partly regrets his order and changes it to 22?



When the planning system runs again, it should get rid of excess supply. However, the reservation will lock the purchase and the transfer to a quantity of 27.



The PINK-RED transfer has been reduced to 22. The inbound part of the BLUE-PINK transfer is not reserved, but because the outbound part is reserved it is not possible to reduce the quantity below 27.

Lead Time Calculation

When calculating the due date of a transfer order different kinds of lead time will be taken into account.

The lead times that are active when planning a transfer order are:

- Outbound Warehouse Handling Time
- Shipping Time
- Inbound Warehouse Handling Time

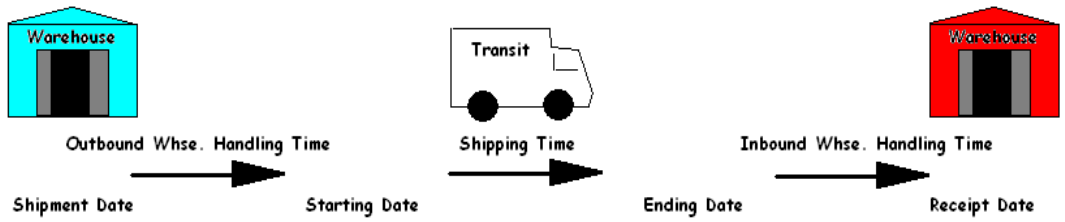
On the planning line, the following fields are used to provide information about the calculation.

- Transfer Shipment Date
- Starting Date
- Ending Date
- Due Date

The shipment date of the transfer line will be shown in the Transfer Shipment Date field, and the receipt date of the transfer line will be shown in the Due Date field.

The starting and ending dates will be used to describe the actual transportation period.

The following illustration shows the interpretation of the starting date-time and ending date-time on planning lines related to transfer orders.

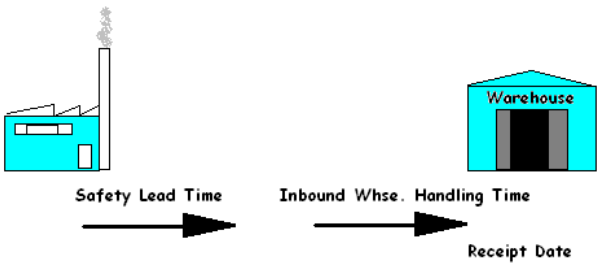


In this example, it means that:

- Shipment date + Outbound handling = Starting Date
- Starting Date + Shipping time = Ending Date
- Ending Date + Inbound Handling = Receipt Date

Safety Lead Time

The Default Safety Lead Time field in the Manufacturing Setup window and the related Safety Lead Time field on the item card will not be taken into account in the calculation of a transfer order. However, the safety lead time will still influence the total plan like it will affect the replenishment order (purchase or production) in the beginning of the transfer chain when the items are put on the location from which they will be transferred.

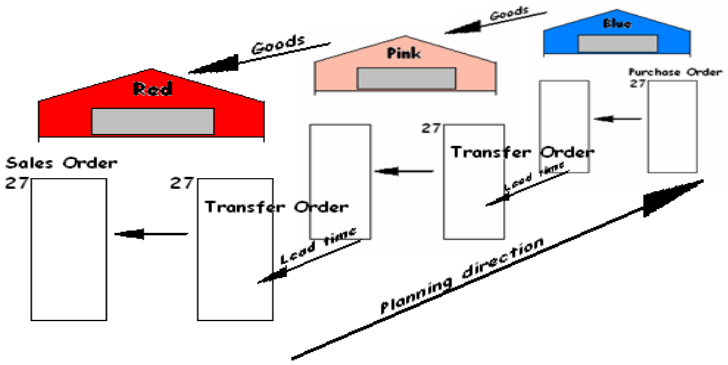


On the production order line, the Ending Date + Safety Lead Time + Inbound Warehouse Handling Time = Due Date.

On the purchase order line, the Planned Receipt Date + Safety Lead Time + Inbound Warehouse Handling Time = Expected Receipt Date.

Reschedule

When rescheduling an existing transfer line, the planning system must look up the outbound part and change the date-time on this. It is important to note that if lead time has been defined, there will be a gap between the shipment and the receipt. As mentioned, the lead time can consist of more elements, such as transportation time and warehouse handling time. On a time line, the planning system will move back in time while it balances the elements.



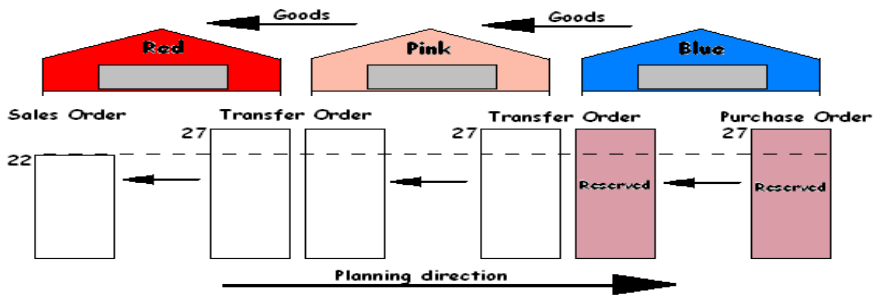
Therefore, when changing the due date on a transfer line, the lead time must be calculated in order to update the outbound side of the transfer.

Serial/Lot Numbers in Transfer Chains

If the demand carries serial/lot numbers, and the planning engine is run, it will give rise to some directly created transfer orders. For more information about this concept, see Item Attributes. If, however, serial/lot numbers are removed from the demand, the created transfer orders in the chain will still carry the serial/lot numbers and will therefore be ignored by planning (not deleted).

Order-to-Order Links

In this example, BLUE SKU is set up with the Order reordering policy, while PINK and RED use Lot-for-Lot. When a sales order of 27 is created on location RED, it will lead to a chain of transfers with the last joint at location BLUE being reserved with binding. In this example, the reservations are not hard reservations created by the planner at PINK location, but bindings created by the planning system. The important difference is that the planning system can change the latter.



If demand is changed from 27 to 22, the system will lower the quantity down through the chain, with the binding reservation also being reduced.

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