Vendor Managed Inventory (VMI)

Version 1.0

Management Summary

Modern Supply Chain Management (SCM) concepts address important root-causes of current limitations in logistics networks. Efficient built-to-order strategies and short time to delivery goals require fast and flexible supply networks.

In this context **inter-company visibility and transparency,** a prerequisite of high-level integration between customer and supplier, plays a central role.
The **Vendor-Managed-Inventory** concept represents one major process type in the family of pull-based systems.

This recommendation, based on ODETTE's Supply Chain Monitoring (SCMo) recommendation, describes the basic business process model and the corresponding functionality, responsibilities and implementation steps for the vendor managed inventory concept.

It sets a standard for the overall VMI concept and the corresponding IT applications. The medium term goal is to enable European-wide, standardised use of VMI applications from different software providers and marketplaces.

VMI basically **checks** continuously if the actual or planned **inventory** levels of the VMI inventory are too high or too low in relation to the **demand** of the next days/weeks. The supplier will get early and clear signals whether to speed up or to slow down production.
This fulfilment methodology will bring a great benefit for both customers and suppliers by reducing non-value adding and administration costs, making supplies more secure and efficient and reducing inventory and transport costs.

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Representative	**Company**
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Dätz, Sabine	Siemens VDO
Fecke, Franz Josef	SupplySolution GmbH
Keller, Johannes	SupplyOn
Kohl, Stefan	SAP AG
Mannchen, Kurt	ICON
Mayer, Stefan	Audi AG
Merle, Oliver	Bosch
Schild, Norbert	Logica CMG
Schinnen, Johannes	Brose
Schweiger, Michael	Audi AG
Tilgner, Jens	Audi AG
Vollmer, Jörg	Bosch

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Abbreviation List

3PL	Third Party Logistics
ADU	Average Planned Daily Usage
ASN	Advanced Shipping Note
BOM	Bill of Material
DELFOR	Delivery schedule message used in EDI
DUNS	Data Universal Numbering System
EAI	Enterprise Application Integration Information Flow
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
EXW	Ex Works
JIS	Just In Sequence
KPI	Key Performance Indicator
Qty	Quantity
SCIP	Supply Chain Interoperability Protocol
SCM	Supply Chain Management
SCMo	Supply Chain Monitoring
SL	Service Level
VDA	German Association of the Automotive Industry
VMI	Vendor Managed Inventory
XML	Extensible Mark-up Language

1. Philosophy of Supply Chain Management

The starting point for Supply Chain Management activities is an in-depth understanding of the current situation in the supply network (e.g. material and information flows). On this basis, consistent and agreed cross-company business processes are established. In general this requires an adaptation / re-engineering of internal business processes by the participants. IT and the Internet play a major role to enable and support SCM concepts.
Core elements of the SCM philosophy are:

- Customer demand drives the whole inter-company supply network (**synchronisation, built-to order**).
- Increased reaction speed and **flexibility** of the supply network.
- Where applicable, **multi-tier concepts** are enabled.
- **Exception** based management (alerting) based on workflows.
- Integrated inter-company processes are needed to collect and share relevant data ➔ **Visibility** and **transparency**
- Information relevant for decision making is updated in an appropriate time period ➔ **quick responses**
- **Scenarios** can be simulated due to the global availability of information.
- Enable **win-win** partnership.
- Find **root causes** rather than cure the symptoms.

2. Introduction to VMI

2.1 Definition and Process Description

Vendor Managed Inventory (VMI) is a concept and process for consumption-based Supply Chain Management. It requires the supplier to maintain inventories within predefined and mutually agreed thresholds based on a min / max-range. The supplier can freely deliver within this indicated range.

The basic requirement for a successful VMI process is a good partnership and cross-company information sharing and transparency close to real-time. Therefore communication and visualisation of the min / max-range, the inventories and the gross demands of the customer is elementary.

2.2 Basic Principles and Information Flows

VMI is based and controlled using the following information:

- Customer's actual gross demands = planned consumption (BOM explosion of the production plan without further parameters)
- Actual customer inventory and daily consumption
- Actual in-transit inventory
- Actual supplier finished product inventory (optional)
- Agreed minimum and maximum stock levels (fixed quantities or dynamic expression as days of stock)

Based on these principles and information flows the functional process is as shown in the schematic below.

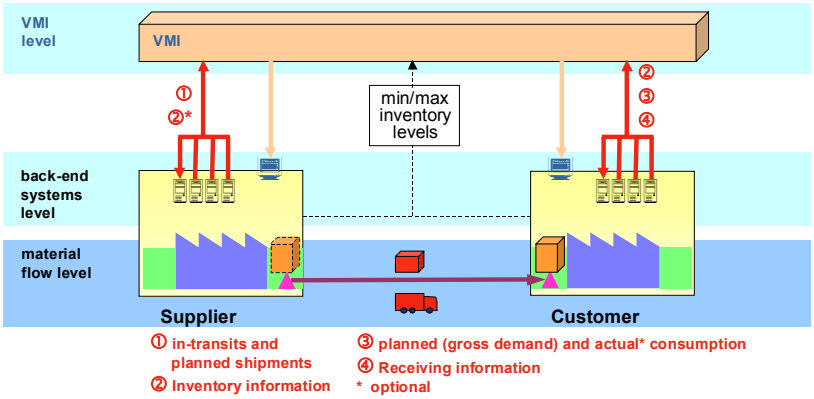


Figure 1: Basic Principles and Information Flows

2.3 Scope of VMI and delimitations

VMI is a fulfilment methodology that can be realised with a customer or supplier-owned stock (consignment) and also with an external, e.g. 3PL, owned stock. It is also independent of the terms and conditions of transport.

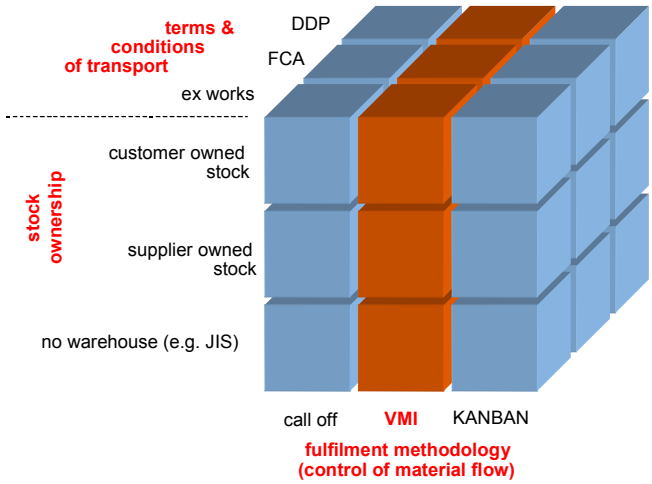


Figure 2: Concept Cube

Definitions:

- **Stock Ownership/ supplier owned stock**

The VMI consignment stock concept comprises the following features:

- the supplier is the owner of material in a warehouse which is normally close to, or even within, the customer plant
- the customer can use stock without prior notification
- the transfer of ownership is effected after withdrawal of material by the customer
- this VMI concept is in common use, but consignment isn't automatically VMI.

- **Fulfillment Methodology**

VMI is a fulfilment methodology. Other well-known fulfilment methodologies are:

- Call-Off
  - customer determines fixed quantity and times (day) for deliveries (push)
- Just In Sequence (JIS)
  - customer determines fixed quantity and time (hour) and sequence of part numbers for deliveries (push)

- KANBAN Concept
  - Replenishment signal after every consumption (pull)
  - delivery quantities and times are predefined based on consumed quantity (supplier reacts)
  - Forecast / planned consumption is not taken into account

2.4 Goals and Benefits

The general goals and the expected benefits of the VMI process are reduced non value-added activities and administration, a more secure and efficient supply, lower inventory and transport costs.

- **Reduced non value-added activities and administration**
  - Reduce significant effort / cost for the supplier in following volatile demand (ad hoc rescheduling, trouble shooting, extra freight, overtime / idle time, etc.)
  - Reduced manual effort and responsibility for the customer (automated provision of updated planned consumption (gross demands) and inventory information)
  - Reduced effort of handling and administration for both the customer and supplier
  - Supplier has the opportunity to optimize production scheduling (lot sizes)
- **More secure and efficient Supply**
  - Supplier is responsible for guaranteeing customer supply / replenishment
  - Early warnings enable tracking and controlling of the whole process
  - Minimized ad hoc activities and related effort / cost
  - Robust with regard to interference
  - Prevention of stock-out and over-supply situations / smooth and secure supply with minimal inventory
  - Increased transparency, flexibility and synchronisation of the 1:1 relationship
- **Reduced Inventory and Transport Costs**
  - Improved inventory levels in the selected part of the supply network
  - Reduction of the total inventory (safety stock…) in the supply chain
  - Reduction of transport and freight costs by optimization of transport frequency and lot sizes, and transport planning

2.5 Further Considerations

- Multi-Sourcing: VMI is not limited to single-sourcing. Prerequisites for using multi-sourcing are:
  - separation of supplier-specific inventory information (goods-in and real consumption)
  - separation of planned consumption per supplier (quotas)

  Advice: A process to ensure the reconciliation between real and planned consumption according to the quotas should be in place in the ERP system
- The main focus is on direct material for series production, however other products may also be controlled by VMI
- The predictability, reliability and relative stability of the demands is important (VMI does not resolve allocation problems or very volatile demands)
- All data has to be up-to-date and correct, and sent on a regular basis, e.g. daily
- Flexibility agreements should be committed
- Bilateral agreements regarding transport are essential (frequency, minimum lot sizes…)
- VMI and Pick-Up (e.g. VDA 5004 Recommendation) by customer are not complimentary processes

2.6 Tracking / Alerting / Early Warning

Based on all the information flows described above an alert system is necessary to provide early warning of issues requiring corrective action. The alert processes are described and explained in Chapter 4.5.

3. Business Process Description

The complete documentation for the business process description is available on the Odette homepage or on CD-ROM. The documents provide easy navigation, explain the process dependencies and describe the business sub-processes in detail. They are grouped into 3 level-1 processes:

The **Initialisation Processes** describe how to set-up the complete concept. This recommendation does not include statements regarding user registration, firewall-settings, training, business model / fee structure, integration test, release test, etc. These topics are not VMI specific and should be treated either according to company internal procedures or by specialised standardisation bodies.

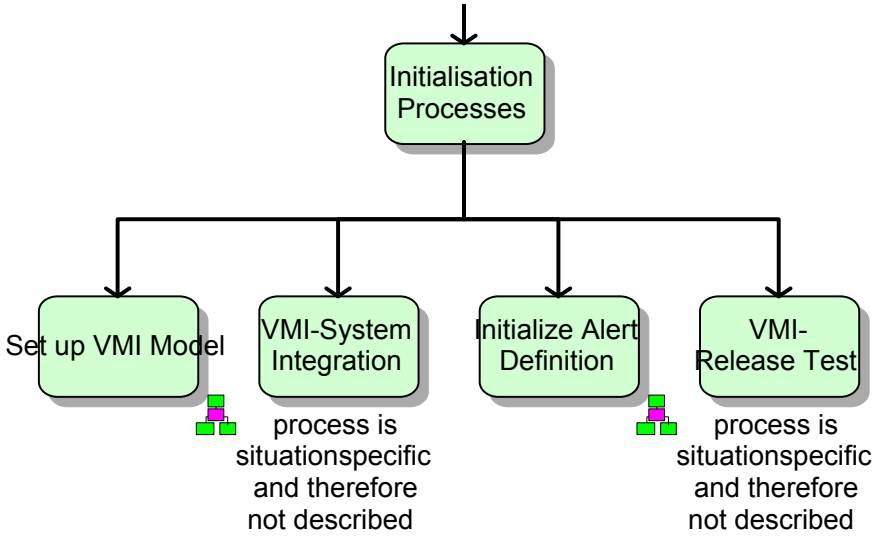


Figure 3: The Initialisation Process

The **Service Processes** describe the change of master data and parameters, change of alert parameters, measurement tracking and reporting.

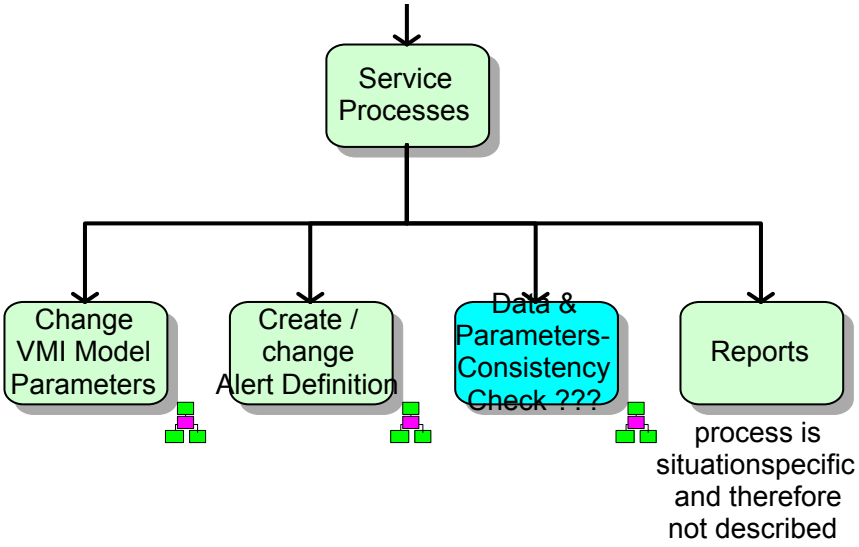


Figure 4: The Service Process

The **Operative Processes** describe the demand update, inventory update, alert calculation and alert management. The basic concept is detailed in this section.

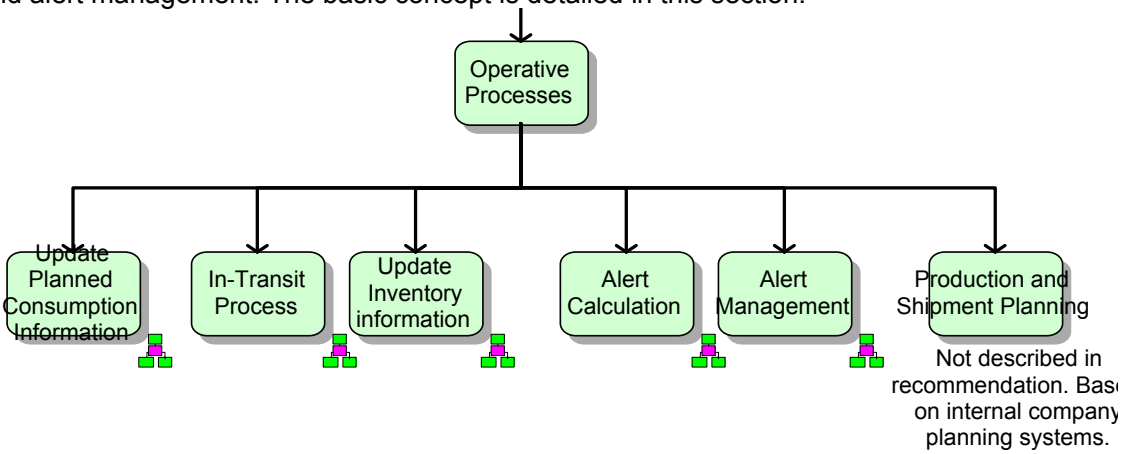


Figure 5: The Operative Process

3.1 Operative process

The following schematic shows the operative process of the ARIS model shown previously in a compact way as a process circle with the different functions, the necessary and resultant data, the responsibilities and the interaction with the VMI level (IT-application).

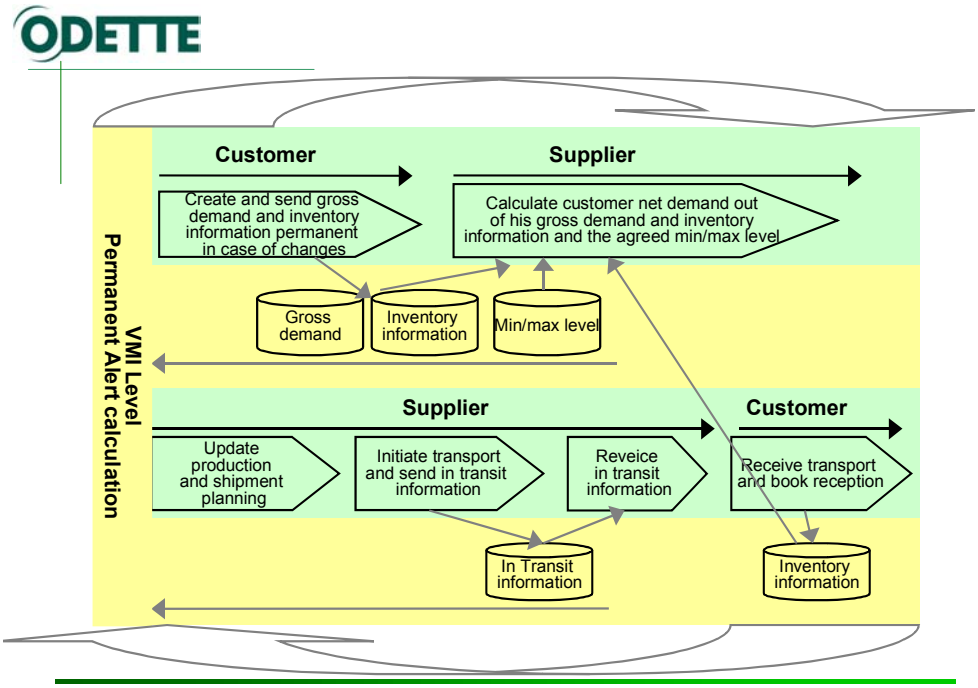


Figure 6: Overview operative process

3.2 Business Cases

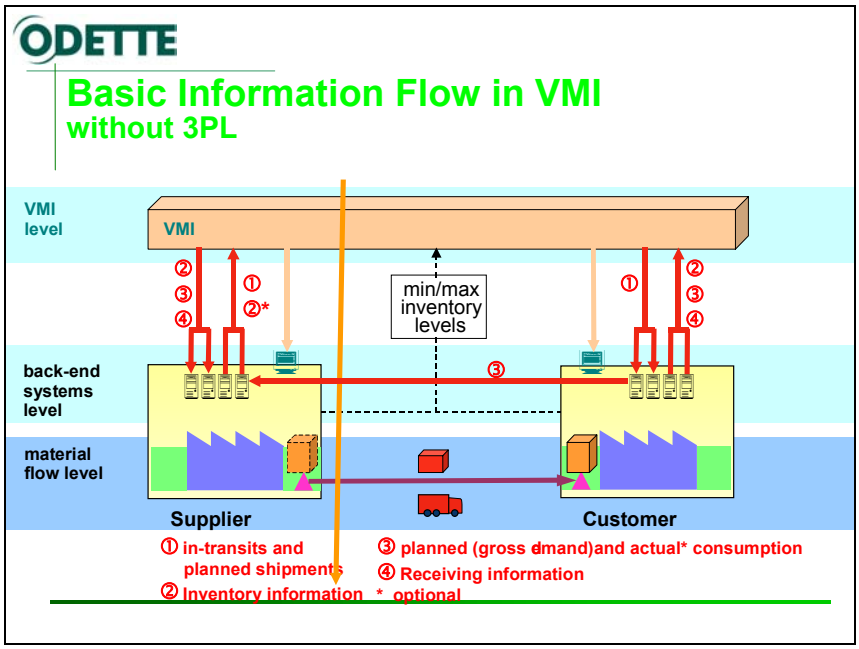


Figure 7: Basic Information Flow without 3PL

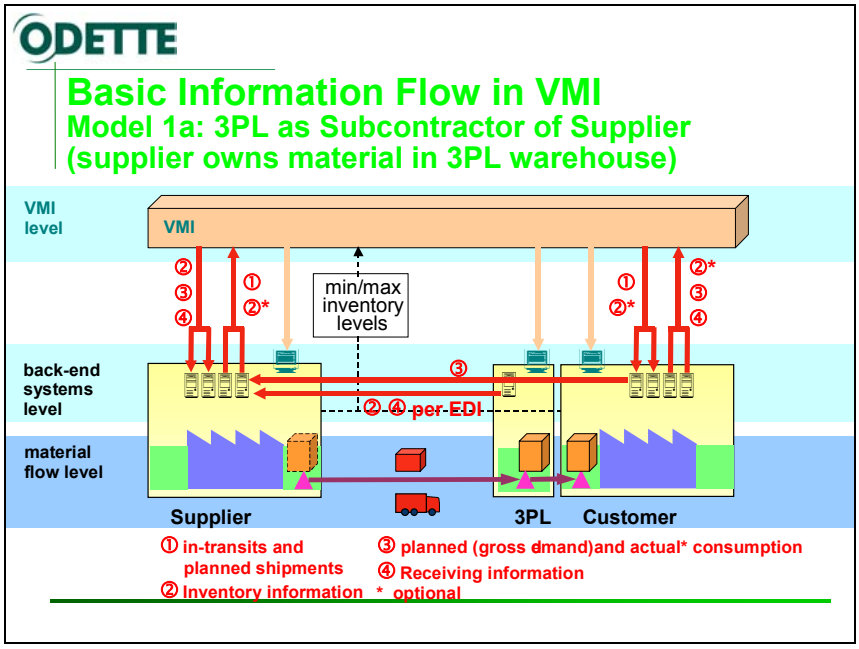


Figure 8: Basic Information Flow - Model 1a

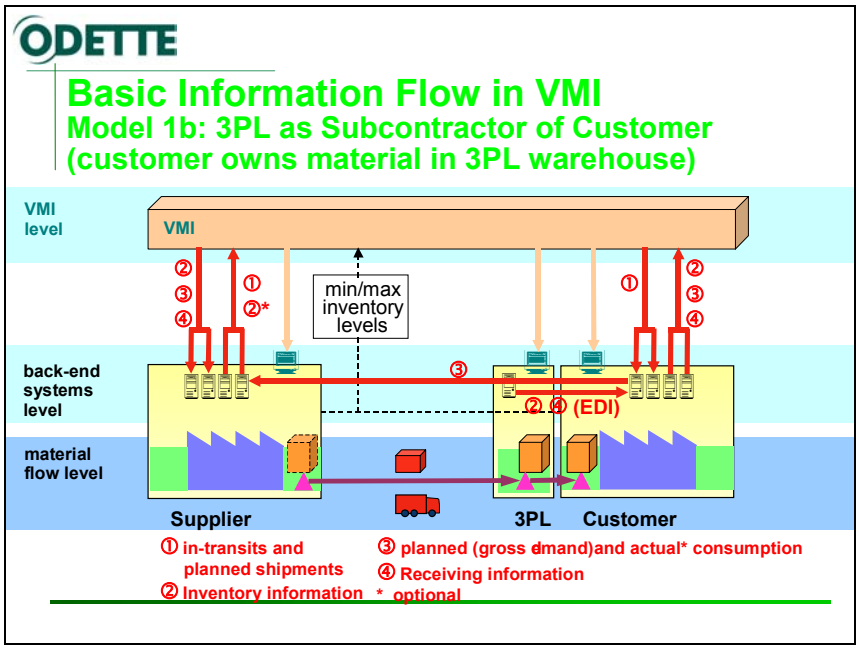


Figure 9: Basic Information Flow - Model 1b

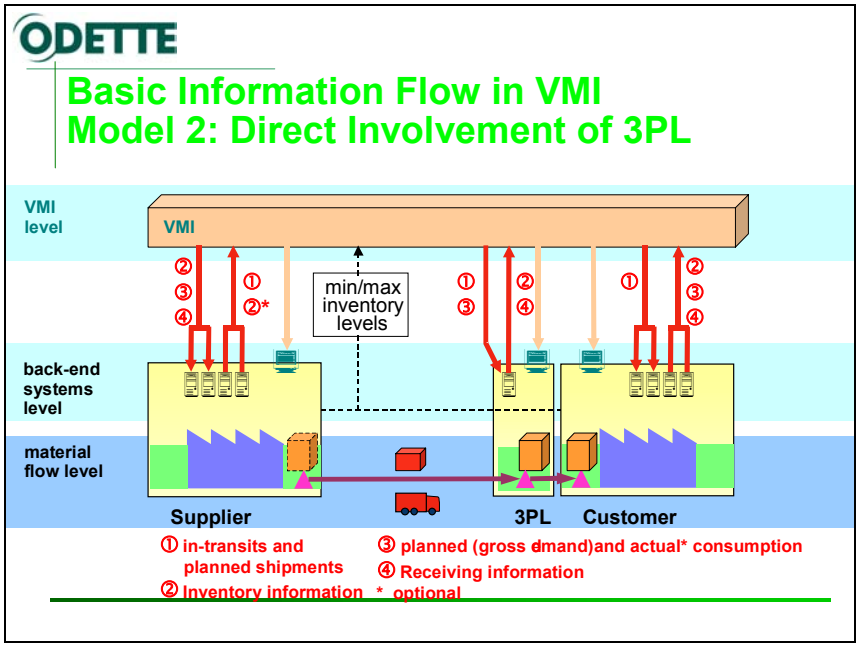


Figure 10: Basic Information Flow - Model 2

4. Functionality

4.1 Basic Functions

4.1.1 Visibility and Consistency of Information

Customer inventory information has to be sent a minimum of once a day in order to show up-to-date inventory levels. Planned consumption has to be updated on a timely basis and needs to be synchronised with Customer inventory levels.

Customer inventory figures and receipts need to be synchronised and have to be updated several times per day (e.g. hourly).

Material in transit (ASN) has to be synchronised with receipts at the Customer. ASN information and supplier inventories need to be synchronised (only if supplier inventory is used) and have to be updated several times per day (e.g. hourly).

4.1.2 Matching Delivery Notes

Matching delivery notes / ASN with goods received

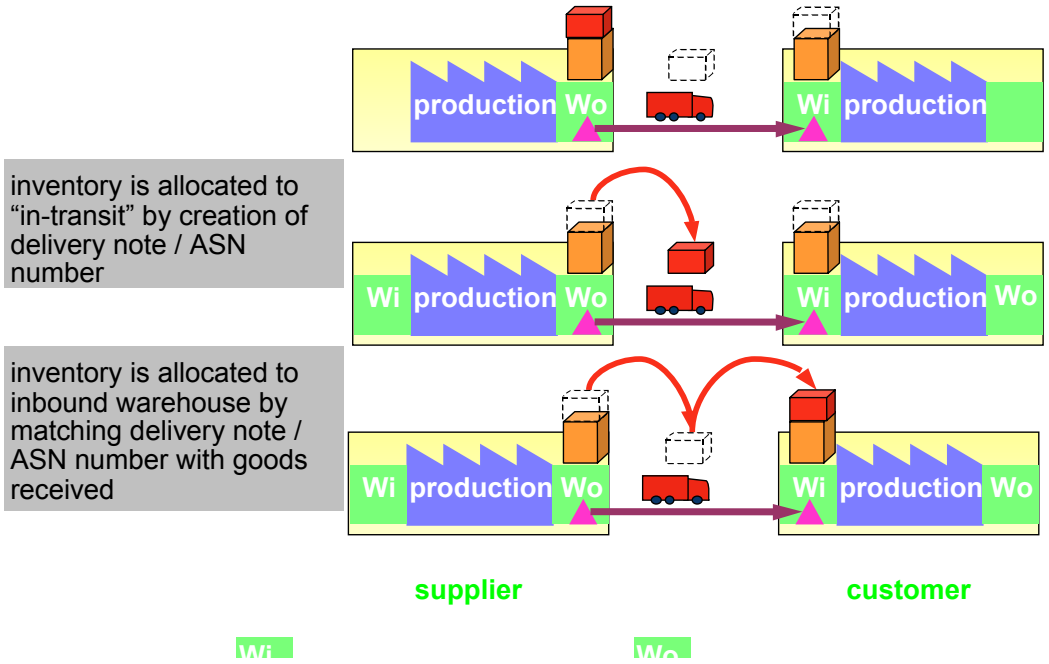


Figure 11: Matching delivery notes / ASN with goods received

4.1.3 Definition of Inventory

- actual inventory:
  - actual stock in the VMI warehouse (customer inbound warehouse, 3PL warehouse close to the customer site)
  - inventory between inbound VMI warehouse and the status change to finished product on the customer's side; especially useful for Ship to Line (optional)
  - Supplier inventory of finished products at supplier dispatch (optional)

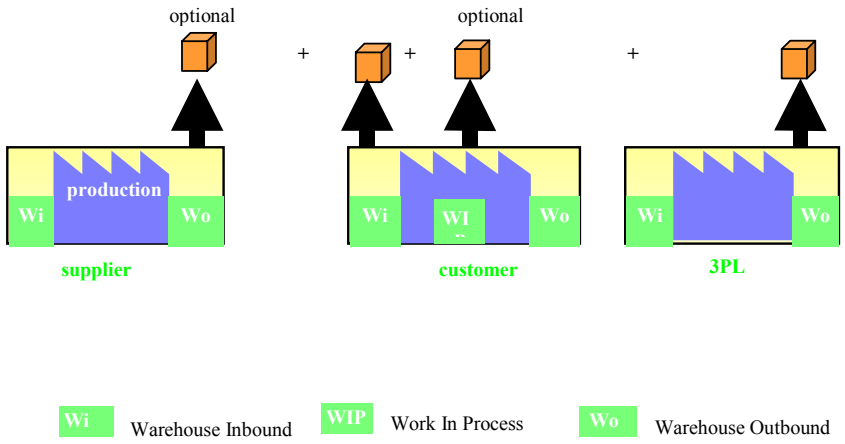


Figure 12: Definition of inventory

Blocked stocks (long-term quality problem) are not included in VMI stocks, but should be communicated to the supplier.

4.1.4 Definition of Daily Consumption Information

Daily Consumption information is optional. However, the Customer and Supplier will benefit from the capability to check the actual consumption against the planned consumption.

Calculation of consumption of previous day:

+ opening stock (previous day at 00:00 a.m.)
+ stock receipts (total during day)
- ending stock (previous day at 12:00 p.m.)
= consumption (daily)

Comment:

Daily Consumption should not be used directly for invoicing / self billing processes as inventory adjustments due to damages or scrap, for example, are not considered.

4.2 Customer Functions

4.2.1 General rules

- The customer notifies the supplier of the planned consumption. The supplier has to ensure an adequate supply of goods based on the inventory level settings;
- Customer and Supplier mutually specify an appropriate minimum range of coverage.
- The minimum level depends on the following factors:
  - Planned consumption
  - Production lead time
  - Transport lead time
  - Container and/or Minimum delivery Quantity (lot size)

- Maximum level settings will be agreed in order to limit the value or space related to the goods in inventory
- The Customer may notify a suggested delivery quantity, which will help the Supplier to automate the shipping process. The suggested delivery quantity is the difference between the Maximum Inventory Level and the total sum of Stock at the Customer and in Transit taking into account the Container or Minimum Delivery Quantity (lot size)
- When the supplier exceeds the Maximum Level Setting, the customer is allowed to return the goods, or to charge the supplier's account.
- Suppliers must be given instructions whether to respond to every alert or only critical alerts and on the time fence for responding to alerts.

When goods are on an EXW basis, the Customer will define:

- Day and Time when the Truck regularly leaves the Supplier's plant (EXW or similar Inco-Terms)
- Transport Lead Time from Supplier to Customer (EXW or similar Inco-Terms)

4.2.2 Min / Max Level Considerations

Min / Max - level calculation:
Minimum and Maximum Inventory levels have to be agreed mutually by the Customer and the Supplier (handshake).
The following processes should be reviewed by the customer before introducing a Min / Max system:

- Forecast data accuracy
- Level of inventory accuracy
- Container / Lot / Minimum Delivery Quantity
- Inventory Data Update Frequency

A number of approaches may be used to determine the size of Minimum and Maximum Inventory levels. The levels may be set manually or automatically by a download from an ERP system and measurement may be in Units or Days On-Hand.

It is recommended that these levels remain static for an appropriate period and to review them on a periodic basis (monthly).

Example:

Average Planned Daily Usage (ADU) =	(Forecast total/(actual number of weeks with > zero planned usage))/5
Min Calculation =	Days of Safety Stock * ADU
Max Calculation =	Min + (5/Weekly ship freq.*ADU) + (Transit days * ADU)
Min Calculation = (with Container Qty)	Above Min Calculation rounded up to the nearest Container Qty
Max Calculation = (with Container Qty)	Above Max Calculation rounded up to the nearest Container Qty

It is recommended to review the influence of lot size in relation to warehouse capacity in order to determine the maximum level.

4.2.3 Planned Consumption

Within the VMI process the Customer provides Planned Consumption information on a daily and weekly basis (to be agreed by customer and supplier), also known as Gross Demand.
The Planned Consumption does not include material on-hand at the Customer or material in transit. The schedule states the actual date and time of planned consumption, either for production or for shipment purposes.

Planned Consumption does not control the shipment from the Supplier to the Customer. The actual or projected Minimum and Maximum Inventory levels alone control these shipments.

Planned Consumption, which has not been used by the defined date / time (e.g. because of production rescheduling, tool breakdown, etc.) has to be visualised / communicated to the supplier using one of the following concepts:

- Preferred process:
  A new Planned Consumption will be communicated (assuming a daily MRP run in the customer ERP system will be undertaken before synchronizing the planned consumption and stock movements to the supplier)
- Work-around process:
  Planned Consumption with past dates has also to be visualised in the VMI level (assuming no daily MRP run in the customer ERP system will be undertaken)

4.3 Supplier Functions

4.3.1 General Rules

Shipping to the Customer

- The supplier's responsibility is to keep the Customer's inventory levels between the Minimum and Maximum inventory levels, within the limits of responsibility of the Forecast, i.e. projected inventory levels.
- The supplier is only permitted to ship parts to the Customer that will maintain the inventory below the maximum level and must assure on-time shipment that guarantees the inventory will not fall below the minimum.
- If the inventory level drops below minimum, there will be an alert. The supplier must respond to this immediately, in accordance with the planned consumption of the Customer.
- Shipping frequency and shipping windows may remain as previously agreed with the Customer before the introduction of VMI. The supplier should continue to ship on the same days and times, for example Tuesdays and Thursdays at 12:00h. The main difference between the outgoing "push" method of shipping and the VMI approach is that the supplier should now plan the shipment based on the actual and projected Min / Max stock at the warehouse.

Special Transports (Expedited Freight)

- The responsibility for special transport caused by quality issues, engineering change, deviation from routing instructions, etc. remain the same as prior to VMI.
  - The Customer will accept responsibility for the cost of expedited freight under the following conditions (for disputes, the forecast information should be used, not the average daily usage):
  - Customer has a negative inventory adjustment (loss) for an item that is greater than X% of that week's forecast
  - Usage is over X% greater than the forecast for that period
  - Customer schedules unplanned overtime generating an increase in planned consumption greater than X% of that week's forecast.

4.3.2 Implication regarding production and transportation planning

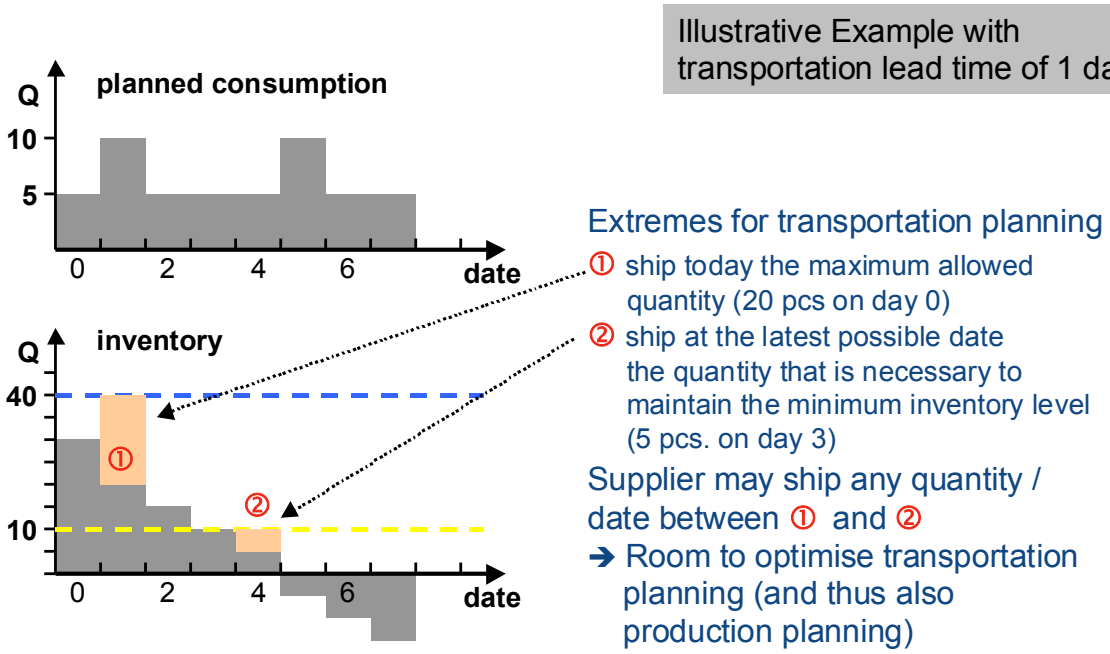


Figure 13: Example with transportation lead time of 1 day

4.4 Engineering Changes

4.4.1 Process and Method of Change Management

Change Management and Impact on VMI

The Change Management process can be undertaken in two ways. The first approach is to continue to request shipment of the old product up to a given date and then switch the shipping request to the new product; this is called “fixed input into production”. The alternative approach is to continue to supply and use the old product until they are all consumed and then switch demand to the new product; this is known as “flow into production”.

The diagram below shows the effect of each approach on the VMI inventory profile.

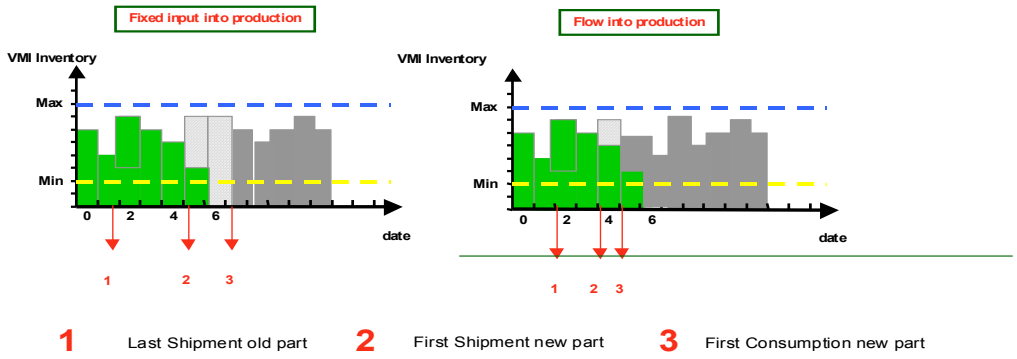


Figure 14: Change management and impact on VMI

At a parts level, Change Management can be achieved by either issuing a new part number for the incoming part or by a revision of the issue level of the existing part number.

The visualisation of Change Management-specific information, such as the match of old/new part number, the part number and revision level and controlled inventory maintenance, are key requirements for a successful VMI process.

Recommendation

- Optional management of the changed / new part numbers within the VMI process.
- Bilateral agreement between the customer and supplier regarding the use of changed or new parts within the VMI process.
- Changed or new parts should be specifically visualized.
- Management of Engineering change is not the main focus of VMI

4.5 Alert Definition and Management

4.5.1 Standard alerts

- Inventory below the Min-Level / above the Max-Level
- Significant change of planned consumption (e.g. deviation exceeds agreed flexibility)
- No data update for more than 1 day
- Overdue arrival (e.g. no matching of delivery notes / ASN with goods received within the agreed time frame)
- Engineering change notification (optional)

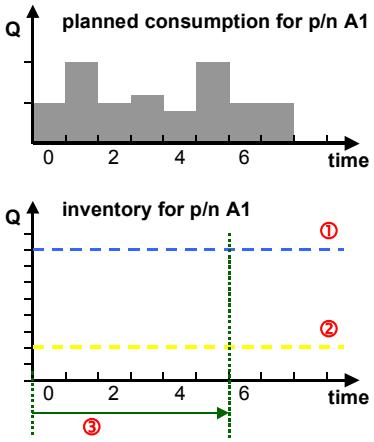
4.5.2 Alert definition and calculation

4.5.2.1 Inventory below Min / above Max-Level

Calculation

- Stock in-transit
- Planned shipments (optional)
- Agreed min / max thresholds:
  - agreed time window where future inventory must be within min / max bandwidth
  - mathematical calculation based on several parameters (example in 4.2.2)
  - absolute number, e.g. units or
  - dynamic expression, e.g. days of inventory

Alert Example

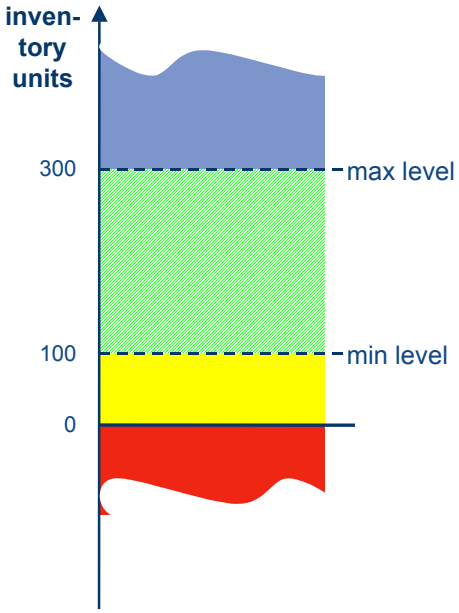


Illustrative Example
- 1 Part number(p/n)
- transportation lead time : 1 day
- Min. Level: 10 quantity units
- Max. Level: 40 quantity units
- time window: 5 time units

Parameters for Alert Definition
① **maximum** inventory level
② **minimum** inventory level
③ agreed **time window** where actual and planned inventory needs to be between min and max

Figure 15: Alert Example

Basic Alert Definition



blue = **inefficient** situation;
generation of too high cost;
action for optimisation recom-
mended

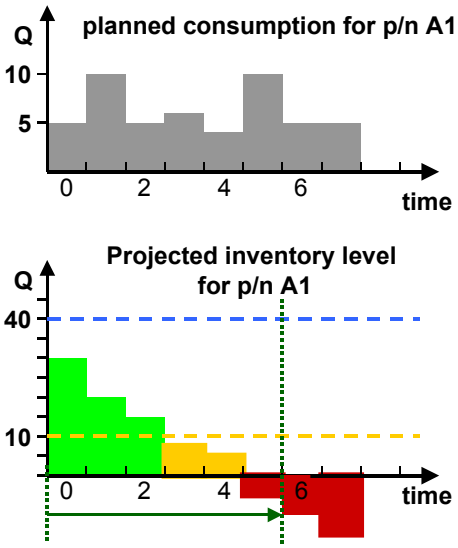
green = **safe** situation;
no action necessary

yellow = **tense** situation;
to avoid critical situation immediate
action & close follow-up necessary;
agreed flexibility is limited

red = **stock out** situation; immediate
trouble shooting action necessary

Figure 16: Basic alert definition

Alert Calculation for projected inventory based on stock-on-hand



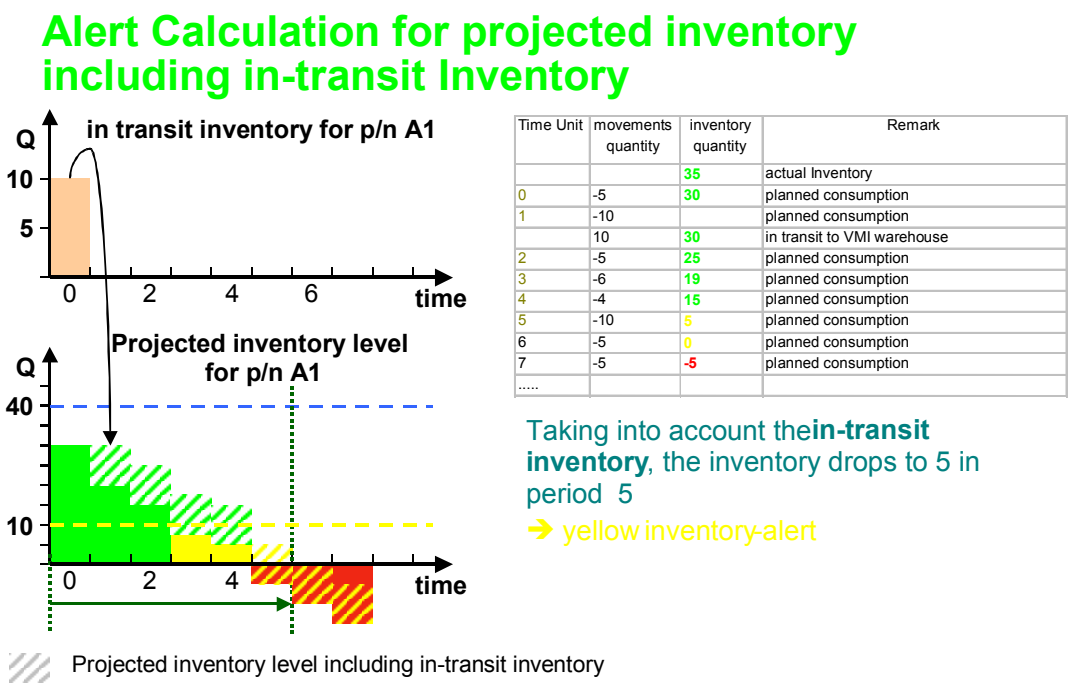
Time Unit	movements quantity	inventory quantity	Remark
		35	actual Iventory
0	-5	30	planned consumption
1	-10	20	planned consumption
2	-5	15	planned consumption
3	-6	9	planned consumption
4	-4	5	planned consumption
5	-10	-5	planned consumption
6	-5	-10	planned consumption
7	-5	-15	planned consumption
.....			

With the actual inventory and the planned consumption the “projected inventory” development can be calculated.

As in-transit inventories and planned shipments are **not** taken into account,

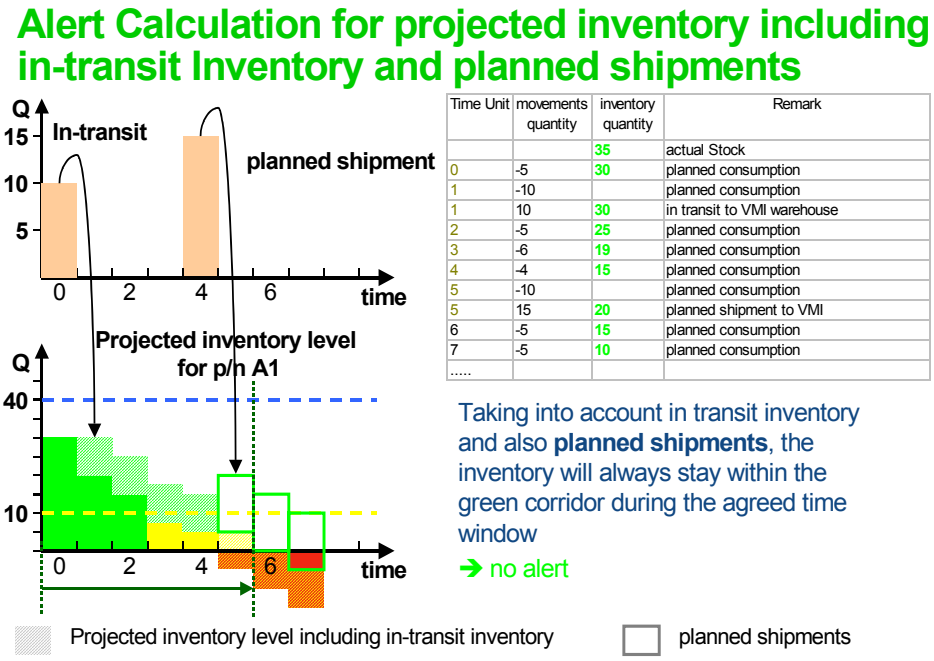
- the projected inventory drops below MIN in period 3 ➔ yellow inventory alert
- the inventory drops below 0 (stock-out) in period 5 ➔ red inventory alert

Figure 17: Alert calculation for projected inventory based on stock-on-hand



Time Unit	movements quantity	inventory quantity	Remark
		35	actual Inventory
0	-5	30	planned consumption
1	-10		planned consumption
	10	30	in transit to VMI warehouse
2	-5	25	planned consumption
3	-6	19	planned consumption
4	-4	15	planned consumption
5	-10	5	planned consumption
6	-5	0	planned consumption
7	-5	-5	planned consumption
.....			

Figure 18: Alert calculation for projected inventory including in-transit inventory



Time Unit	movements quantity	inventory quantity	Remark
		35	actual Stock
0	-5	30	planned consumption
1	-10		planned consumption
1	10	30	in transit to VMI warehouse
2	-5	25	planned consumption
3	-6	19	planned consumption
4	-4	15	planned consumption
5	-10		planned consumption
5	15	20	planned shipment to VMI
6	-5	15	planned consumption
7	-5	10	planned consumption
.....			

Figure 19: Alert calculation for projected inventory - in-transit and planned shipments

4.5.2.2 Significant change of planned consumption

An alert may occur when the customer communicates a significant change of planned consumption. The basis for activating the alert is mutually agreed flexibility margins.
There are two basic alternatives to alert significant changes of planned consumption.

Alternative 1: 1 defined margin

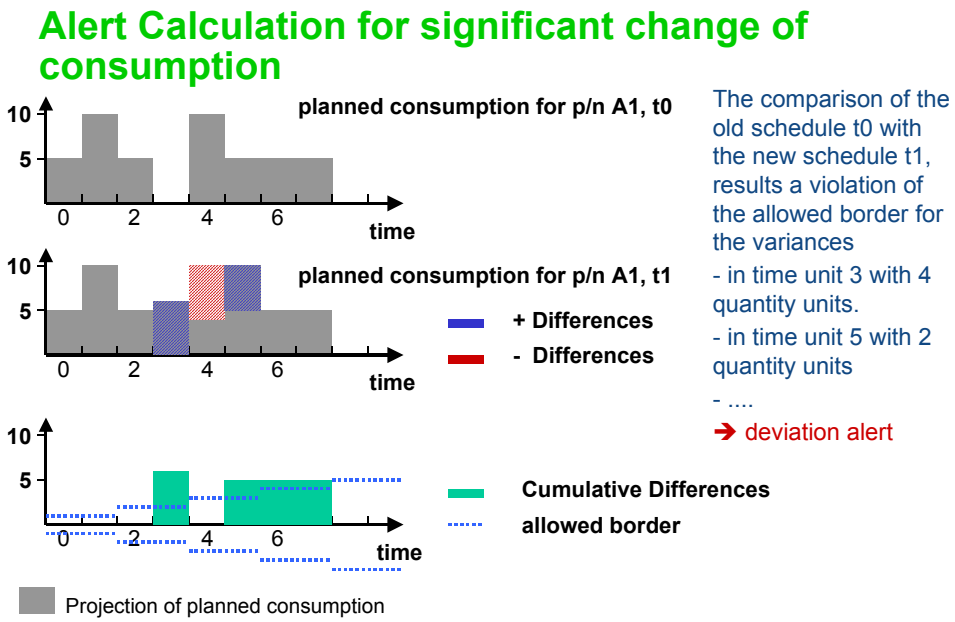


Figure 20: Alert calculation for significant change of consumption - alternative 1

Alternative 2: 2 defined margins

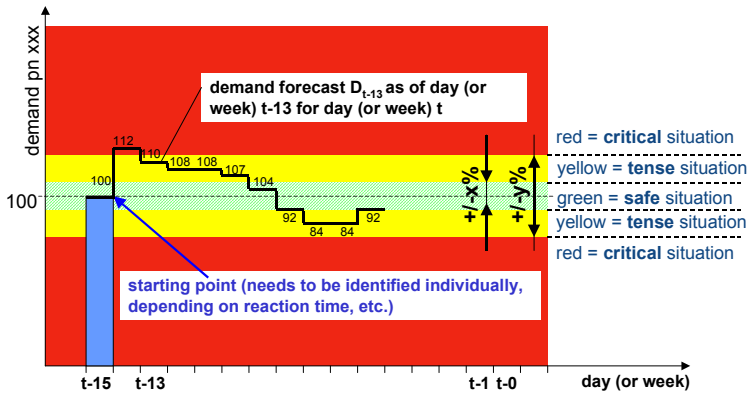


Figure 21: Alert calculation for significant change of consumption - alternative 2

4.5.2.3 No data update for more than 1 day

- Based on the defined synchronisation between inventory and consumption information the alert gives a warning to the supplier that due to missing transmissions data integrity is not assured

4.5.2.4 Overdue arrival

- Realistic in-transit times are agreed for supplier deliveries. An alert is given when the due date of receiving has expired.
- The alert gives the customer and the supplier a warning that the planned transit time is overdue and hence the possibility of a stock implication or stock-out occurrence
- Possible explanations can be that the receiving and the ASN are not correctly booked and matched or the ASN has not been transmitted correctly.
- Both customer and supplier have to agree over what period of time an overdue arrival of in-transit inventory will be included in the inventory calculation.

4.5.2.5 Engineering change notification

- Please refer to chapter 4.4

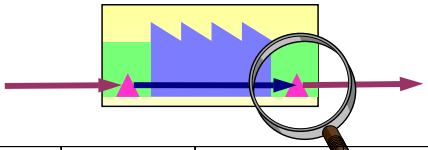
4.5.2.6 Measuring point of alerts

- Close to the synchronisation time of planned consumption, inventory levels and goods receiving

4.5.3 Alert Management, Communication and Workflows

- VMI supports the principle of **exception-based management**. Hence, the system needs to recognise whether a situation (e.g. demand / inventory) is "normal" or "exceptional". Therefore **thresholds** need to be defined (e.g. minimum and maximum days of inventory).

Alerts inform the persons responsible for corrective action about those exceptional situations, which are visualised in the alert board / action item board of the VMI application (see picture below).



colour	alert type	control point	part number	action item
●	low inventory	outbound warehouse	123 456 701	A 17
●	low inventory	outbound warehouse	123 456 702	A 17
●	low inventory	outbound warehouse	123 456 703	A 13
●	high inventory	outbound warehouse	123 456 706	

action item	step	Who	Action	When	Status	Follow-up
A 17	1	John	Call maintenance	10:00	Done	-
	2	Maint	Inform Repair	16:00	In progres	15:00

Figure 22: Alert Generation, Alert Board and Action Item Board

Filtering, sorting and grouping of alerts assist the end user to prioritise and manage corrective action. The filtering and sorting criteria may include priority, alert type, alert colour or user. Grouping criteria could involve finding a common root cause for several alerts (e.g. machine breakdown affecting several part numbers). Action items can consist of several steps that can be assigned to different persons for resolution.

In addition, **alert notifications** (e.g. emails) need to be generated and distributed to predefined user group(s). The *Alert Definition Board* records who is to be informed and when for each alert type and location. The Board also records the agreed reaction time for resolution and how the issue is to be escalated in the event of a failure.

Organisational Unit: Stamp & Die Inc., Plant xyz
Central Administrator: Mr. Black

alert type	control point	part number / family	alert colour	alert threshold	alert owner name	Maximal reaction time (mrt)	...
inventory on hand	inbound warehouse. 3	137 387 $$$	● red	1,5 DOS	Mr. Miller	2 hours	...
			● yellow	2,5 DOS	Mr. Miller	6 hours	...
			● blue	10,0 DOS	Mr. Miller	24 hours	...
inventory on hand	outbound warehouse B	076 587 6$$	● red ● yellow ● blue	...	...	...	...
no inven-tory update	inbound warehouse 3	137 387 $$$	● red	1,5 days			
no inven-tory update	outbound warehouse B	076 587 6$$	● red	1,5 days			
...	...	...	...	...			

if the alert owner does not react within the specified time limit, the next person according to escalation scenario will be notified (e.g. via email)

DOS = days of stock, $ = wildcard

Figure 23: Example for Alert Definition Board (Part 1)

Organisational Unit: Stamp & Die Inc., Plant xyz
Central Administrator: Mr. Black

part number / family	alert colour	...	escalation step 1 name	mrt	escalation step 2 name	mrt	additional alert sub-scription	information time lag (itl)
137 387 $$$	● red	...	Mr. Blue	4 h	Mrs Jones	6 h	g.bush@usa_corp.com a.hill@down_ltd.com	6 h 12 h
	● yellow	...		12 h		24 h	g.bush@usa_corp.com a.hill@down_ltd.com	12 h 24 h
	● blue	...		48 h		60 h	-	-
076 587 6$$	● red ● yellow ● blue	...	...	...				
137 387 $$$	● red	...	...	...				
076 587 6$$	● red	...	...	...				
...	...	...	...	...	...	...	...	...

additional persons in- and outside the organisational might be interested to be informed about exceptional situations ⇨subscription

in general, subscribers are not interested in alerts that can be solved quickly (=within the itl)

$ = wildcard, mrt = maximal reaction time

Figure 24: Example for Alert Definition Board (Part 2)

4.5.4 Alert Archiving

Archive of alerts

- Time of archiving: minimum 1 year
- Kind of information: all defined standard alerts
- Availability: both customer and supplier via VMI level
- Data_Elements:
  - Alert_Type
  - Alert_Owner (Supplier)
  - Alert_Object (Based on Alert_Type, e.g. Part_Number)
  - Alert_Time (Datetime)
  - Reaction_Time
  - Turn_Around_Time
  - Max_Escalation_Level

Archive of basic data for alert analysis

- Time of archiving: minimum 2 months
- Kind of information: all agreed data items
- Availability: both customer and supplier via VMI level
- Data_Elements:
  - Current_Date
  - Supplier
  - Part_Number
  - Lead_Time
  - Actual_Inventory
  - Min / Max – Level in units and Days of Supply (t = 0 ... t_max)
  - Planned_Consumption (t = 0 ... t_max)*
  - In_Transit (t = 0 ... t_max)*
  - Planned_Shipments (t = 0 ... t_max)*
  - Production authorisation / material authorisation

4.6 Rating and Supplier Evaluation

4.6.1 General

- Close short / close long (difference between delivery note quantity and quantity received)
- Alerts
- Min / Max
- Schedule deviation
- Note! The reason for a Min/Max-Alert can be the result of a Schedule deviation-Alert
- Deviation between gross demand and issue
- Logistics supplier evaluation including:
  - on-time delivery
  - quality of packaging and documentation
  - flexibility

4.6.2 Delivery Schedule System

Basic Principles Service Level measurement VMI

- Customer defines min and max inventory time range
- Customer transmits gross demand, inventory level and movements
- Based on this data the supplier calculates the net demand and his resultant deliveries
- The supplier is responsible for ensuring that the customer stock is always between defined min and max range

Service Level measurement method alternatives

- Prio 1: Black and white method or
- Prio 2: Weighted over- and under-delivery areas (following VDA 5001)

Black and white measurement

- The supplier is responsible for ensuring that the customer stock is always between the defined min and max range
- If he succeeds, his service level is 100%
- If he doesn't succeed, i.e. the stock is under the min or over max, his service level is 0%
  → **Black and white measurement**

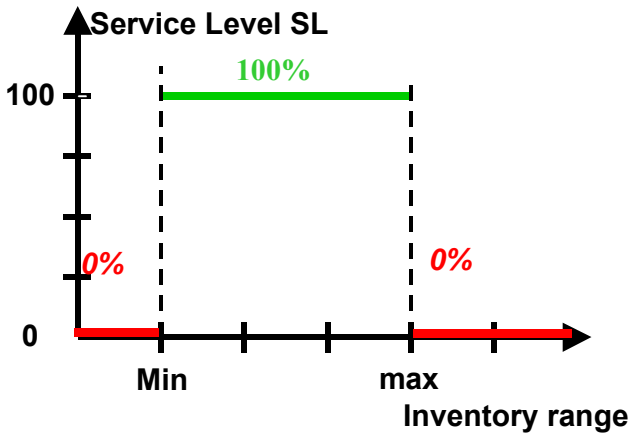


Figure 25: Black and white measurement

Weighted over- and under-delivery areas (following VDA 5001)

Steps for calculation of Service Level:

- Calculation of Under/Over Delivery Areas
- Consideration of Weighting Factors
- Calculation of Cumulative Under/Over Delivery Area
- Calculation of the Weighted Figure G
- Selection of the Tolerance Category
- Calculation of the Service Level

These steps are explained in the following charts:

Weighted over- and under-delivery areas (following VDA5001)

- Calculation of Under/Over Delivery Areas

  Multiplication of the under min or the over max stock quantity with the deviation time
  - Under Delivery Area: 25 * 2 = 50 [pieces*days]
  - Over Delivery Area: 25 * 1 = 25 [pieces*days]

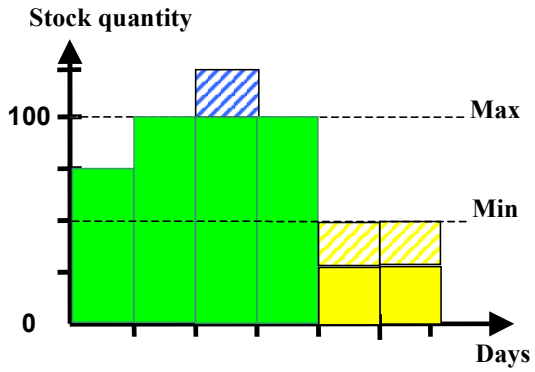


Figure 26: Weighted over- and under delivery areas

- Weighting factor
  - Under delivery = 2, Over delivery = 1
- Calculation of cumulative and weighted Under/Over Delivery Area
  - 50 * 2 + 25* 1 = 125 pieces*days
- Calculation of the Weighted Figure G

This cumulative under/over delivery area is now related to the cumulative gross demands during the period under consideration (6 days):

"Weighted figure G": G = 125 pieces*days / xyz pieces = abc days

Calculation Example

- Selection of the Tolerance Category

The Tolerance Categories reflect the relative importance of the parts being considered. A part requiring the highest service level is rated Category "A". In contrast a part requiring the lowest service level is rated Category "C". The "upper tolerance limit" is the delivery deviation acceptable for a service level of 100 %. The "lower tolerance limit" is the delivery deviation below which will result in a service level of 0 %. The tolerance limits for the three tolerance categories are shown in the table below:

Tolerance Limit		Category A [days]	B [days]	C [days]
upper tolerance limit "a"	≤	1	2	5
lower tolerance limit "b"	≥	4	6	10

Figure 27: List of tolerance limits

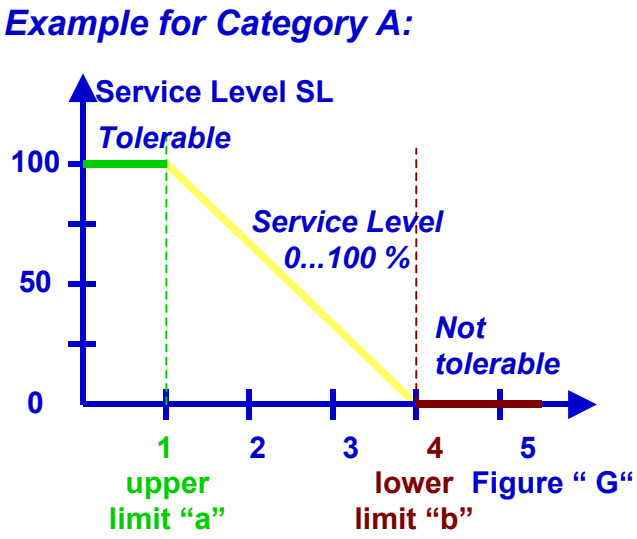


Figure 28: Example for Category A

Calculation Example

- Calculation of the Service Level

Based on the calculated "weighted figure G" and considering the tolerance limits, the service level can now be calculated according to the following formula which will produce the graph shown on the previous chart:

$$\mathbf{SL = \max \{0;\ 100 - 100 * \max (0;\ \frac{G - a}{b - a})\} \text{ in \%}}$$

This formula shows that the Service level cannot become negative, and stays within the range 0...100 %. For the example shown the service level of the three tolerance categories are:
G = 4,67 days:

- Category A: SL = max {0; 100 - 100 * max [0; (4,67 - 1) / (4 - 1)]} = 0 %
- Category B. SL = max {0; 100 - 100 * max [0; (4,67 - 2) / (6 - 2)]} = 33 %
- Category C: SL = max {0; 100 - 100 * max [0; (4,67 - 5) / (10 - 5)]} = 100 %

→ The service level depends very much on the tolerance category

5. Responsibilities

The VMI Concept is based on a well-defined agreement between two partners.
As a basic principle these partners are customer and supplier.

5.1 Partners

Supplier

The supplier has to supply the customer with the required quantity of parts by satisfying the following conditions:

- Gross requirements information
- Stock information
- Flexibility agreement

Customer

The customer has to provide the necessary information, in a timely manner, taking into account the defined preparation time.

Service provider

The service provider's responsibility is as defined in the agreement with one, or both, of the partners.

5.2 Agreement

Participants within the agreement have a joint responsibility to agree and document a specific *Logistics Agreement* that defines all responsibilities on a detailed level.
This document should include clear responsibilities for:

KPI´s

The participants should define objectives and KPI's including the method of measurement and monitoring. Recommended KPI's include the following:

- Compliance of the Min / Max levels
- Average days of stock
- Demand forecast quality

Alerts

Each partner is responsible for keeping their data updated and ensuring a defined level of data accuracy, e.g.

- Parameters (lead-times, alert thresholds, etc.) should be agreed mutually with the appropriate customer or supplier.
- Clearly defined responsibilities for responding to the various alerts (predefined workflow).
- The Supplier should communicate the promised date and time of shipment. This should be done within an appropriate time after the inventory has gone into the red.
- Both the Customer and Supplier will receive an alert when inventory / demand goes in the red due to special circumstances

- The Customer will send a manual alert explaining the issue and what action needs to be undertaken.
- The Customer's scheduler will code the event as inactive in the VMI rating.
- The Customer will record the reason the part went into the red in the rating's comment field.
- Each participant defines a central contact person for general co-ordination purposes.
- If required, the participants agree on a central / global person to co-ordinate the complete supply network.

Data quality

Data quality is a key requirement for a successful VMI process. For this reason sensibility checks and rigorous detection and elimination of the root causes of false alerts are fundamental and need to be established in the work procedures.

- Each partner is responsible for keeping their data updated and ensuring a defined level of data accuracy, e.g.
- The responsibility for system performance and helpdesk needs to be assigned.
- If there is ambiguous information the receiver of information is responsible for clarifying the situation with the sender.

Exception handling

When deviation from the standard process is necessary, the parties have to clarify the conditions in advance.

Responsibility regarding costs and savings

When VMI and Min / Max is fully functional there are likely to be savings and costs that occur. The apportionment of savings and costs should be discussed and agreed prior to introduction. The main areas where there could be significant costs or savings are:

- Increases / decreases in shipment frequencies
- General freight costs
- Instances of premium freight
- Line shutdowns or scheduling changes
- Excess inventory at both the supplier and the customer
- The cost of using the Min / Max tool
- Training
- Staff additions or reductions due to the Min / Max process

Process

This includes the criteria that establish:

- when to ship
- what logistics to use
- when to expedite

In addition to this, both partners have to agree contractual terms regarding the conditions of warranty, liability and insurance.

6. Data Description

VMI deals with 3 **categories** of data / data flows:

- **Company-internal data flow**
  Individual company integration concepts are required for the information flow **between** the **backend system(s) and** the **respective VMI Instance**
  Synonyms: EAI *Information Flow (EAI= Enterprise Application Integration)*, vertical information flow
  Basic data sets are:
  - in-transits and planned shipments
  - inventory information
  - planned (gross demand) and actual consumption
  - receiving information
  - min / max levels

- Data-flow between customer and supplier VMI instance
  The Information flow **between** the **VMI instances** is key to interoperability.
  Synonyms: *Interoperability Information Flow*, horizontal information flow.
  Basic data sets are:
  - in-transits and planned shipments
  - inventory information
  - planned (gross demand) and actual consumption
  - receiving information
  - min / max levels
  - alert communication
  - general information (e.g. partner identification)
- **VMI-internal data** is stored and updated in the VMI instance of each company. Typically this is data for:
  - administration and user rights
  - master date that is needed for the VMI process but not available on ERP-level
  - transportation link parameters

Figure 29 illustrates the information flow in a **decentralised architecture:**

- Back-end systems in every organization keep dynamic and static data
- Back-end systems need to update the VMI instances after every status change (e.g. “inventory level for part number xyz drops to 100 units”) => EAI Information Flow
- VMI Instances need to synchronize the corresponding partner instance; Interoperability Information Flow based on **Supply Chain Interoperability Protocol** (SCIP)

Further information regarding interoperability can be found in the Odette Supply Chain Monitoring Recommendation.

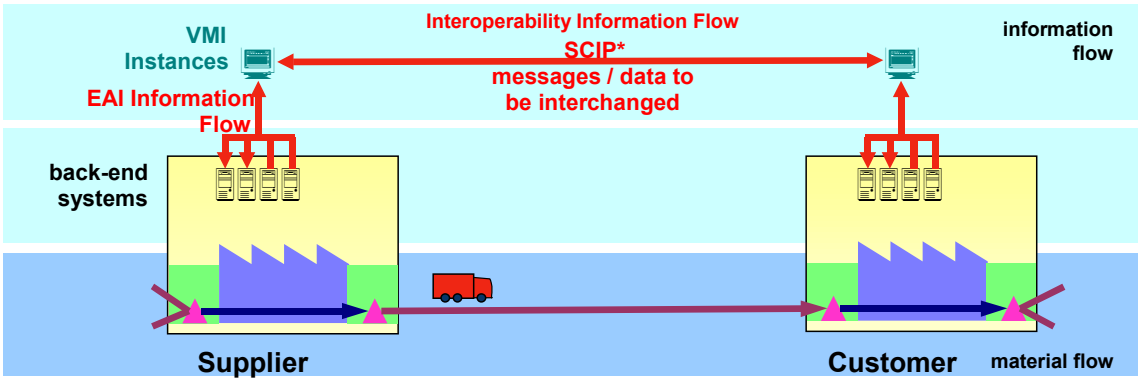


Figure 29: Basic Information Flow with decentralised Architecture

7. Implementation Check List

The Application Matrix should be used to check the suitability of the process before making a decision to implement VMI (see Appendix 8.1).
The following main steps should be reviewed prior to implementation commencing.

7.1 Before going live with VMI

At an early stage both the customer and the supplier should check national regulations and the effects of implementing VMI especially with regard to taxes and custom duties.
Similarly, there is a list of matters that have to be agreed by both partners before going live with VMI.

7.1.1 Competence / Position of the Customer's Materials Requirement Planners

During parallel processing (appropriate period, e.g. 1 week):

- Maintain the agreed min / max levels
  Comment: If possible in the ERP system, otherwise directly in VMI level
- Verify that the stock shown to your suppliers is accurate.
- Introduce transit time from the supplier to the plant.
  (Depending on the terms of delivery this may be the task of the supplier)
- Verify that all the relevant part numbers are set up in the VMI level.
- Identify the method of alerts for each contact - email (recommended), online notifications, or fax
- Make sure the supplier provides the planned shipment information (if required for transport planning) and ASN's properly.
- Ensure proper processing of delivery notes in goods received, so that the ASN's in transit are automatically removed once they have arrived.
- Verify the supplier's fabrication authorisation days and ensure that they are properly processed at the VMI level.
- On the last day of parallel processing, change the ERP settings to show gross demand to the supplier.

7.1.1 Competence / Position of the Suppliers

During parallel processing:

- Verify all the part numbers are set up on VMI level. Description, packing unit... Look for missing or unknown parts. Contact Customer with discrepancies.
- Inform and discuss with the supplier any concerns with the Minimum and Maximum levels.
- Check the different modes of transport proposed by the Customer in order to agree the most effective transit solution
  (Depending on the terms of delivery this may be the task of the customer)
- Test synchronisation of inventory and demand information and ASN (in conjunction with the customer)
- Check the last delivery note advised to the Customer.

- Introduce material in-transit, i.e. ASN's that have already left the plant but not arrived at the Customer (manually or by EDI).
- Set up the appropriate alert medium; email (recommended), online notifications, or fax in order to receive automated alert, e.g. for an inventory level dropping below minimum.

7.2 After going live with VMI

7.2.1 Competence / Position of the Customer's Materials Requirement Planners

General principle:

- Do not modify manually the quantities and dates in the forecast schedule. The supplier will not consider the quantities in the schedule as shipping orders, but as production consumption information.

Random tasks:

- Verify that the planned shipments have been provided (if required for transport planning).
- Verify that the ASN's have been provided correctly.

Regular tasks:

- Whenever an automated VMI Alert is received check the situation carefully and initiate appropriate corrective action.
- Review Min / Max levels every month at a minimum (frequency depends on the complexity of the plant), send an advice to the supplier if a change is made

Phase out of a product

- Recalculate the Min / Max level more frequently and send an advice to the supplier after each Min / Max adjustment
- Verify the product life cycle demand
- Put a note into the comments field saying that the part is phased out and the Min / Max levels may fluctuate more frequently.

Ramp-up / Launches

- Prior to material release, sample parts are to be ordered via spot buys
- Once a blanket purchase order (PO) is issued, the part will need to be visible in the VMI level
- Consider the supplier's lead-time when establishing PO quantity and date required.
- Recalculate the Min / Max level more frequently and send an advice to the supplier after each Min / Max adjustment
- Send an alert notifying the supplier to view the forecast for launch requirements
- Put a note into the comment fields saying that the part is in a ramp-up phase and the Min / Max levels may fluctuate more frequently.

7.2.1 Competence / Position of the Suppliers

Regular tasks:

- Keep the Customer's inventory levels in the green.
- Produce parts based on the forecast / fabrication authorization.
- Provide planned shipment information. Give shipping instructions to the warehouse or shipping department taking into account the situation of the VMI level. Introduce the planned shipment in the system for the material available. The quantity to send to the Customer in every shipment should be decided by the supplier according to the Min / Max levels. A "Suggested delivery" should help the supplier to know how much should be shipped.
- Provide actual shipment information (ASN)
- Whenever an automated VMI Alert is received check the situation carefully and take appropriate corrective action.

7.3 Process Monitoring

Following implementation the following reviews should be undertaken with respect to monitoring the effectiveness of the VMI process:

- What KPI´s should be introduced, in addition to the delivery rating (see 4.6) and by whom, when and how often are they to be monitored?
- How are the monitoring results to be communicated between the two partners?
- Check the accuracy of the calculation methods.

8. Appendix

8.1 Application Matrix VMI

Application areas for VMI *

1. Relationship between the Partners	Characteristic			
1.1 Partner classification	A-customer / supplier	B-customer / supplier	C-customer / supplier	
1.2 Partner turnover	A-customer / supplier	B-customer / supplier	C-customer / supplier	
1.3 Tier level	distributor - OEM	OEM - 1st tier	OEM - 2nd tier	1st-tier - 2nd tier
1.4 Character of Partnership	exchangable partner (one-time sales/buys)	permanent partner	strategic partner	
1.5 Distribution of Power	dominated by customer	balance of power	dominated by supplier	
1.6 Target market	Production Run	Aftermarket		
2. Products				
2.1 Product Complexity	products with single stage prouction process	products with multi-stage production process	complex products (systems) with multi-stage structure	
2.2 Priority ($-Volume)	A-products	B-products	C-products	
2.3 Standardisation	standard products without variants	standard products with variants	customer specific products based on standard modules	highly individual customer specific products
2.4 Reliability of Supply	low	medium	high	
2.5 Character of Production	non-repetitive production (one-time)	small-lot production	series production	mass production
2.6 Class of Demand	indirect material	direct material	spare parts	
2.7 Replenishment Lead-time	short	medium	long	
2.8 Sourcing	single sourcing	multi-sourcing		
2.9 Life time cycle	ramp-up	stable	phase-out	
2.10 Frequency of engineering changes	low	medium	high	
2.11 Sensibility regard. Quality	low	medium	high	
2.12 Demand Pattern	steady	seasonal fluctuation	sporadic fluctuation	cyclic (ongoing change between shortage and overcapacity situation)
3. Processes				
3.1 Production Strategy	built to stock	configure to order	built / assemble to order	design to order
3.2 Investment in Production Facilities	invest for production facilities rather low	medium invest for production facilities	invest for production facilities rather high	
3.3 Manufacturing Type	process manufacturing	discrete manufacturing		

Relevance of Characteristic for VMI

high

medium

low

no relevance

* Source for grid of characteristics: Study "Supply Chain Collaboration 2003", BVL, ISBN 3-00-011286-3

Figure 30: Application matrix VMI

Explanation how the Matrix is to be used

The Application Matrix should be used to assist in the decision as to whether the introduction of a VMI process is feasible and practical.
On the basis of different checkpoints the matrix shows which characteristics are most relevant in a VMI process.

Examples:

(a) See 1.1 partner classification (concerning quality):

VMI has a high relevance in the relationship between suppliers to A- and B-customers or customers to A- and B-suppliers.

Reason: It is expected that A and B class customers and suppliers achieve higher quality performance levels than C class customers and suppliers. Therefore, there is a greater probability that the quality of the parts and service within the VMI process will ensure a robust process.

(b) See 1.2 partner turnover (concerning quantities)

VMI has a high relevance in the relationship between suppliers to A-customers or customers to A-suppliers.

VMI has a low relevance in the relationship between suppliers to C-customers or customers to C-suppliers.

Reason: As the volume of work increases between partners there is likely to be a more constant and predictable demand.

(c) See 2.9 life time cycle

VMI has a high relevance in a stable life cycle and has no relevance during ramp-up or phase-out cycle. However, if the customer and supplier have organised a good information flow during ramp-up and phase-out cycles VMI could support the management of stock for both parties (e.g. engineering changes).

The content of the matrix should be used as guidelines. The relevance stated in the matrix reflects the opinion of the project team. If necessary, the user should add and amend checkpoints and characteristics to reflect the specific nature of his business or relationships.