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3rd Party Logistics Providers' Role in Replenishment

Classic and Future Models in the
High-Tech/ Electronics Sector

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Executive Summary

The concept of vendor managed inventory (VMI) has been around for over 20 years now and has brought replenishment decisions to the forefront of logistics management. However our review of current streams in replenishment concepts reveals that a high level of confusion still exists in the logistics field concerning replenishment models, terminology, key factors, intents and content. Consistent and holistic frameworks that span multiple models are rare. Additionally, the industry is searching for ways to address the question of how 3rd party logistics providers (3PLs) can add further value, as classic models only address vendor and buyer and not 3rd parties in active roles. We address these issues with the development of a generic replenishment model that explains all major types of replenishment and portrays various concepts of 3PL involvement.

As globalization and customer demands increase, logistics operations and the management of supply chains have to evolve even further. This can be observed nowhere better than in the High-Tech industry, where low inventory, high service levels and a short time-to-market are key success-factors. High-Tech products range from low-value to extremely high-valued "perishables" (e.g. memory chips), product lifecycles are extremely short with high costs of obsolescence and supply chains are highly modularized and fragmented. Many new and innovative supply chain models that build on 3PLs can be found in this ecosphere.

In classic models (vendor managed / buyer managed inventory / consignment inventory), 3PLs add significant value by offering the full range of these different replenishment concepts in parallel within one single operation. With this, buyers can use the specific strategic advantages but do not run into the related problems in the field of ERP-systems architectures and accounting legislation. E.g. corporate governance legislations (Sarbanes Oxley etc.) today often force a clear physical and legal separation of assets with external ownership, especially if located on company grounds. 3PLs step in here as neutral intermediaries running the corresponding warehouse management systems and triggering ownership transfers and related work flows. Exemplary, Schenker Asia/Pacific is running a hub inbound-to-production of a major high-tech producer in Hong Kong and is capable of intelligently integrating up to 300 suppliers with different ownership status in a single hub. Buy-sell-hubs are new in terms of expanding the traditional scope of service offerings of 3PLs. Within these hubs, 3PL provide procurement services to brand-owners that have outsourced production to contract manufacturers and otherwise would have to rely on the contract manufacturers to procure their supply parts.

Future models involve 3PLs providing services that go beyond operations in management and entrepreneurial ways. Examples include 3PL managed regional inventory pooling hubs for customers or the management of full supply networks across continents. Moreover 3PLs can broaden their portfolios offering infrastructures and capabilities that improve and facilitate collaborative planning processes. It is clear that efficient replenishment models in the future will rely heavily on sophisticated competencies of 3PLs. Though for these, new pricing and incentive schemes for 3PLs will be vital to enable realization of these new services to their full potential.

1 Introduction

The vendor managed inventory (VMI) concept brought replenishment decisions into the forefront of logistics management. VMI started with the retail industry in the early 1990s. VMI practices have evolved over the past 20 years and the pace of innovation continues. New models in the high-tech industry are built on 3rd party logistics providers (3PLs) who operate various replenishment models – including consignment warehouses, buyer and vendor managed inventories – in one single hub. With this, brand owners can leverage the specific advantages of each replenishment model without running into the accounting problems of handling ownership transfers.

Advanced models for the future as developed in this research project go even further. They involve 3PLs moving beyond the role of pure operator, taking over management tasks for supply networks. From today's standpoint, this is a future option for many 3PLs looking to migrate their service offering up the value chain.

The findings were collected in an extensive world-wide field research in cooperation with the 3rd party logistics provider Schenker, with on-site visits and expert-interviews in Europe, USA and Asia.

2 The High-Tech Supply Chain and Inventory Cost and Risk

Supply chains in the high-tech environment are special in many ways. Products range from low-value goods, such as cases or bolts, to extremely high-valued "perishables", as e.g. memory chips, and CPUs, with very short product lifecycles (usually less than 12 months) and related high costs of obsolescence if held too long in stock (Figure 1).

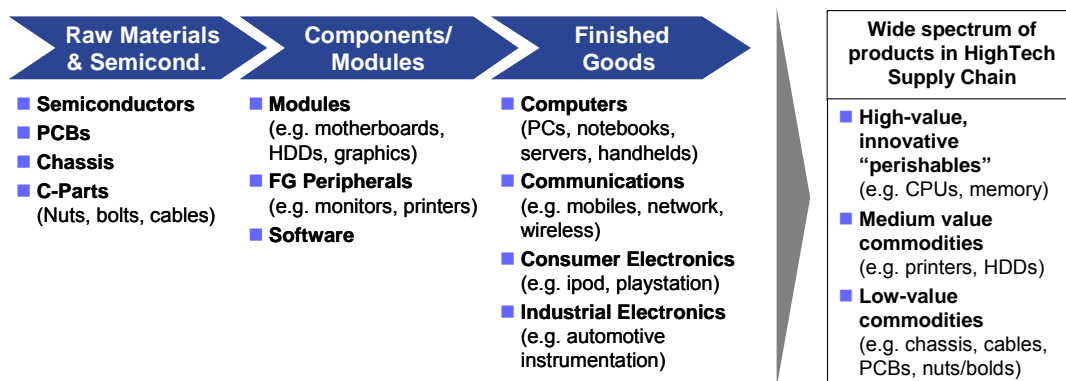


Figure 1: Range of products in the high-tech supply chain

This coincides with a highly modularized industry, both from a product and a value chain perspective: powerful module producers (e.g. Intel, AMD, and Microsoft), and extreme business process outsourcing in logistics (3PLs) and final assembly (contract manufacturing companies), see Figure 2. Additionally, demands are highly volatile making forecasting highly complex. Forecast accuracy was reported to be often below 50%.

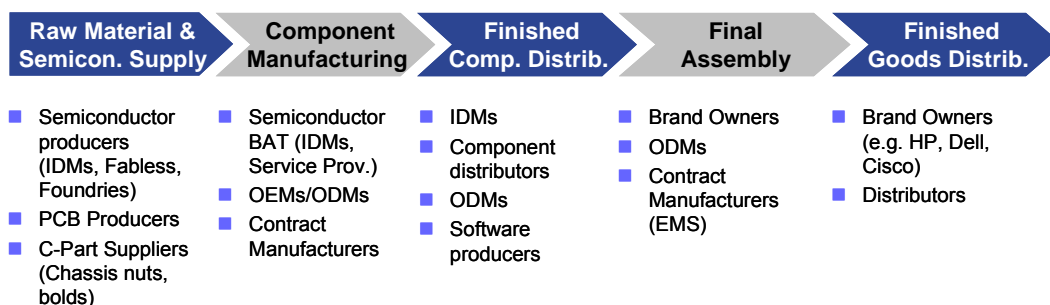


Figure 2: Players in the high-tech supply chain

In this environment, the cost of inventory (cost of capital and costs for obsolescence or buyer default risk) are very high and play a significant role in the optimization of supply chains. Thus, replenishment models such as vendor managed inventory (VMI), that enable the shift of inventory risk to upstream players in the supply chain (i.e. to the suppliers), are highly welcome and well-adopted.

3 A Framework for Replenishment Models

Replenishment is the task of ensuring that the supply within a supply chain meets the demand. In the high-tech supply chain, replenishment points are usually found either inbound to production or to final assembly or outbound in customer distribution as e.g. distribution centers, in-store buffers or merge-in-transit points (see Figure 3).

The words vendor and buyer are relative to the replenishment point; e.g. in replenishment point 1, the component supplier is the vendor and the manufacturer the buyer. In replenishment point 2, the manufacturing party is the vendor and the customer or reseller takes the buyer's position.

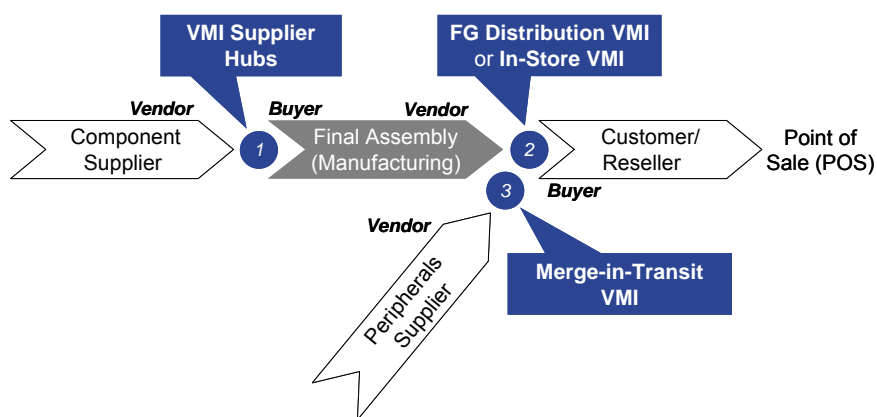


Figure 3: Typical positions of VMI in the high-tech supply chain

3.1 Expanding the Scope of Replenishment

Traditionally, replenishment was done within existing structures and therefore focused only on the execution, namely ownership and management of inventory (see Figure 4). This is where classic replenishment models such as buyer managed inventory (BMI), buyer managed vendor owned inventory (BMVOI) and vendor managed inventory (VMI) programs have their differentiation characteristics (see chapter 4).

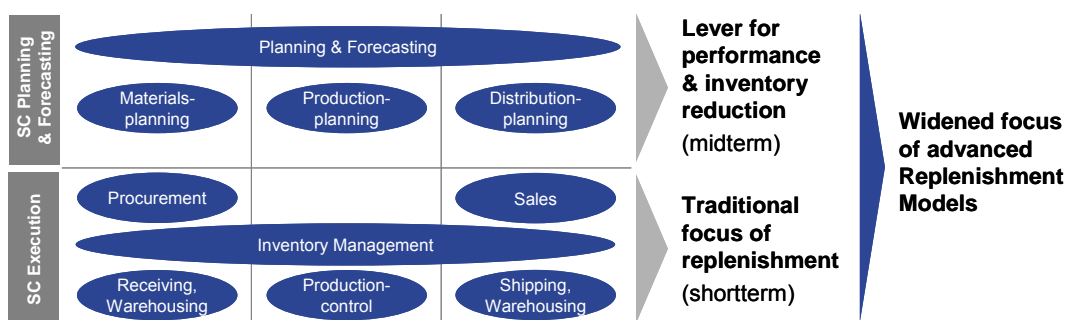


Figure 4: Widening the focus of replenishment

The advanced models portrayed in this report, include 3rd parties as active players within replenishment (see chapter 4 and 5) – creating options for new supply network configurations – and expand the view to include midterm forecasting and planning as most leverage in terms of inventory reduction are found here.

The resulting differentiating factors, namely forecasting and planning, management, and ownership of inventory, are portrayed in Figure 5. These factors define the replenishment model. Excellence in operations and relationship attributes needed are enabling factors that ensure that the chosen model can be implemented and run in reality.

Forecasting & Planning	<ul style="list-style-type: none"> ■ Who makes the sales and production forecasts for inventory planning? ■ Who defines inventory level targets and penalties for non-conformance?
Management of inventory	<ul style="list-style-type: none"> ■ Who takes the explicit replenishment decisions: What to order when in which quantity?
Ownership of Inventory	<ul style="list-style-type: none"> ■ Who holds the balance sheet title for the inventory positions (current assets)? ■ Who holds the liability (risk) of the inventory?

Core differentiating factors

Figure 5: Core differentiating factors in replenishment

3.2 Replenishment Classification Model

Based on the factors defined before, the different replenishment types can be classified in comprehensive form. We call the defined framework Replenishment Classification Model (see Figure 6). The content of the different models is described in the following two chapters, starting with the classic models and then moving towards the more advanced models.

		Classic Models			Advanced Models				
		Buyer Managed Inventory BMI	Buyer Managed Vendor Owned Inventory BMVOI **	Vendor Managed Inventory VMI	3PL Managed Buyer Owned Inventory 3MBOI	3PL Managed Vendor Owned Inventory 3MVOI	3PL Managed Inventory 3MI	Collab. Planning, Forecast. & Replenishment CPFR	3PL Managed CPFR 3MCPFR
Key Model Differentiators	Inventory Forecasting & Planning	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	joint	joint, 3PL enabled
	Inventory Management*	Buyer	Buyer	Vendor	3PL	3PL	3PL	Vendor	3PL
	Inventory Ownership	Buyer	Vendor	Vendor	Buyer	Vendor	3PL	Vendor	3PL
	Information Technology	Vendor/ Buyer/ 3PL	Vendor/ Buyer/ 3PL	Vendor/ Buyer/ 3PL	3PL	3PL	3PL	Vendor/ Buyer/ 3PL	3PL
	Warehouse Management	Buyer/ 3PL	Buyer/ 3PL	Buyer/ 3PL	3PL	3PL	3PL	Buyer/ 3PL	3PL
	Transportation Management	Vendor/ Buyer/ 3PL	Vendor/ Buyer/ 3PL	Vendor/ 3PL	3PL	3PL	3PL	Vendor/ 3PL	3PL

Figure 6: Replenishment Classification Model

4 Classic Replenishment Models

Classic replenishment models such as buyer managed inventory (BMI), buyer managed vendor owned inventory (BMVOI) and vendor managed inventory (VMI) are well-adopted today in supply chain management. The following gives a short introduction and the roles that 3PLs play today in these models.

4.1 BMI, BMVOI and VMI

Traditionally, the task to manage the replenishment was assigned to the downstream buying party in the supply chain, called *buyer managed inventory* (BMI). The buyer manages (i.e. takes all replenishment decisions on what to deliver, when and where to) and holds the ownership of the inventory kept at his sites. Thus, the buyer has to carry the costs and risks associated with inventory (usually capital and obsolescence costs). The *vendor managed inventory* (VMI) concept inverts this relationship and gives full responsibility of inventory management *and* ownership to the vending party. The vendor carries the responsibility for actively taking the replenishment decisions. The idea behind this is to give the vendor additional degrees of freedom that allow him to align replenishment with his own production planning. In exchange he takes the full burden of inventory and thus is also highly incentivized to reduce inventory levels. In supply chains with powerful focal companies, a combination is sometimes found: *buyer managed vendor owned* (BMVOI) inventory (aka. consignment stock). The buyer *manages* the inventory and forces the vendor to keep the *ownership* and *risk* of the inventory until the inventory is actually used by the buyer. The problem with this model is that the vendor carries the costs and risks without being able to alter or optimize the level of inventory, a *suboptimal* model from a supply chain perspective.

Today, sophisticated approaches to replenishment in the high-tech sectors tend to use *all three models in parallel* for their inbound supplies: BMI for strategic buys, especially for high-value price-sensitive goods (e.g., memory chips, CPUs) where prices change daily and forward buying matters, VMI or BMVOI for most other products and commodities, where cost of capital and risk of inventory weigh higher than potential price gains from market buys.

4.2 3PLs in the Parallel Management of Replenishment Models

What role can a 3PL play in a VMI relationship? One would expect only *two* parties to be involved – the buyer and the vendor –, not three. Looking more closely at VMI and BMVOI from an operations and accounting perspective reveals, that one of the challenges lies in the management of the transfer of ownership and the triggering of the related accounting workflows in both vendor and buyer enterprise resource planning (ERP) systems. This is especially complex given that in high-tech often supplier hubs are used for the inbound flows. These can require the connection and coordination of up to 300 suppliers in an efficient manner – as found, e.g., in the Schenker operated Hong Kong inbound-to-production supplier hub of a major mobile phone producer. Accounting legislation and the architecture of ERPs often prohibit the inclusion of non-balance-sheet inventory positions – as VMI and

BMVOI positions are from a buyers' perspective – into the buyers' ERP or warehouse management system. Experience with e.g. Sarbanes Oxley shows that corporate governance regulation tends to even increase this dilemma, forcing clear physical and legal separation of assets with external (vendor-) ownership, especially if they are located on company grounds.

This is where 3PLs step in as *neutral intermediaries* that runs the corresponding warehouse management systems (WMS) and trigger the ownership transfers and related work flows. 3PLs offer sophisticated and in most cases highly customized WMS and interface systems together with web-based visibility tools to connect with vendors and buyers systems.

4.3 3PL Operated VMI Supplier or Merge-in-Transit Hubs

In our review of high-tech contract logistics operations of Schenker in the Asia/Pacific region, we found these replenishment types in all major segments of the high-tech sector, e.g. major PC and notebook, network equipment, and mobile phone producers, as well as contract manufacturing companies.

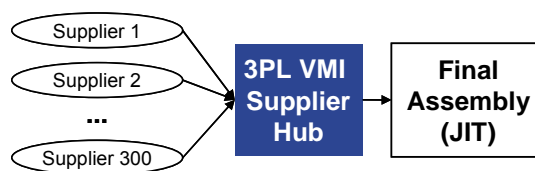


Figure 7: VMI Supplier hubs operated by a 3PL

They used inbound-to-production supplier hubs (see Figure 7) or merge-in-transit VMI installations (see Figure 8) to manage the ownership transfers and warehouse applications. In most cases, the supplier hubs act as a buffer for just-in-time production feeding with short lead-times (30 minutes to 3 hours). Ownership transfer was in most cases not before the pallets reached the docks of the production lines.

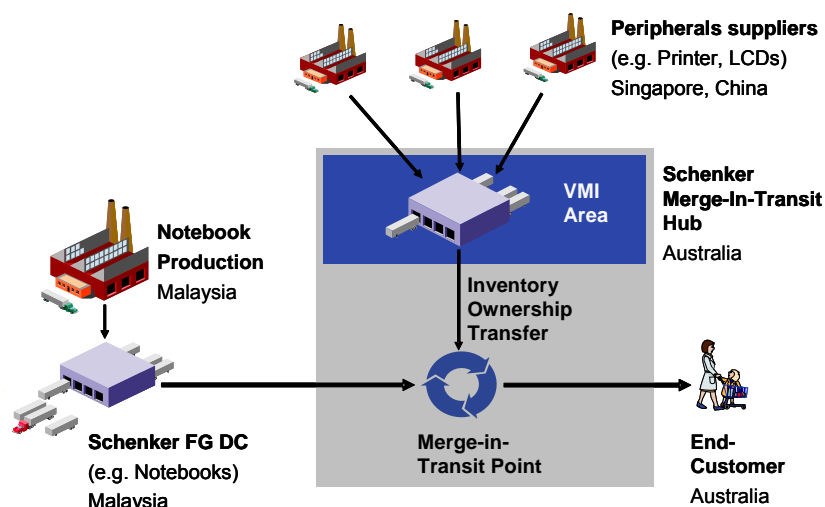


Figure 8: Merge-in-Transit VMI Hubs in the Notebook Supply Chain

In most cases the pure replenishment and warehousing functionality is combined with sophisticated value-added services to utilize synergies and avoid double handling of goods. These value-added services provided by 3PL typically range from pick-pack, kitting and final assembly works to quality control and repair/rework services.

4.4 3PL Enabled Procurement Services in Buy-Sell-Hubs

A new model of replenishment is the buy-sell-hub e.g. being implemented by Schenker for several high-tech brand-owners in Asia. This concept provides a solution to the problem that many brand-owners face today: having lost procurement power to contract manufacturers after complete outsourcing of the production – quite a profitable part of the value chain for most high-volume producers.

The buy-sell-hub acts as a virtual trading company between raw materials and component suppliers on one side and contract manufacturers on the other side (see Figure 9). These hubs are run on behalf of the brand-owner. Contract manufacturers are forced by the brand-owners to buy directly from them. Brand-owners negotiate special pricing-terms directly with the suppliers (P_B) who agree to deliver all goods via the buy-sell hub. In the hub, the 3PL replaces the supplier's invoice (with price P_B) with the brand-owner's invoice. This new invoice usually contains the price conditions that the *contract manufacturer* would get from the supplier (P_C). The 3PL masks the price P_B paid originally by the brand-owner to the supplier, protecting the special agreements between brand-owner and supplier.

The brand-owner gains from this arrangement by keeping the price difference ($P_C - P_B$) as profit. Thus he is now able to perform strategic buys and price bargaining directly with suppliers surpassing the contract manufacturer as an intermediary from the physical flow of materials' perspective. While the contract manufacturer gets the same price P_C as before, the suppliers end up with lower sales prices P_B . To protect the suppliers in regard to the contract manufacturer concerning their special agreements with the brand-owner, 3PLs can mask the price P_B paid originally by the brand-owner to the supplier, thus only disclosing the known price P_C to the contract manufacturer.

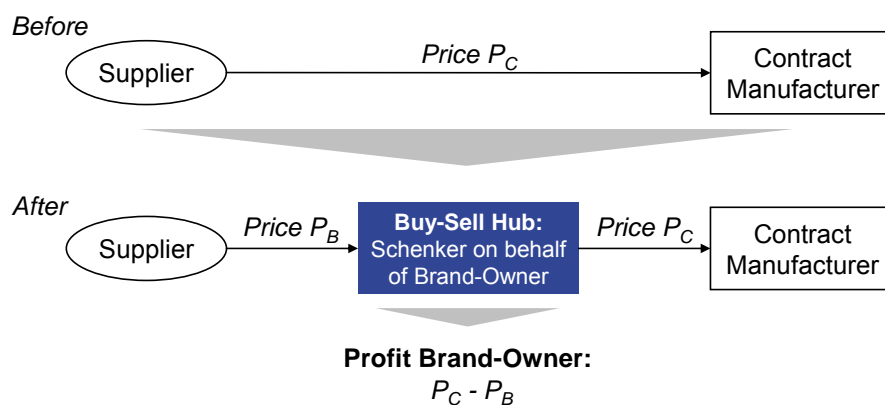


Figure 9: Buy-sell hub model in-between suppliers and contract manufacturers

Most buy-sell-hubs found so far are regional inventory pools that feed inbound-production hubs situated close to final assembly. In a more complex setting, the 3PL provides these services also as direct shipment without a physical hub in between, where invoices and corresponding paperwork are exchanged during transportation.

From an ownership perspective, most of the buy-sell hubs are run in a VMI mode. Thus, inventory is managed by the vendor and the ownership stays with him until the goods are requested by the contract manufacturing company. Then the ownership is transferred – usually only for the short transport to the production site – to the brand-owner. When it passes the production dock, ownership transfers to the contract manufacturer. This limits ownership and risks of inventory for the brand-owner to a minimal time span, maximizing the profit gained from the process.

5 Future Scenarios: Advanced Replenishment Models for the High-Tech Sector

When designing materials flows for replenishment, most supply chain planners still start from single vendor-buyer relations. Our research indicates though, that future applications of high-performance supply chains need to focus on supply networks that consider both the buyer and the supplier perspective. New optimization opportunities can be achieved if 3rd parties – such as 3PLs – receive more comprehensive roles in optimizing *networks* rather than single operations or hubs for just one side – suppliers or customers.

5.1 3PL Managed Inventory: 3MI, 3MBOI, 3MVOI

3PL managed inventory (3MI) and 3PL managed buyer owned or vendor owned inventory (3MBOI/3MVOI) models all place the 3rd party logistics provider into the role of actively managing replenishment (as already depicted in Figure 6).

The high-tech industry shows potential for 3PLs taking on more comprehensive roles in improving supply networks by integrating several suppliers and even competing players as a neutral intermediary. In the following, we describe two examples of such future scenarios.

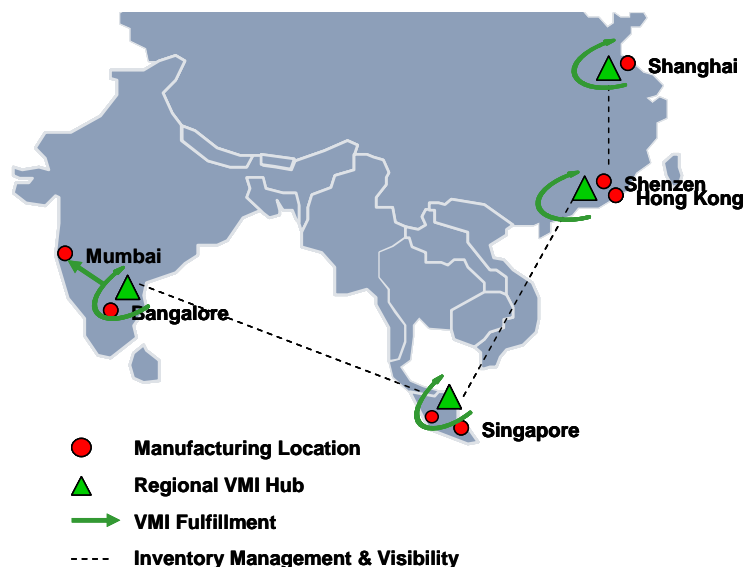


Figure 10: 3PL managed regional pooling hub network for a major high-tech producer

Case One: Regional Inventory Pooling Hubs

Today's supply networks in the high-tech sector are mostly driven by strong focal companies (usually the brand-owning companies). Taking a supply chain perspective – independent from the ownership of different parts of the networks – reveals a widespread fragmentation and suboptimal settings that result from one-sided optimization of the buying companies:

- **Supplier's View:** The case of a major graphic cards supplier in Asia gives a good example: This supplier has to replenish 35 brand-owners or contract manufacturing companies each operating VMI supply hubs to buffer their inbound material flows for final assembly or production lines. In these hubs, customers usually require minimum inventory levels of 2-4 weeks of supply. As these supplies are kept in 35 independent locations the total inventory stored in the distribution network is extremely high. As most customers are in close proximity to each other, a reduction of inventory could be achieved by pooling supply at few locations. This can be done by a 3PL, who could set up central pooling hubs of inventory to efficiently replenish the customers' production. Due to their close proximity to the buyers each of these hubs would circumvent several of the buyers' own hubs without sacrificing service levels (see Appendix on the effect of pooling on inventory levels).
- **Brand-owner's View:** Most of today's major high-volume producers (e.g. PCs, Notebooks, Mobile handsets, network equipment) have several production sites spread out in south-east Asia and China. Setup of the production networks was in most cases more evolutionary or subsidies driven than optimal from an inventory perspective. Substantial stocks are still located directly at the production sites although many components are being used in multiple production locations. Thus – also from producer's inventory standpoint – central regional feeding hubs for major producers can make sense, if they are managed centrally by one player. This could be provided by a 3rd party logistics provider being responsible for the replenishment. Combined with the potentials from optimization logistics operations (transportation and warehousing) of a supply network (see exemplary network for a major producer in Asia in Figure 10) 3PLs can provide significant value.

Case Two: Managing Supply Networks Across Continents in the Automotive Sector

Related, though not yet implemented in the high-tech industry, is a concept called “supply net solutions” used by Schenker in the automotive sector. In this concept, the 3PL takes over the full replenishment network for certain regions, which offers abundant potential for optimizing logistics operations. Schenker provides this service for the Asian supply of the manufacturing plants of a major tier-one automotive supplier in Germany. They take over responsibility for consolidation in Asia, transportation, deconsolidation in Germany and production feeding of the Bosch sites located in Germany. The service includes the actual replenishment decisions within this part of the supply network by Schenker, the ownership of the inventory stays with the manufacturer as the buyer (3MBOI) though.

Impact on Pricing and Incentive Schemes for 3PLs

Pricing of transportation and warehousing today is still usually based on activities done, rather than with respect to cost-optimal processing of customer demand orders. A carrier-company is usually paid by distance and weight and warehousing providers by SKUs or pallets stored and moved. The implications are simple: providers will try to maximize revenue by

maximizing transportation or warehousing – counterproductive from a brand-owners standpoint.

Thus, before 3PL managed supply networks (as e.g. for 3MBOI and 3MVOI) can work adequately, still some substantial work is needed on aligning the true objectives of the relationships and the incentive schemes set for 3PLs. A solution to this could be *new pricing schemes* where 3PLs participate in the optimization of the network – going away from pure activity-based payments and including profit-sharing components or other sophisticated new arrangements.

Another way could be the more extreme model - 3PL managed inventory (3MI). In this scheme, for the parts of the value chain they manage, 3PLs would actually take over *ownership* of the inventory (e.g. for the whole part between suppliers dock and brand-owners production site, including management of the warehousing and transportation network in-between). Thus 3PLs would actively take over entrepreneurial risk from their clients' value chains, in that way evolving towards general contracting or turnkey solution providing for defined value chain parts. Derived from the VMI principle, this would bring together management (the capability to optimize) and the ownership (the incentive to optimize) in the replenishment model.

But, 3PLs would need to be able to gain adequate margins for these additional risks, requiring a *major change in mind-set on the brand-owners' side* away from arm's length commodity relationship more towards strategic partnering. The contract manufacturing industry has shown that these business models of venturing can be highly successful for the process providers, *if they are able to bundle their risks* with sophisticated and innovative solutions that deliver countable benefits for the brand-owner *and* the service providers through leveraging their scale and scope economies. E.g. was Foxconn (Hon Hai Precision), the market leader in contract manufacturing services, able to achieve a 4,4 % *after tax* margin with his services in 2005. In that way service providers could advance their market position in terms of power and customer commitment and escape the commodity trap of pure operations services.

5.2 CPFR and 3MCPFR

In VMI, accurate forecasting and planning is the basis for lean processes and low inventory levels. Building on VMI as a base model, the target of *Collaborate planning, forecasting and replenishment* (CPFR) is the joint development and efficient alignment of forecasts and demand fluctuations between vendor and buyer in the supply chain. CPFR was developed in the retail industry at the end of the 1990s. With this, inefficient inventory levels or stock-outs caused from inaccurate forecasting can be reduced significantly.

Although VMI has been widely adopted in the high-tech industry, CPFR usage is still rare and mostly used in a “scaled-down version” when compared e.g. to the full process proposed by the VICS (Voluntary Interindustry Commerce Solutions) initiative. One interesting case is the HP initiative using a comparable concept of collecting forecast commits from their suppliers and contract manufacturers. A major complication concerning the implementation of CPFR in high-tech is the highly fragmented supply chain resulting from the wide usage of

process- and module outsourcing: high number of interfaces and players making efficient usage of CPFR complex.

From our research we can not conclude the 3PLs to be the adequate supply chain member to *create* forecasts but to enable such programs and provide the necessary infrastructure. Being located at the interfaces, 3rd party logistics providers can play a significant role in connecting suppliers and contract manufacturers in high-tech supply chains and standardizing the interfaces. In this role, 3PLs can setup processes and interface technology to run programs like CPFR.

We propose a concept we call *3PL managed collaborative planning, forecasting and replenishment* (3MCPFR, see Figure 6). Especially when coupled with 3MI in supply networks (and with this relying themselves on good forecasts to keep operations efficient and effective), 3PLs can become central integrator nodes in the heterogeneous high-tech supply chains.

Appendix - Impact of Inventory Pooling on Safety Stocks

The impact of an aggregation of inventory, as e.g. in central hubs, can be proven based on the probability functions of the underlying demand.

In normal distributed demand, the probability distribution for a given product in an inventory location is:

$$N(\bar{d}_l, \sigma_l)$$

with d : demand, σ : standard deviation, l : location.

When moving from a decentralized to a centralized (pooled) demand, the distribution functions mathematically convolute. The result of the convolution is the resulting aggregated probability distribution:

$$N(\bar{d}_1, \sigma_1) \oplus N(\bar{d}_2, \sigma_2) = N(\bar{d}_1 + \bar{d}_2, \sqrt{\sigma_1^2 + \rho 2\sigma_1\sigma_2 + \sigma_2^2})$$

with ρ being the correlation between the demands of locations 1 and 2 to be pooled together ($-1 \leq \rho \leq 1$).

Thus, whenever demands are not perfectly correlated ($\rho < 1$), the standard deviation for the aggregated demand at a central location is lower than if held decentral (non-convoluted). As the correlation decreases so does the aggregate standard deviation until in the most extreme scenario no safety stock is necessary. In other words, with uncorrelated demand fluctuations much lower safety stocks are needed to achieve the same service levels for inventory held centrally compared to decentral inventory.

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