

# Are you ready for multi-echelon inventory optimization?

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# Agenda

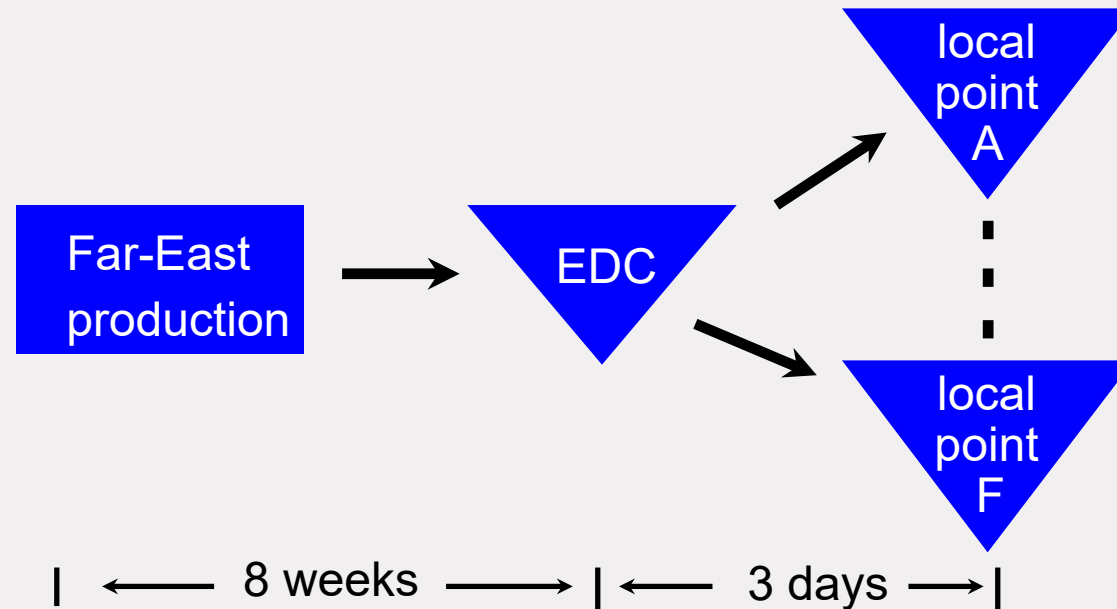
- European Distribution Centers
- Safety Stocks in MRP I systems
- Collaborative Planning and MRP I
- Empirical validation of Supply Chain Optimization models
- ChainStock

# European Distribution Centers

- In 1990 borders within EU vanished, allowing to store goods in a single location for multiple EU countries
- Philips Consumer Electronics produced audio products in the Far-East for the global market
- An EDC allowed for postponement of the allocation decision
- But how much to store in the EDC and how much to store in the sales organizations?
- To convince Audio SCM a quiz was designed, where two scenarios for weeks of stock allocation were proposed: (5,2) and (2,5)

# Case: Inventory capital allocation

How to allocate inventory capital between European Distribution Centre and Regional Warehouses?



# Scenario Definition

- EDC orders biweekly
- Regional warehouses order weekly
- 7 weeks of stocks to be allocated
- Required fill rate 95%
- Scenario 1
  - 5 weeks EDC
  - 2 weeks regional warehouses
- Scenario 2
  - 2 weeks EDC
  - 5 weeks regional warehouses

# Scenario analysis by discrete event simulation

	Scenario 1 (5,2)	Scenario 2 (2,5)	Scenario 3 (1,3)	Scenario 4 (1,2)
Stock in weeks				
Regional fill rate				
EDC fill rate				

# Scenario analysis by discrete event simulation

	Scenario 1 (5,2)	Scenario 2 (2,5)	Scenario 3 (1,3)	Scenario 4 (1,2)
Stock in weeks	7.1			
Regional fill rate	94%			
EDC fill rate	100%			

# Scenario analysis by discrete event simulation

	Scenario 1 (5,2)	Scenario 2 (2,5)	Scenario 3 (1,3)	Scenario 4 (1,2)
Stock in weeks	7.1	7.1		
Regional fill rate	94%	100%		
EDC fill rate	100%	95%		



# Scenario analysis by discrete event simulation

	Scenario 1 (5,2)	Scenario 2 (2,5)	Scenario 3 (1,3)	Scenario 4 (1,2)
Stock in weeks	7.1	7.1	4.1	
Regional fill rate	94%	100%	97%	
EDC fill rate	100%	95%	80%	

# Scenario analysis by discrete event simulation

	Scenario 1 (5,2)	Scenario 2 (2,5)	Scenario 3 (1,3)	Scenario 4 (1,2)
Stock in weeks	7.1	7.1	4.1	3.1
Regional fill rate	94%	100%	97%	92%
EDC fill rate	100%	95%	80%	80%

# European Distribution Centers

- In 1990 borders within EU vanished, allowing to store goods in a single location for multiple EU countries
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- But how much to store in the EDC and how much to store in the sales organizations?
- To convince Audio SCM a quiz was designed, where two scenarios for weeks of stock allocation were proposed: (5,2) and (2,5)
- Thousands of professionals have been questioned between 1991 and 1999 about the best scenario, close to 90% failed to choose the right one
- Later the Fresh Connection articulated these findings

# Safety Stocks in MRP I systems

- MRP I is a multi-item multi-echelon inventory management system
  - Logic
  - User interventions
- In 1990 it was unknown how to set safety stocks in MRP I systems
- In 1995 it became clear that it would be impossible to find mathematical formulas for this
  - MRP I logic yields infeasible order release decisions
  - Only manual intervention can create feasible solutions
  - No one knows how to translate manual interventions into formulas

# Collaborative Planning and MRP I

- End of 1999 Philips Semiconductors SCM was looking for a Collaborative Planning process and tool for the High Volume Electronics supply chain
- SBS policies provided the basis for a highly efficient and effective planning solution
- Between 2001 and 2007 the process was executed on a weekly basis, generating about € 100M additional profit compared to other customer programs like VMI, and 100% customer service
- The CP logic developed was in fact an alternative for MRP I logic, the CP process an alternative for the MPS-MRP process
- As we speak the process is tested in an automotive setting, showing both the deficiencies of MRP I and the capability of material-constrained planning
- In 2017 DD-MRP was shown to be ineffective using a real-life case and discrete event simulation

# Empirical validation of Supply Chain Optimization models

- The software based on SBS policies has been tested in a large number of real-life situations since 2000
- In some recent cases the software is assumed to produce reality, so that scenarios can be compared, and safety stocks can be determined across the multi-item multi-echelon supply chain
- Even though MRP I systems generate infeasible plans and humans intervene, using historical data on demand, average inventory, average lot sizes and supply chain performance, we find that the SBS-based software explains reality
- This suggests that average inventories and average lot sizes drive supply chain customer service

# Key findings

- Getting the math right is a prerequisite for control
- Real multi-echelon planning and control eliminates the Bullwhip effect in supply chains
- In optimally designed supply chains, inventory capital concentrates at the CODP,
- And at item stocks of relatively low value and with relatively long lead times
- Apart from these decoupling points, materials should flow, using allocation and synchronization mechanisms
- It saves a lot of money, creates a lot higher service, and a lot less fire fighting
- But we need a new type of software to make this happen!

# **ChainStock**

## **Software for multi-echelon optimization**





**MULTI-ECHELON INVENTORY SOLUTIONS**

Realistic, accurate and optimal

# CHAIN STOCK

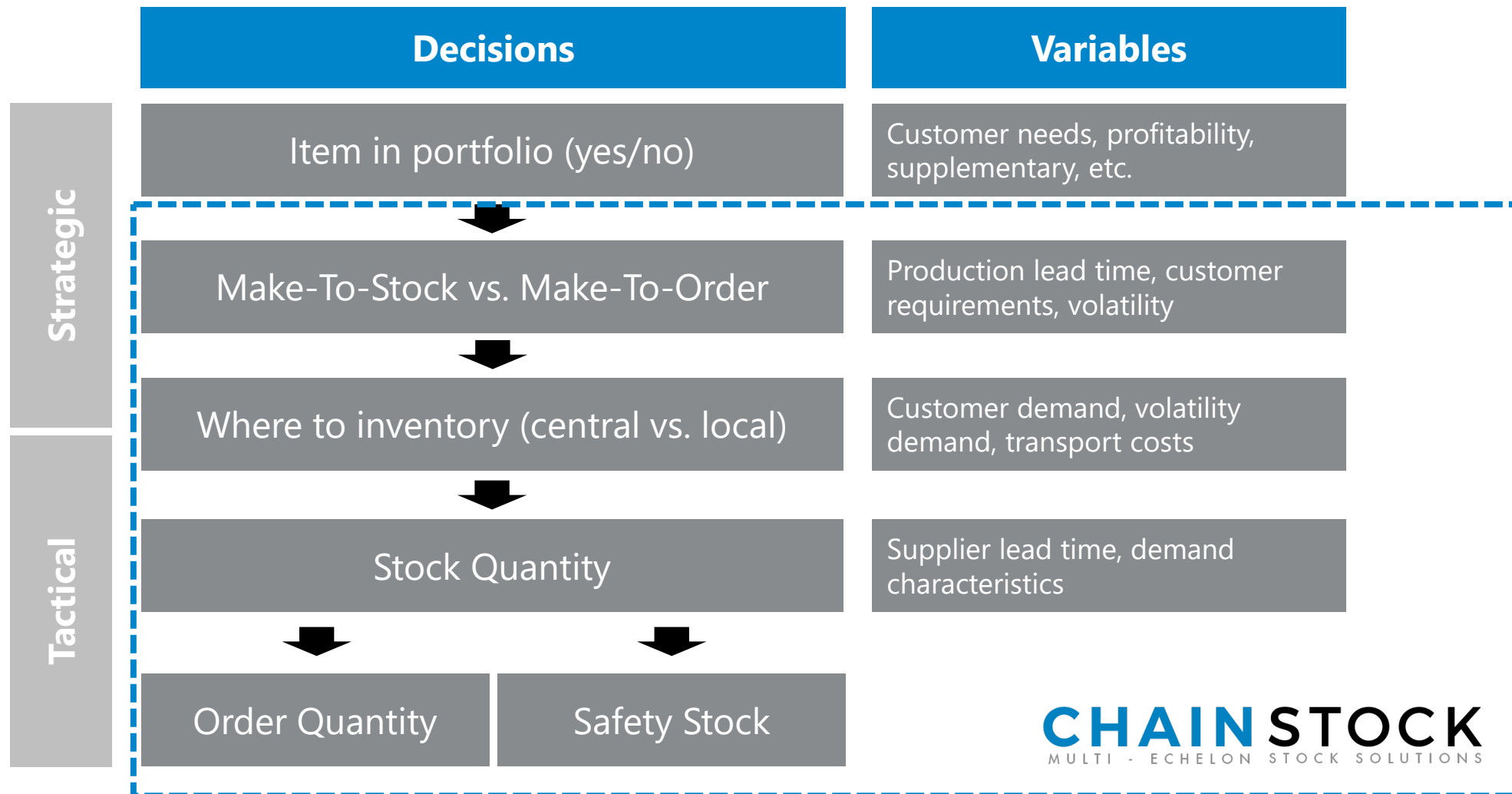
**Mission:** Empower companies to make material planning and inventory (control) a competitive advantage by providing them with innovative software, knowledge and adequate support.

**Product:** ChainStock is a software application offering multi-echelon inventory optimization and -control based on a mathematical model developed by Prof. Ton de Kok from University of Technology Eindhoven. By explicitly representing the supply chain, ChainStock can evaluate & optimize complex supply chain inventory- and service levels in seconds.

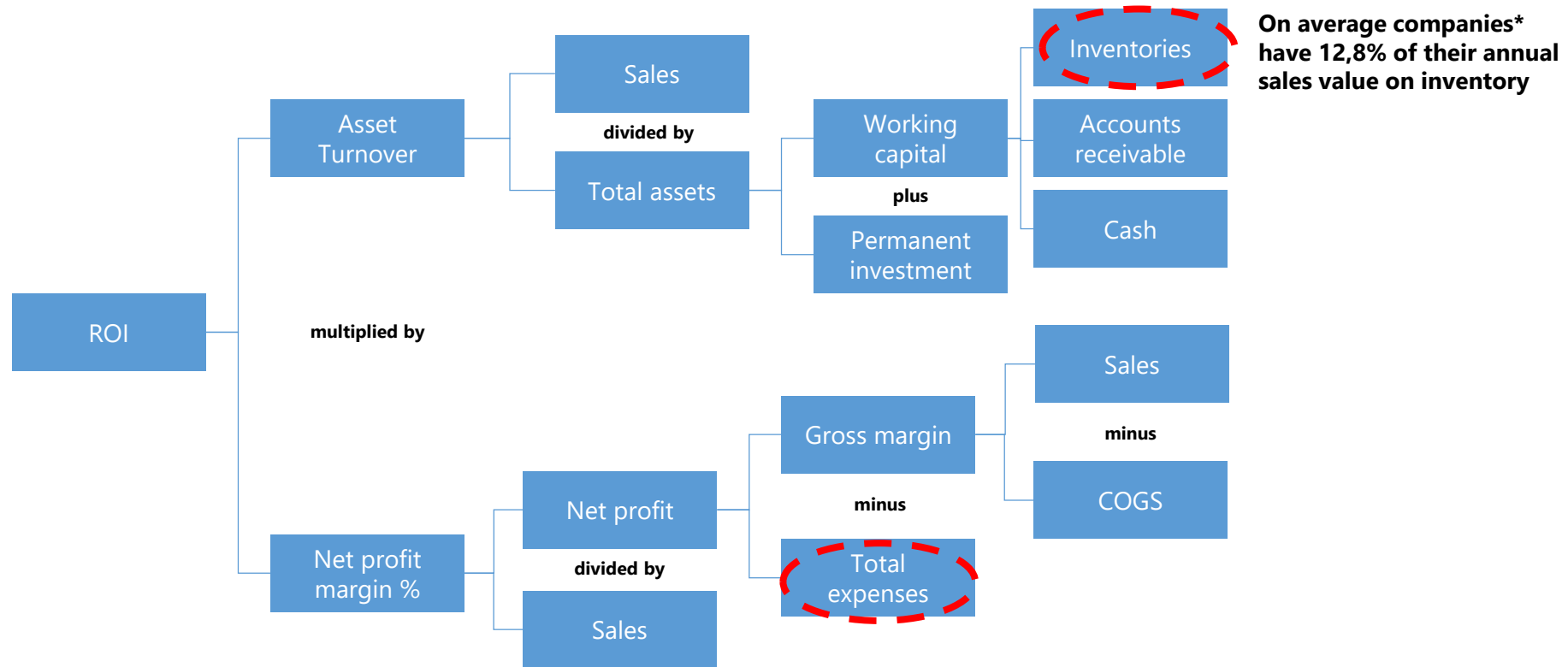
# Why inventory?

- **Strategic:** trading, speculation and risk limitation
- **Capacity:** limited capacity requires stock build (e.g. seasonality)
- **Order quantity:** economic to order more than 1 pcs.
- **Uncertainty:** demand-, supply quantity and lead times
- **Lead time:** Coverage of lead time demand

# Inventory Decision Making



# Impact of inventory on Return On Investment



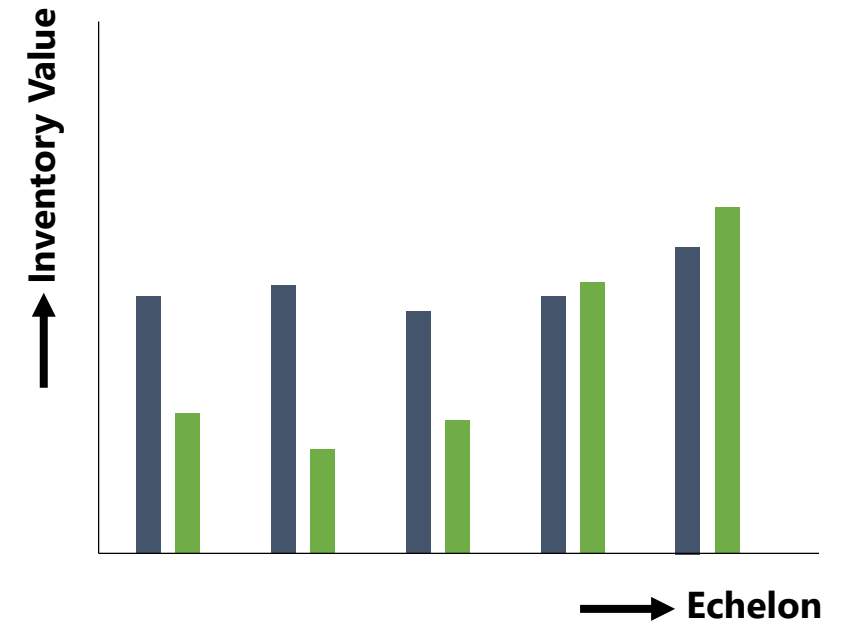
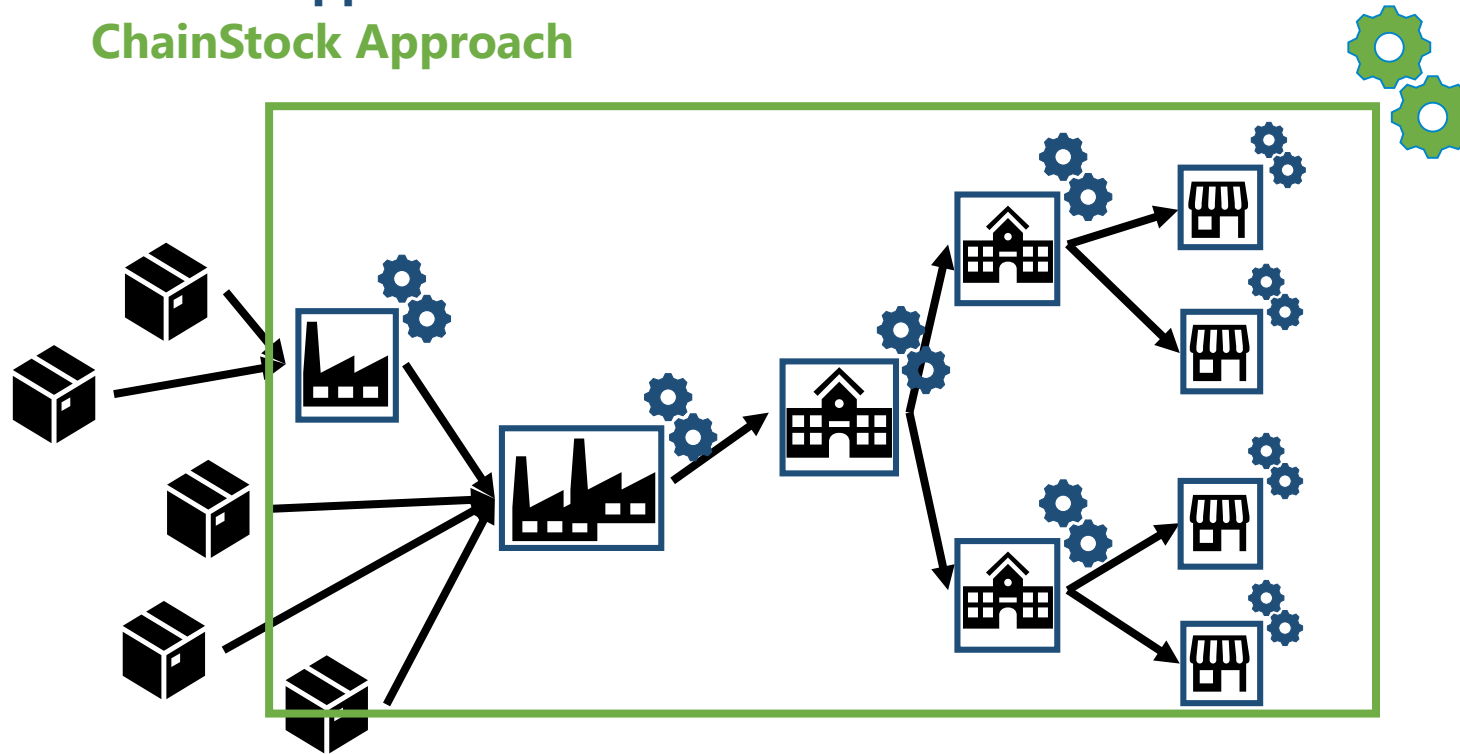
Inventory reduction results in an **increase** of **asset turnover** and **net profit margin**. Meaning that the **ROI** is leveraged from both sides. Efficient inventory (management) is a key issue to become an **industry leader**.

\*source: working capital benchmark PwC July 20

# True Multi-Echelon Inventory Optimization

General Approach

ChainStock Approach



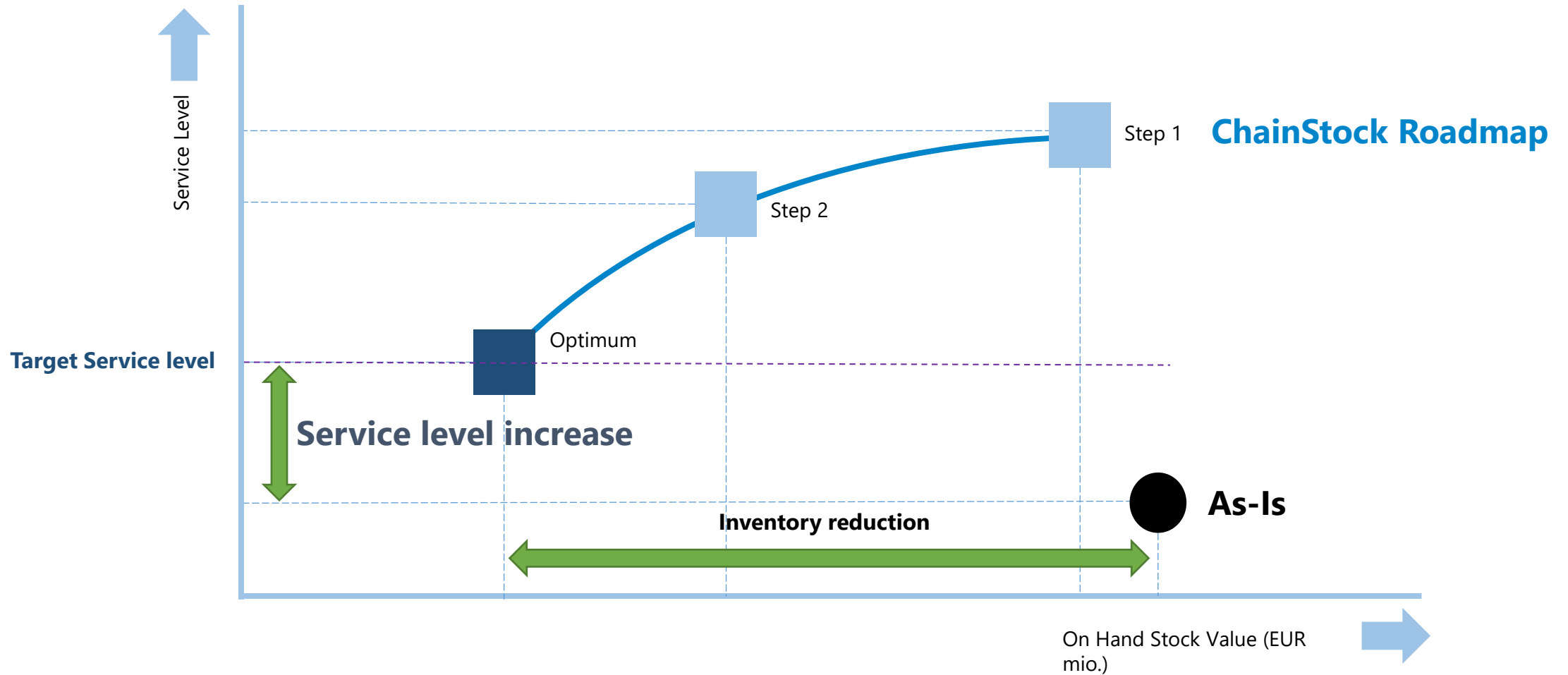
The application of ChainStock in general leads to inventory reductions in the range of 5-30%

# Inventory management scale

## Level of professionalism in inventory management

Symptoms	Level 1	Level 2	Level 3	Level 4	Level 5
	<ul style="list-style-type: none"> <li>• Gut feeling inventory management</li> <li>• Many back orders</li> <li>• No idea about inventory quantities and service level</li> </ul>	<ul style="list-style-type: none"> <li>• Days on inventory policies</li> <li>• Excel based computations</li> <li>• Inventory is monitored</li> </ul>	<ul style="list-style-type: none"> <li>• Basic statistic inventory calculations (P1) based on historic demand</li> <li>• ERP or Excel based computations</li> <li>• Inventory is monitored</li> </ul>	<ul style="list-style-type: none"> <li>• Demand and forecast planning</li> <li>• S&amp;OP processes</li> <li>• Single echelon inventory optimization (P2)</li> <li>• Inventory is monitored</li> </ul>	<ul style="list-style-type: none"> <li>• Demand and forecast planning</li> <li>• S&amp;OP processes</li> <li>• Multi-echelon inventory optimization</li> <li>• Inventory specialist</li> </ul>
Service level:	50-60%	60-80%	80-95%	Up to 99,9%	Up to 99,9%
Saving Potential:	Base Case	Limited	Moderate	High	Very High

# Generate inventory optimization roadmaps



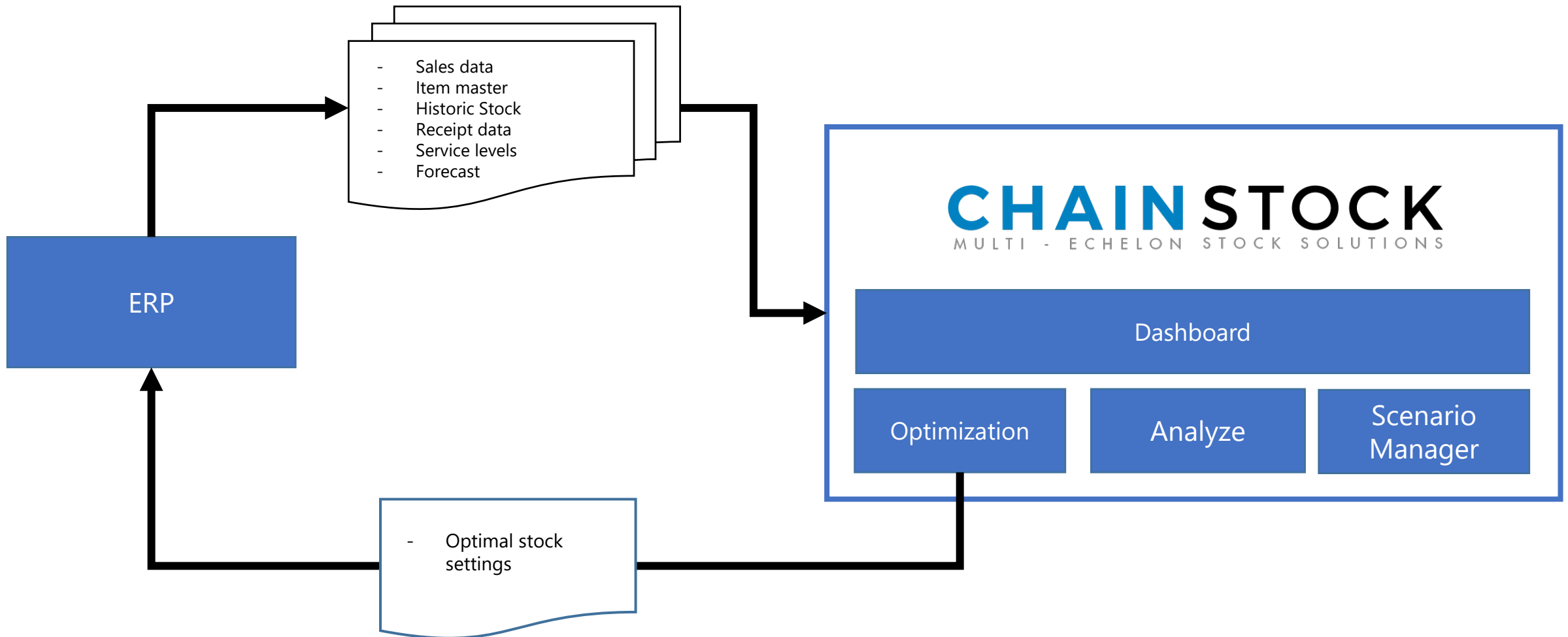


# ChainStock vs. Single and multi-echelon

	Single Echelon*	Multi Echelon (e.g. SAP)	ChainStock
<b>Optimization method</b>	Calculation	Heuristics / Simulation	Optimization based on calculation
<b>Accuracy</b>	Very inaccurate	Inaccurate	Very accurate
<b>Stock inefficiency</b>	20-50%	5-25%	0%
<b>Possibility to evaluate</b>	No	No	Yes
<b>Computation time</b>	Several seconds	Several hours	Several seconds
<b>Demand fitting</b>	Normal distribution	Normal distribution	Gamma/Erlang distribution

*\*Applying single echelon optimization in multi-echelon network*

# Optimization method



# Why ChainStock?

- **Evaluation:** analyzing current and future supply chain strategy scenarios by determining service- and inventory levels on customer-, item- and location level using live data.
- **Service level:** increase of service level with same inventory value and an accurate and predictable performance.
- **Increase of ROI:** Reduction of inventory value and inventory costs.
- **Differentiation:** differentiation of CODP and service level on Product and Customer Combination level.
- **Validated:** the methodology has been applied and validated.

# CHAIN STOCK

MULTI - ECHELON STOCK SOLUTIONS