MIT Supply Chain MANAGEMENT

Multi-Echelon Network Evaluation and Inventory Strategy

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Overview

- **Thesis sponsor – Major global oil field service company**
- **Objective**
  - Assess decentralized vs. centralized material supply model
  - Current Network – decentralized across 30 locations
  - Proposed network – centralized across 3 global distribution centers

Overview

- **Evaluation Metrics**
  - Operations Efficiency
  - Cost Efficiency
- **Scope focus and narrowing**
  - Purchase items (85% of all materials)
  - 3 main segments – drilling, testing and wireline.

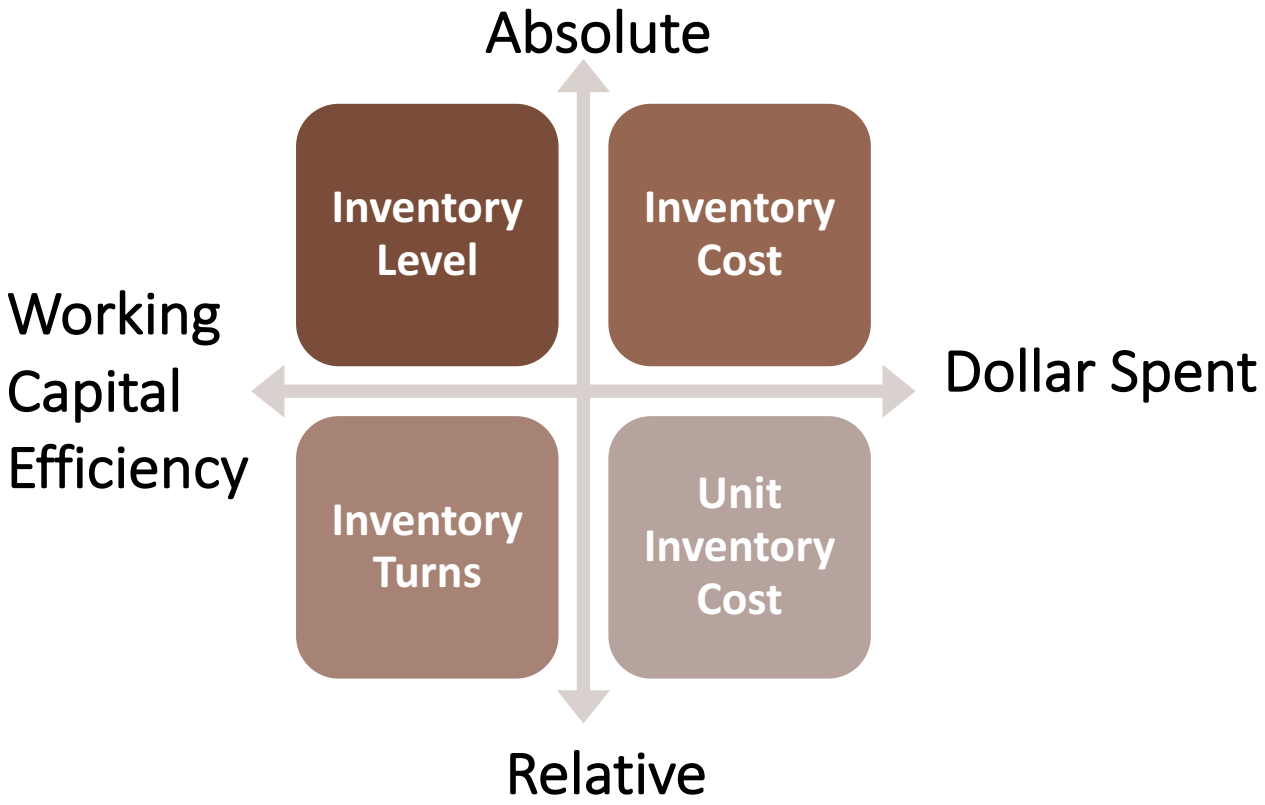
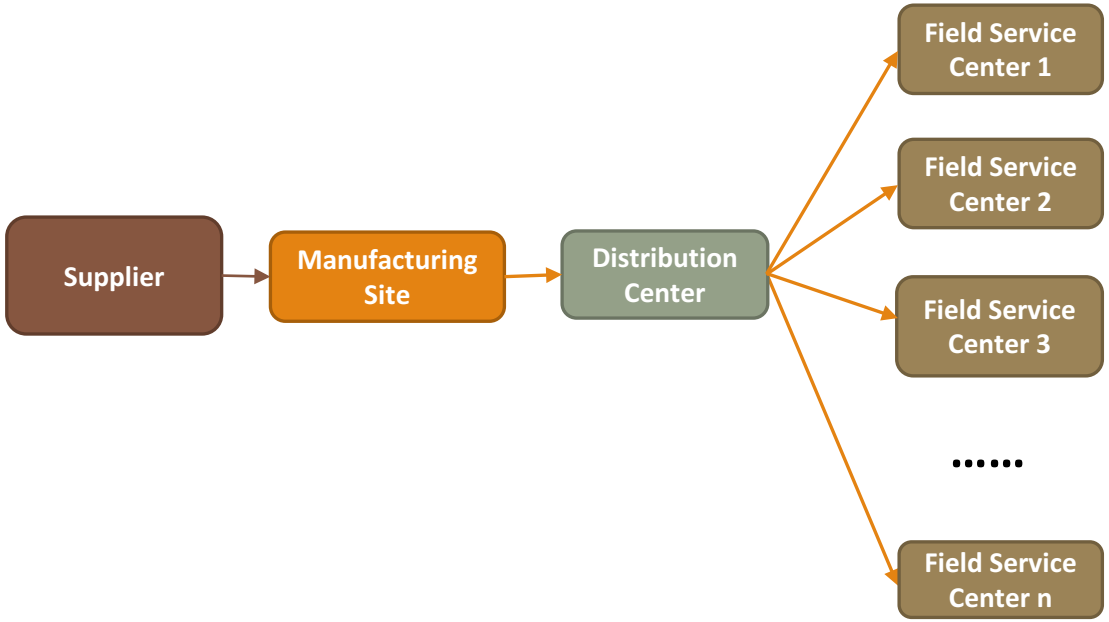
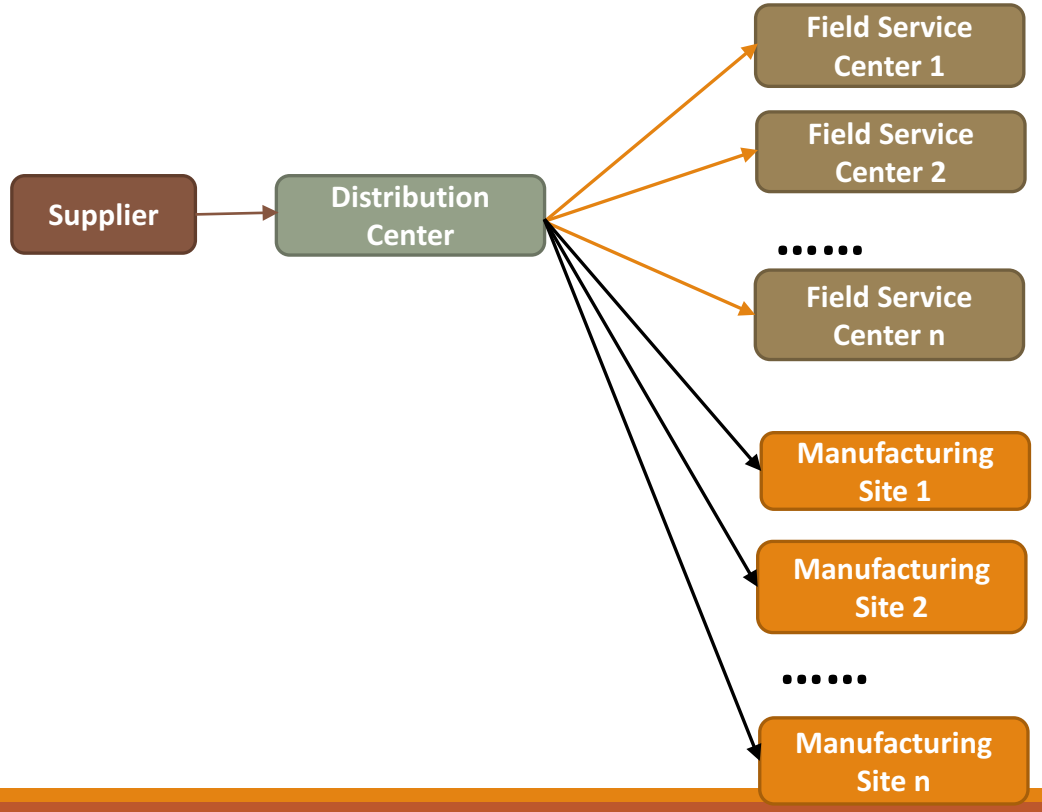


Illustration of current and proposed networks

Current Network
Decentralized Coordination

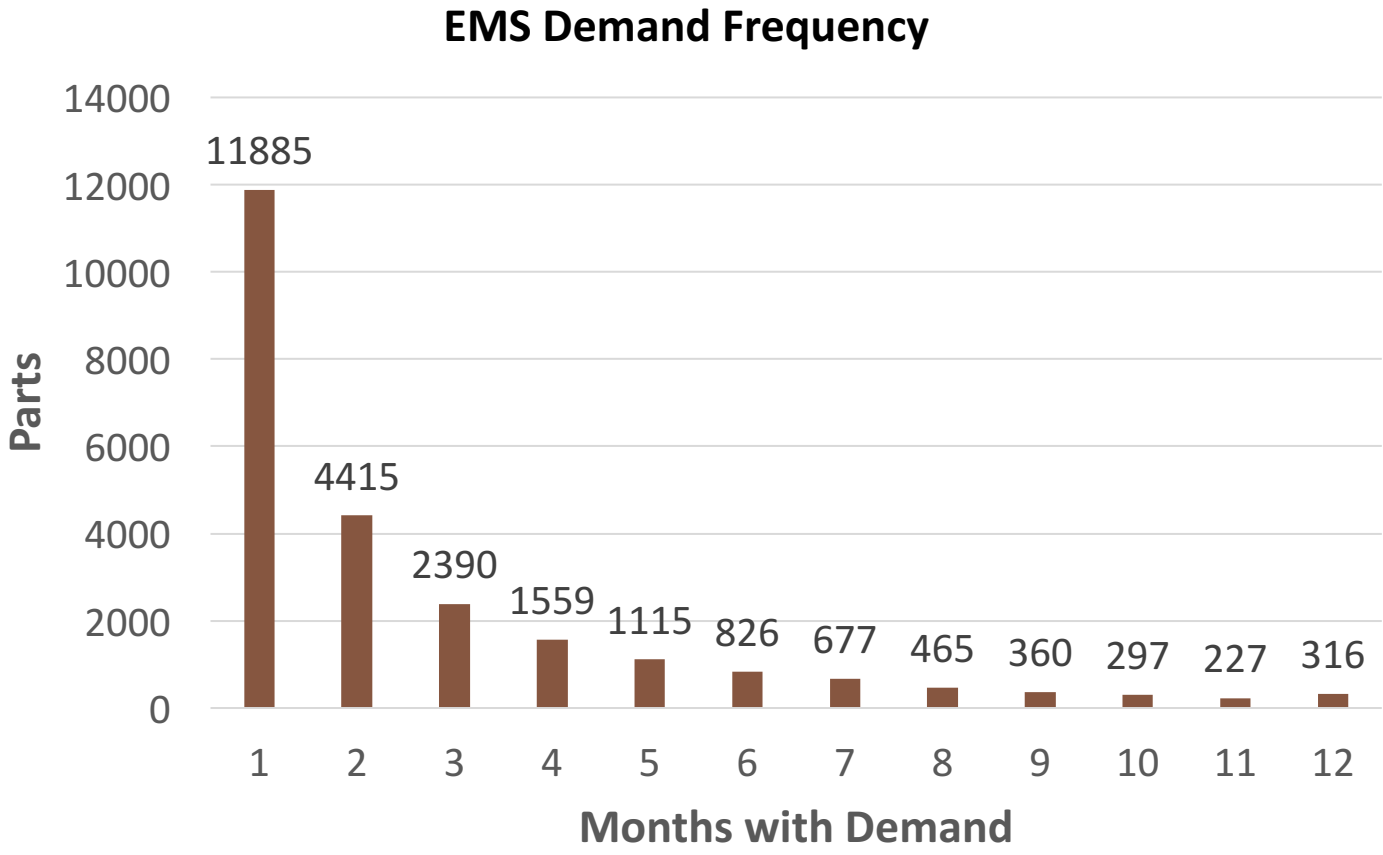


Proposed Network
Centralized Coordination



Demand Profile

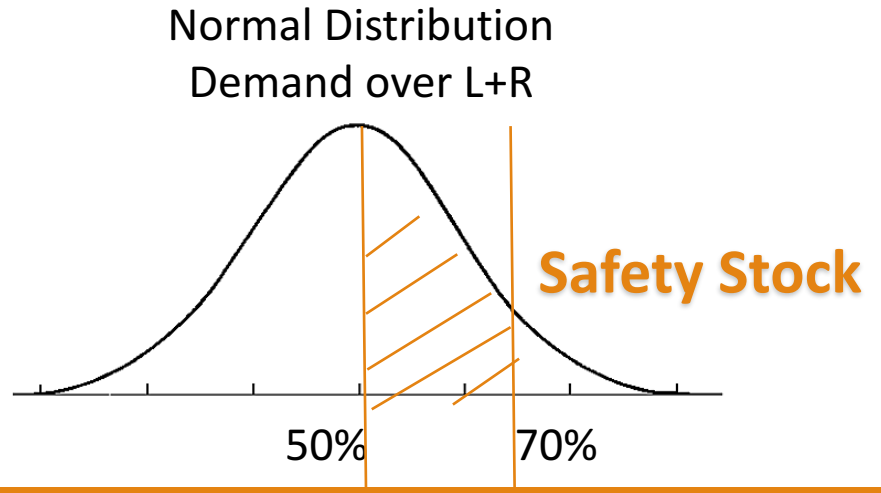
- **Intermittent Demand**
  - EMS & Field Locations
  - Reflects nature of manufacturing process and industry
- **Probability Distribution**
  - Some segments are strong candidates for Poisson distribution



Method

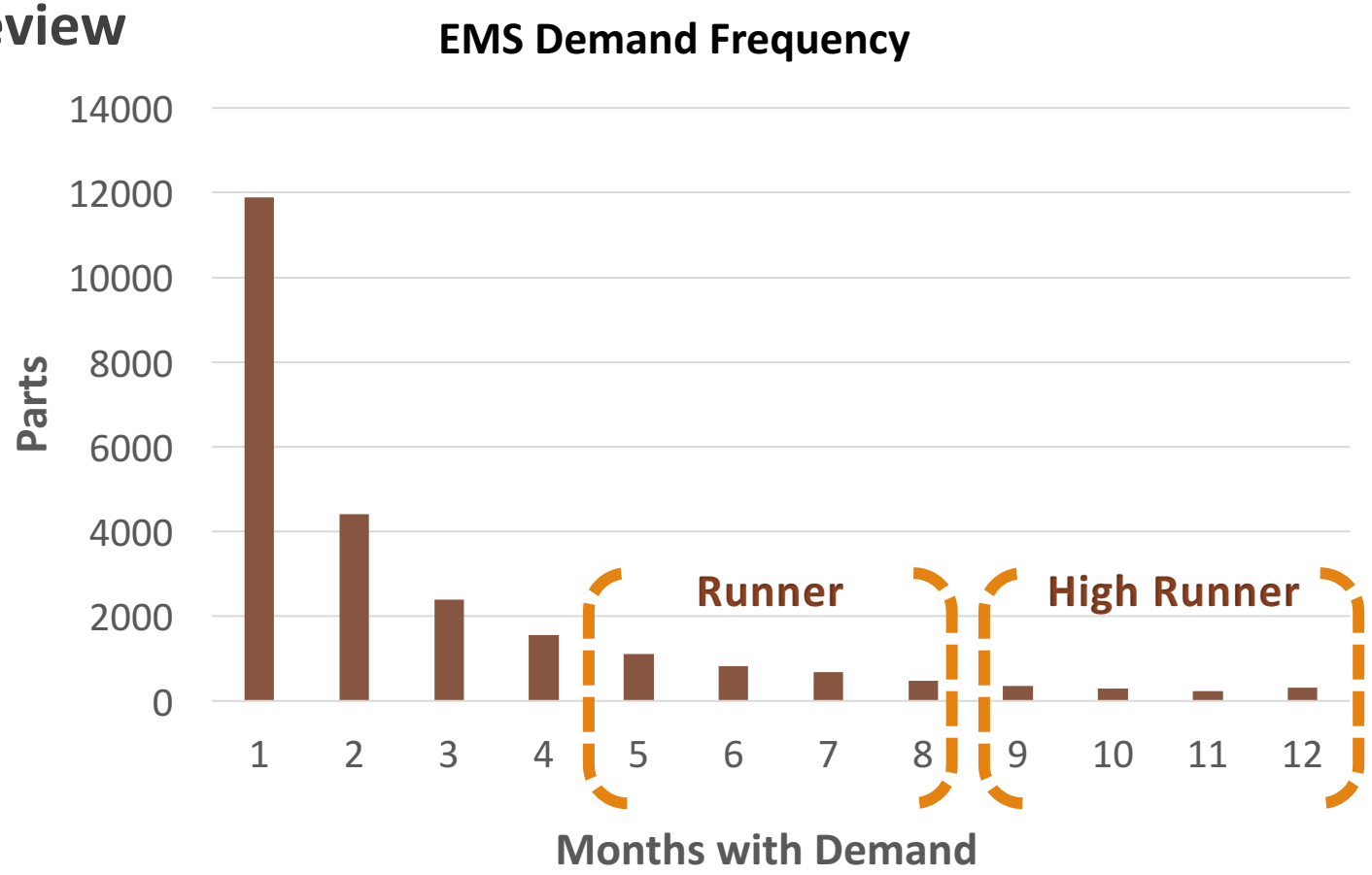
- **Model proposed mode**
  - Base stock replenishment model
  - Weekly Review for replenishment
  - Total Inventory = Safety Stock + Pipeline Inventory
  - Pipeline Inventory = Average Demand / Day x Lead Time by Day
  - Safety Stock

Example
- Demand over L+R ~ 20
- Demand frequency ~ 6



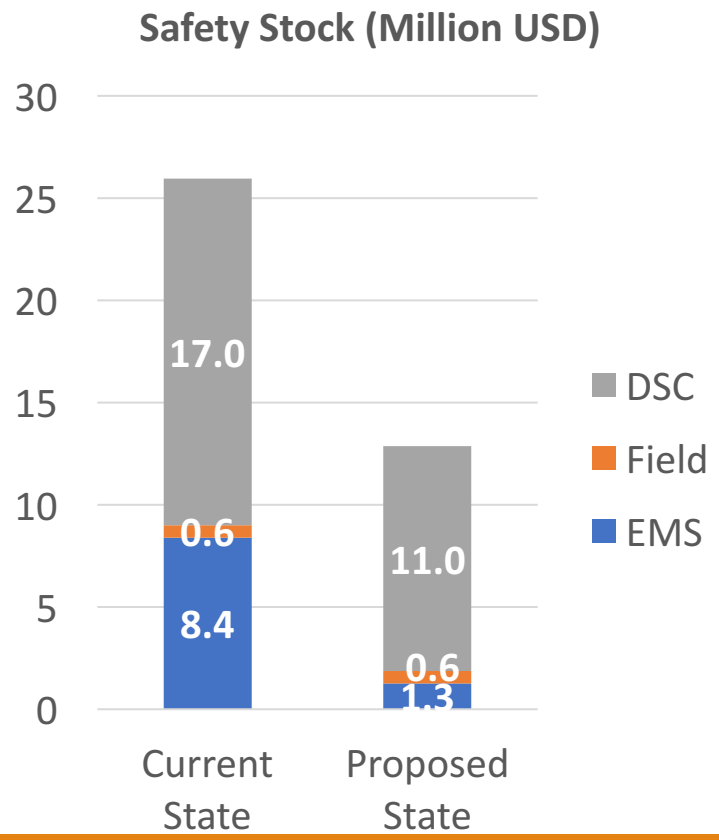
Method Inputs

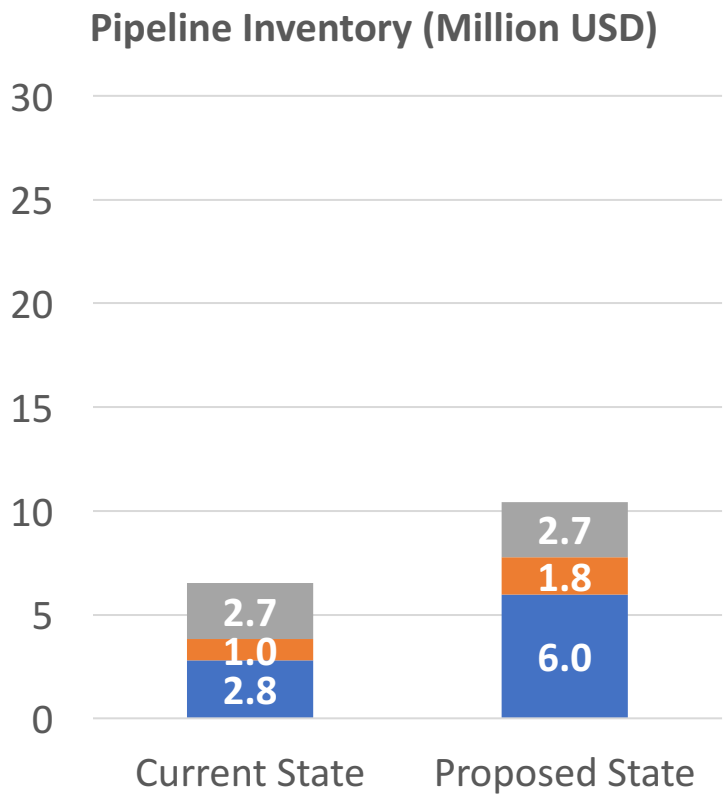
- **Distribution over lead and review time**
  - Poisson if less than 10
  - Normal if greater than 10
- **Service Level Segmentation**
  - High Runner – 85%
  - Runner – 70%
  - Stranger – no safety stock



Result – Initial Evaluation

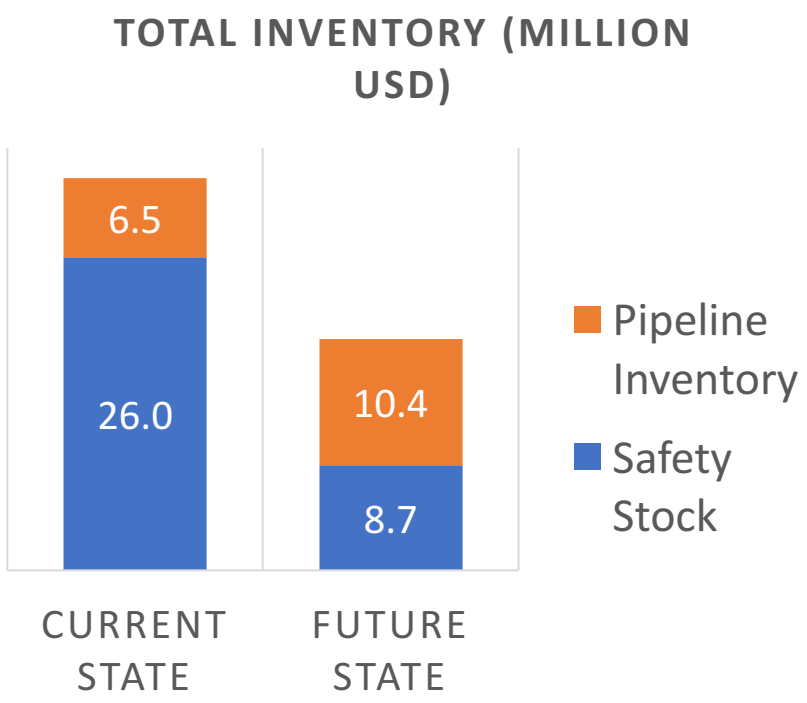
- **Reduction in safety stock outweighs increase in pipeline inventory**

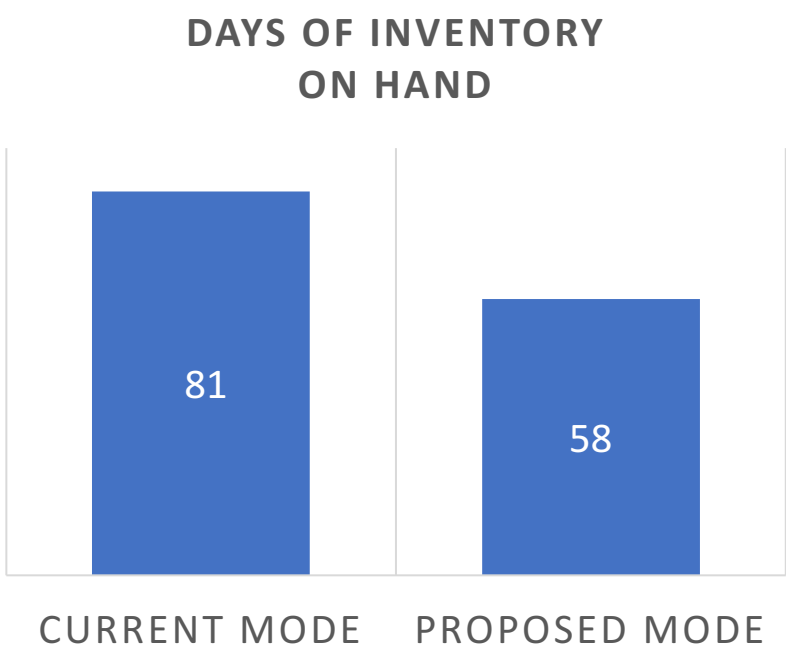




Result – Initial Evaluation

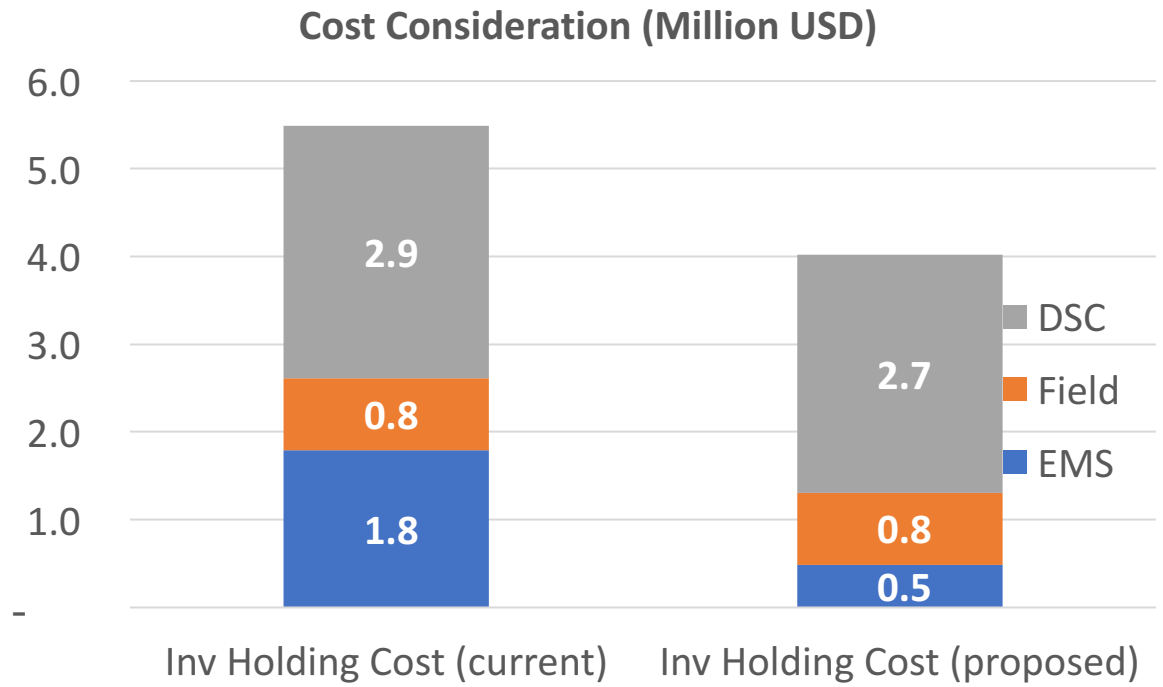
- **Roughly 40% reduction in total inventory**





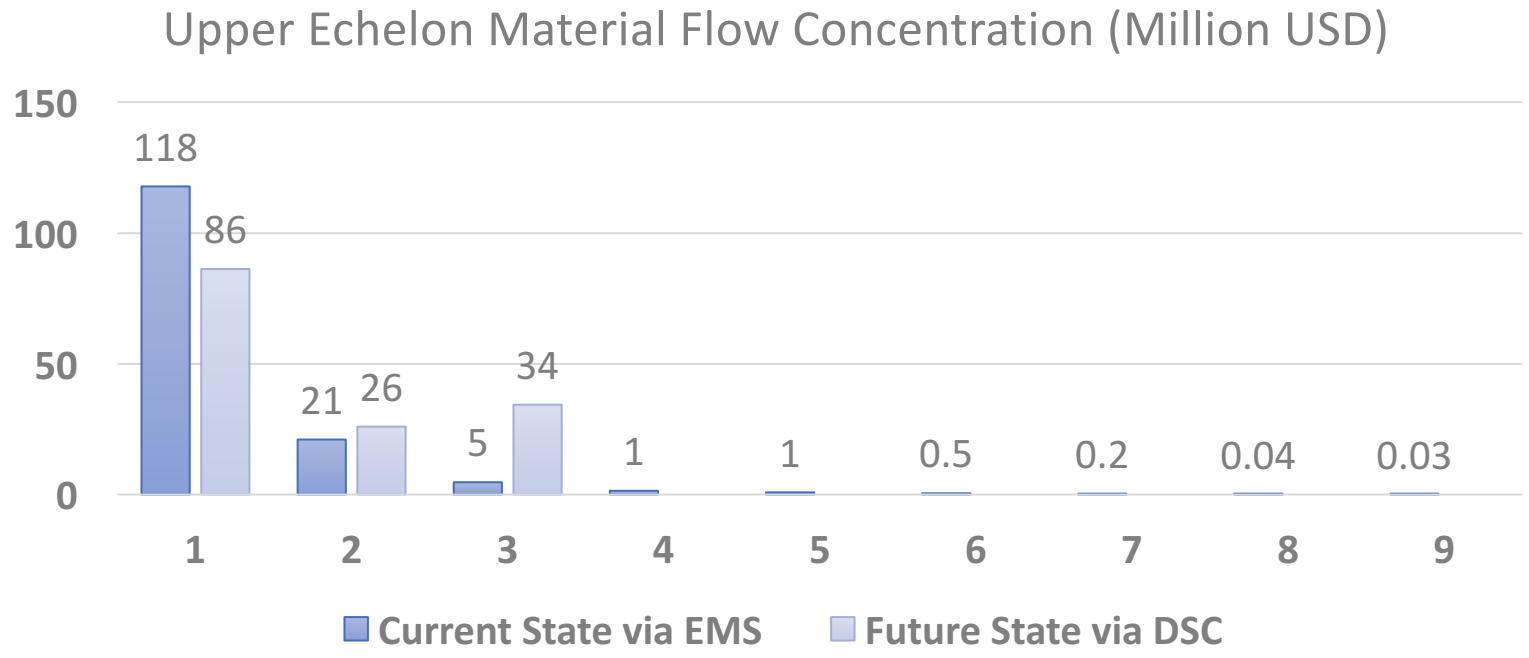
Result – Initial Evaluation

- **Managerial Cost Assumptions**
  - Personnel cost remains constant
  - Order and Review costs remain constant
- **Too good to be true?**
  - Validating the model



Result – Discussion

- **Safety stock reduction of 13.1 million USD… really ?**
- **Fundamental differences between the two systems**
  - Level of demand aggregation



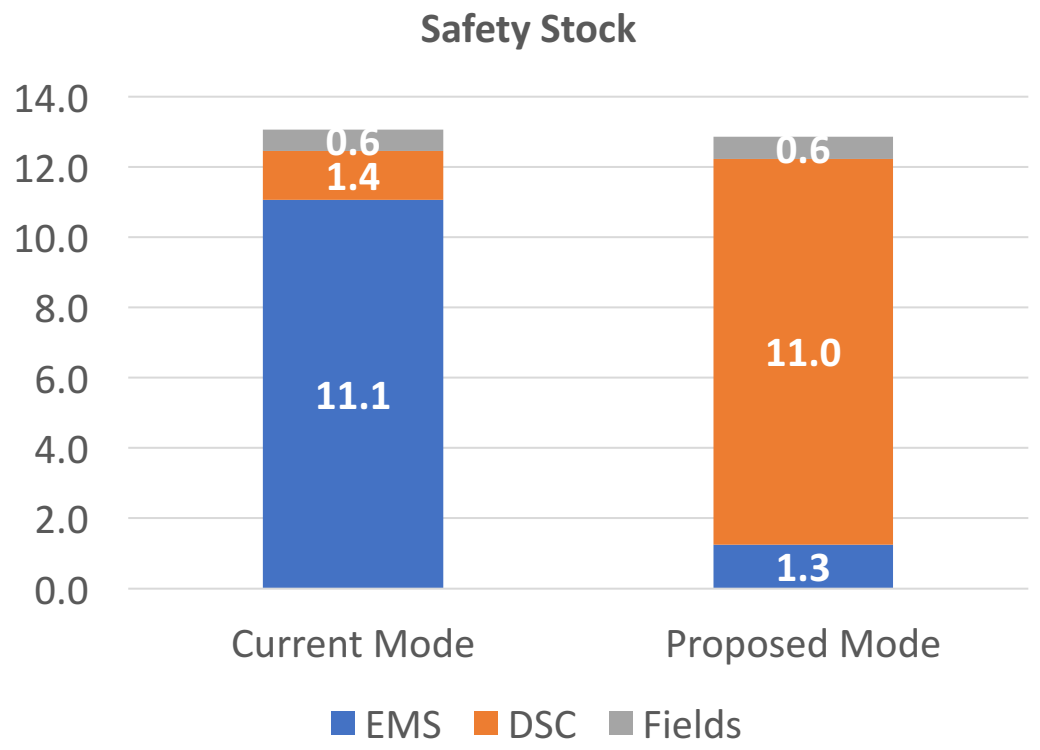
Result – Discussion

- **Tracking demand value**
  - EMS demand (63%) vs. Field Demand (37%)
  - Average part value – EMS (22 USD) vs. Field (6 USD)
- **Tracking transit time**

Average Internal Lead Time	Current Mode	Proposed mode
EMS part	0	18 days
Field part	28 days	7 days

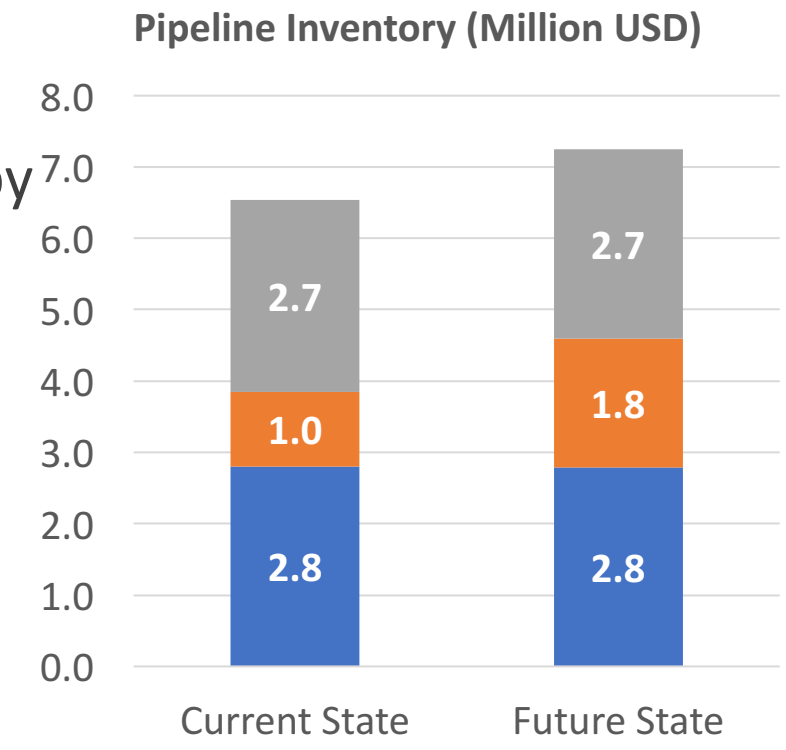
Result – Compare “In-Theory”

- **Model current operations**
  - Same approach as the proposed state
  - Remove excess inventories due to inefficiencies from comparison
- **Compare proposed mode with the “In-Theory” safety stock for current mode**
  - Current Mode = 13.1 million USD
  - Proposed Mode = 12.9 million USD
  - Reduction is now 0.2 million USD or 2%



Result – Compare “In-Theory”

- **Initial assumption of 2x slower materials coordination for proposed mode**
- **If the proposed mode can process as fast…**
  - Proposed mode increases pipeline inventory by 0.8 million
  - This is due to the longer internal transit time with EMS parts, which comprise majority demand



Conclusion

- **Proposed mode could potentially reduce the safety stock by 2% (0.2 million USD), but increase the pipeline inventory by 12.3% (0.8 million USD)**
- **However, there is inefficiency and room to improve the current practice**
  - "In Theory" safety stock is only 13.1 million compared to actual 26 million
  - Recommended further studies include:
    - Inventory policies suitable for slow and infrequent moving demand, e.g. Poisson distribution for extremely low demand parts
    - Cost impact of increasing use of airfreight transport

Q & A

Back up
Other insights

- **Lead time reduction is critical**
  - Pipeline inv. outweighs safety stock
  - Pipeline Inv. = Demand x Lead Time

Future State	Average Lead Time (days)	Current State	Average Lead Time (days)
DSC Process Time	15	EMS Process Time	7
DSC to Field	18	EMS to DSC	7
DSC to EMS	7	DSC to Field	18

- **EMS consume more expensive but slow moving parts**

	Avg Part Value (USD)	%High Runner	%Runner
EMS	22	9%	36%
Field	6	14%	77%

Back up
Scenario Analysis 1 – Reduce Supplier Lead Time

- Safety stock reduction at upper echelon if supplier lead times are shorter
  - More reduction impact with current mode
  - Opportunity to improve current mode

Current Mode			
Lead Time Reduction	**EMS Safety Stock**	**Absolute Reduction**	**% Reduction**
0%	11,077	-	-
3%	10,810	267	2%
5%	10,567	509	5%
10%	10,388	689	6%
15%	10,188	889	8%
20%	9,938	1,139	10%
30%	9,218	1,859	17%
40%	8,691	2,385	22%
50%	8,004	3,072	28%

Proposed Mode						
Lead Time Reduction	**Houston**	**Dubai**	**Rotterdam**	**Total**	**Absolute Reduction**	**% Reduction**
0%	4,087	4,124	2,772	10,983	-	-
3%	4,009	4,085	2,741	10,836	147	1%
5%	4,016	4,088	2,721	10,825	158	1%
10%	3,905	4,054	2,668	10,628	355	3%
15%	3,821	3,720	2,614	10,156	827	8%
20%	3,608	3,704	2,559	9,871	1,112	10%
30%	3,529	3,541	2,443	9,512	1,471	13%
40%	3,251	3,227	2,319	8,797	2,186	20%
50%	2,951	3,048	2,185	8,184	2,799	25%

Back up
Scenario Analysis 2 – Simplify Part Stratification

- Level of safety stock variation at DSC level if part stratification changed from three buckets to two buckets

Part Stratification	HR	Runner	Stranger
Three Buckets	Demand occurs 9 months or above last year (Service Level 85%)	Demand occurs 4 months or above last year (Service Level 70%)	Demand occurs 3 months or below last year (No safety stock)
Two Buckets	N.A.	Demand occurs 6 months or above last year (Service Level 85% or 70%)	Demand occurs 5 months or below last year (No safety stock)

- **Change DSC part stratification in proposed state**
  - Proposed state DSC service both EMS and fields
  - Impact to DSC safety stock depends on the service level defined for runners
  - Minimum change to safety stock (+0.25%) to keep service level at high runner level (85%) for “two buckets”

- **Change DSC part stratification in current state**
  - Current state DSC service only fields
  - Impact to DSC safety stock depends on the service level defined for runners
  - Same level of safety stock between “three buckets” and ”two buckets” if service level for runners defined at 82.5%