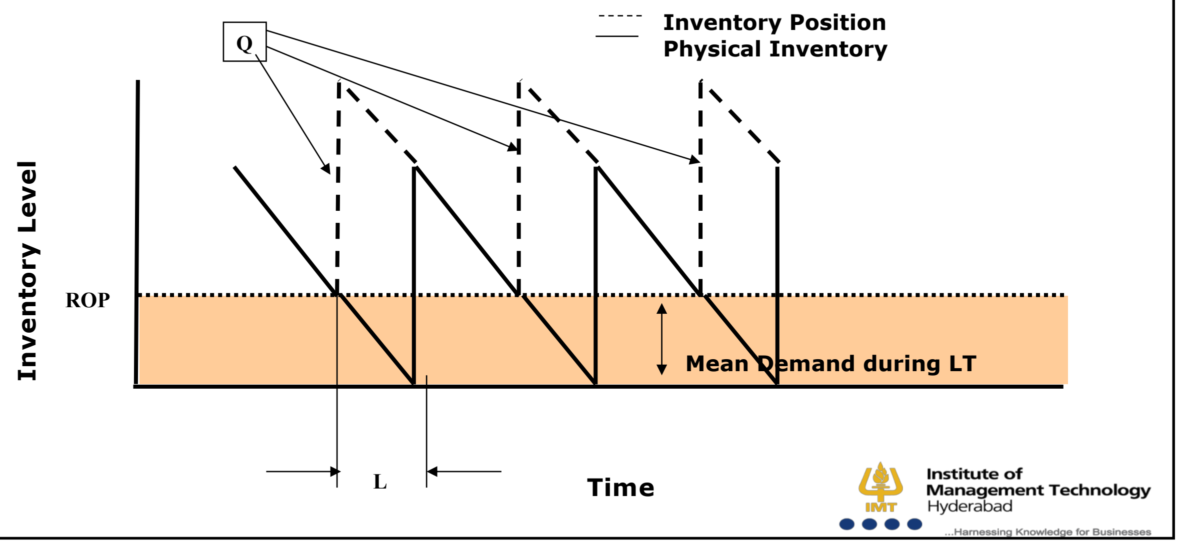
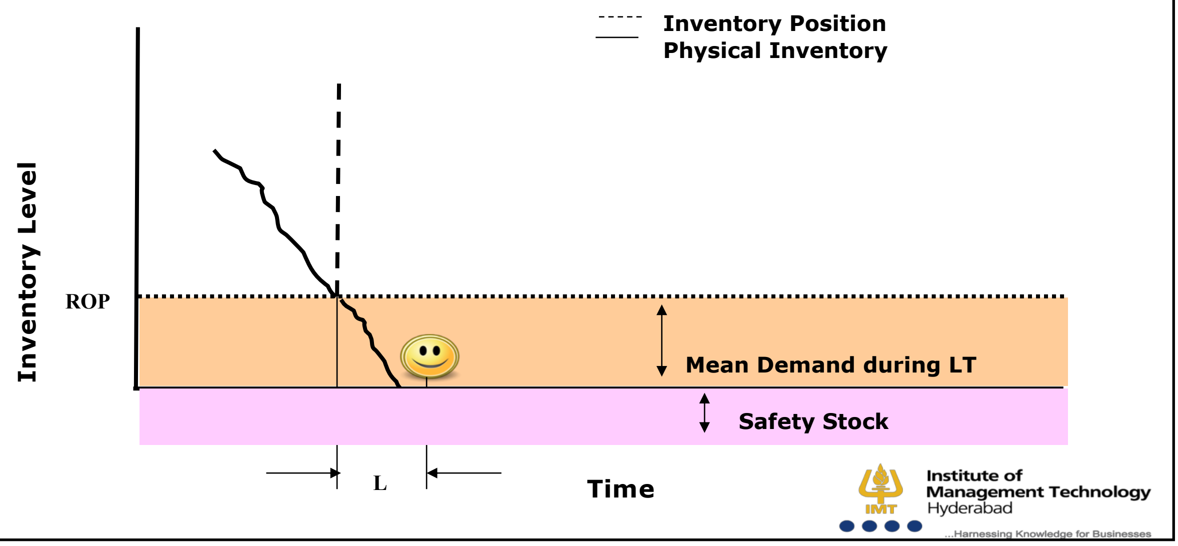
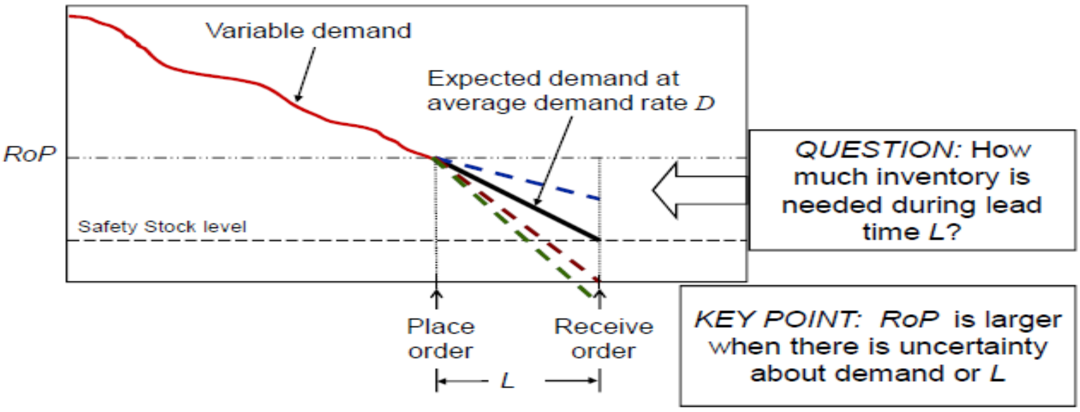
Certain Demand



Uncertain Demand



Back to the multi-period setting



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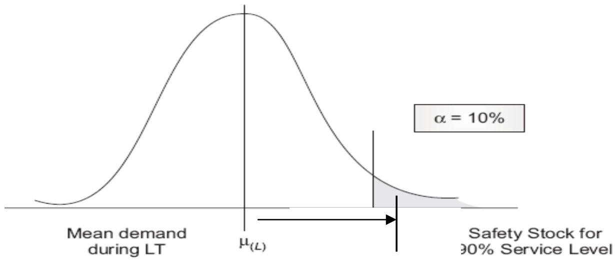
Computing safety stock

Let the demand during lead time follow a Normal distribution
Mean demand during lead-time = $\mu_{(L)}$
Standard deviation of demand during lead-time = $\sigma_{(L)}$
Desired service level = $(1-\alpha)$
The probability of a stock out = α
Standard normal variate corresponding to an area of $(1-\alpha)$ covered on the left side of the normal curve = Z_α



Safety stock (SS) is given by SS = $Z_\alpha * \sigma_{(L)}$

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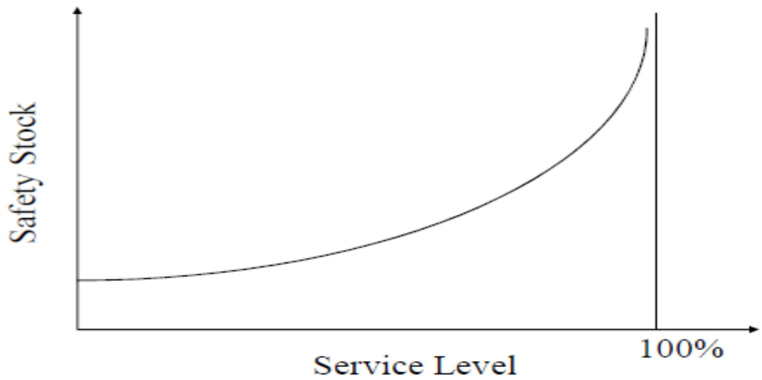
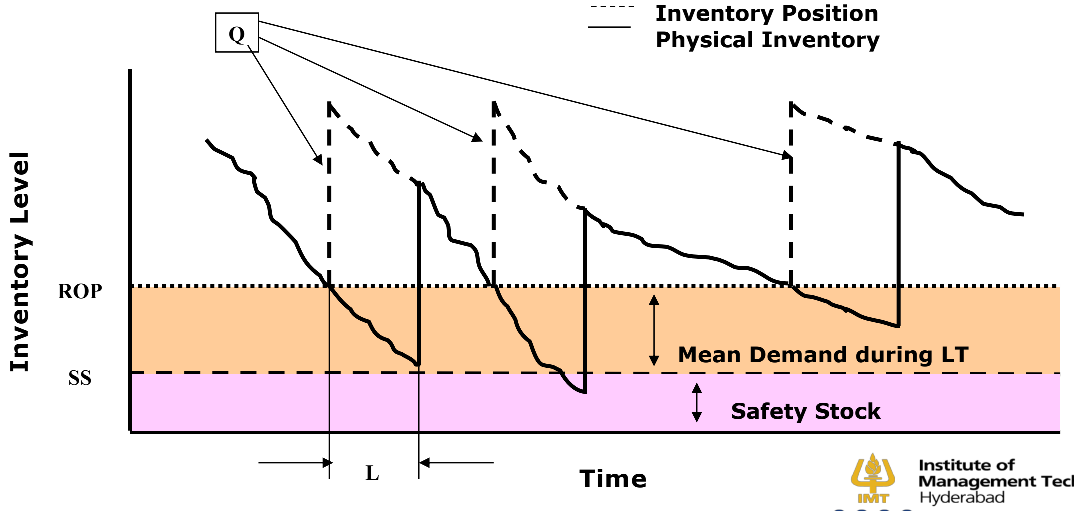
Factors effecting safety stock

- Demand uncertainty (forecast uncertainty)
  - Reducing demand uncertainty (better forecast) reduces safety stock required, reducing material cycle time
- Replenishment lead time
  - Reducing replenishment lead time, improves forecast accuracy, reducing safety stock required (square root factor)
- Variability of supply lead time
  - Reducing variability of supply, improves forecast accuracy, reducing safety stock required

Relationship between Service Level and Safety Stock



Continuous Review (Q) System



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Continuous review policy

L: Lead time
D: Average demand per unit time
σ: Standard deviation of demand per unit time
σ_L :Standard deviation of demand during lead time
ss: Safety stock
k: Safety factor
r: Reorder point
AI: Average inventory
AT: Material Cycle time

$$\sigma_L = \sigma\sqrt{L}$$

$$ss = k \times \sigma_L$$

$$r = D \times L + ss$$

$$AI = \frac{Q}{2} + ss$$

$$AT = \frac{AI}{D}$$

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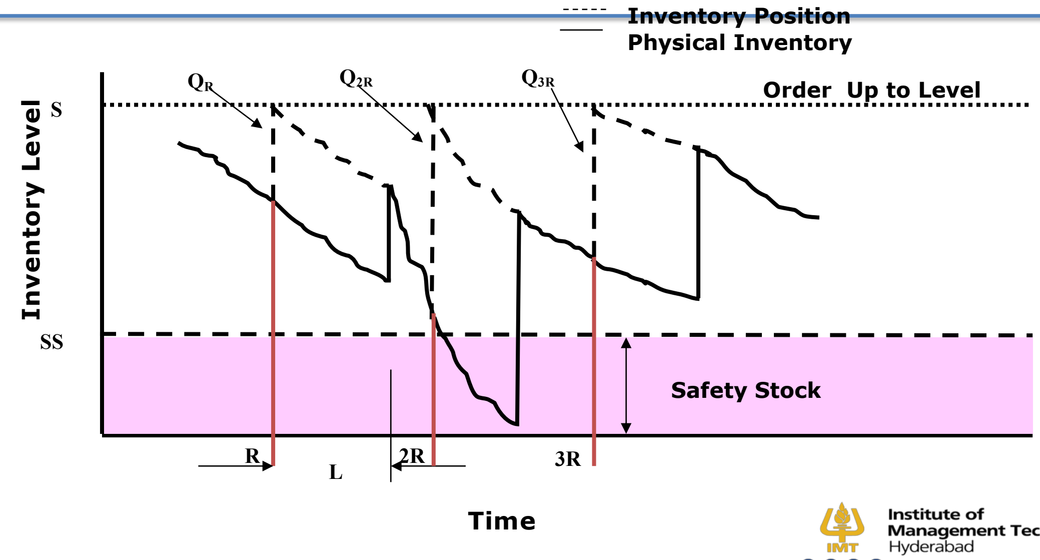
Periodic Review (P) System



Periodic Review policy

L: Lead time
T: Reorder interval
D: Average demand per unit time
σ: Standard deviation of demand per unit time
σ_{L+T}: Standard deviation of demand during L+T periods
F(k): Cycle service level
ss: Safety stock
k: Safety factor
S: Order up to quantity
AI: Average inventory
AT: Material Cycle time

$$\sigma_{L+R} = \sigma\sqrt{L+T}$$

$$ss = k \times \sigma_{L+T}$$

$$S = D \times (L+T) + ss$$

$$AI = \frac{D \times T}{2} + ss$$

$$AT = \frac{AI}{D}$$

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Periodic & Continuous Review Systems

Criterion	Continuous Review (Q) System	Periodic Review (P) System
How much to order	Fixed order qty: Q	$S = \mu_{(L+R)} + Z_{\alpha} \times \sigma_{(L+T)}$ $Q_R = S - I_T$
When to order	$ROP = \mu_{(L)} + Z_{\alpha} \times \sigma_{(L)}$	Every T periods
Safety stock	$SS = Z_{\alpha} \times \sigma_{(L)}$	$SS = Z_{\alpha} \times \sigma_{(L+T)}$
Salient aspects	• Implemented using two bin system • Suited for medium and low value items	• More safety stock • More responsive to demand • Ease of implementation