Inventory 2:
Periodic Safety Stock

- *One-time* safety stock: Uncertain demand and not able to carry inventory
  - Unmet demand is a lost sale
  - Excess product is disposed of
  - Optimal policy: Tradeoff between lost profit and disposal cost
- *Periodic* safety stock: Uncertain demand and/or replenishment lead time, and able to carry inventory
  - Unmet demand is either a lost sale or backordered
  - Excess product is carried over to the next period
  - Optimal policy: Tradeoff with lost-profit or backorder-cost, and inventory carrying cost

Squared Coefficient of Variation

- Provides a normalized measure used to estimate of variance of a process (demand, production, etc.)

$$c = \frac{\sigma}{t} = \text{coefficient of variation (CV)}$$

$$c^2 = \frac{\sigma^2}{t^2} = \text{squared coefficient of variation (SCV)}$$

$$= \begin{cases} 0, & \text{deterministic/exactly (best case, } LB) \\ < 0.75 & \text{low variability} \\ \geq 0.75, < 1.33, & \text{moderate variability} \\ 1, & \text{Poisson} \Leftrightarrow \text{totally random (practical worse case, } UB) \\ \geq 1.33, & \text{high variability (bad control)} \end{cases}$$

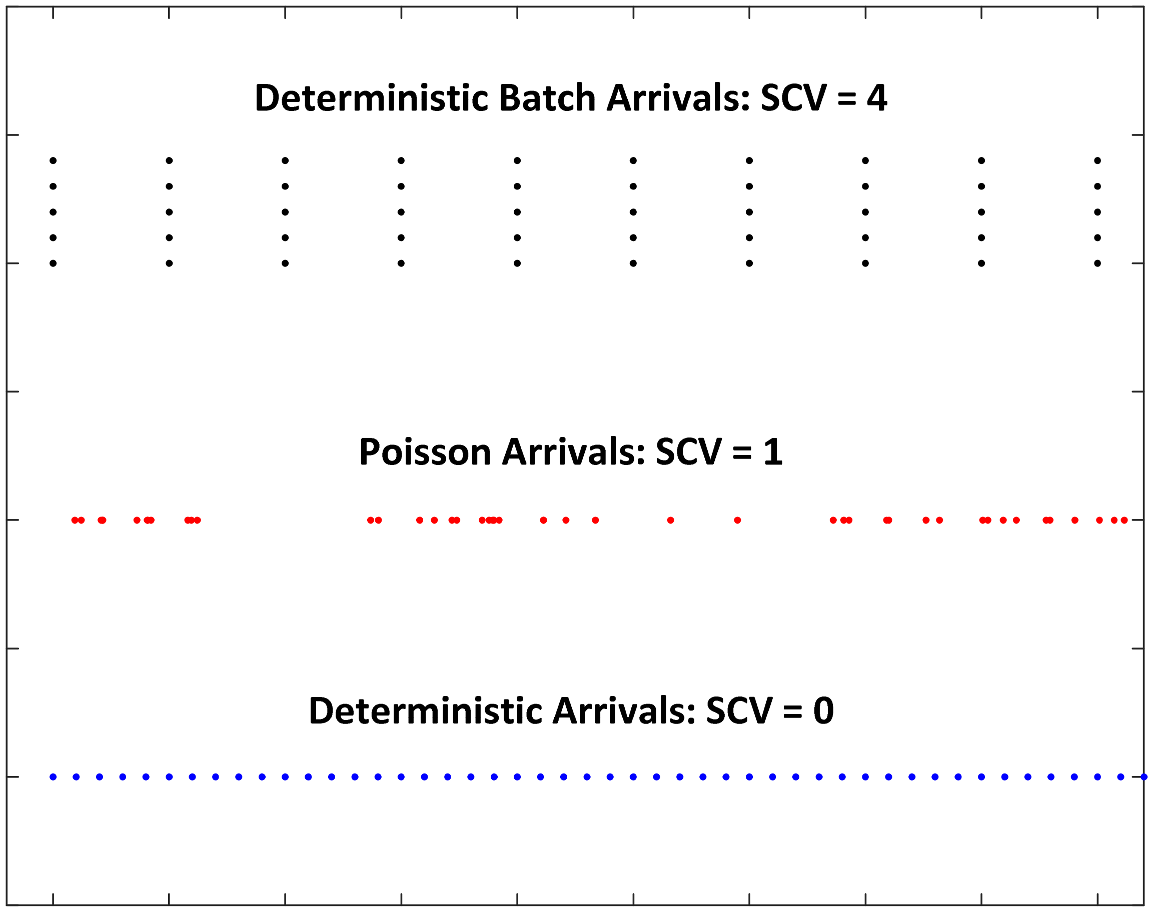
$$\sigma = \text{standard deviation of process}$$

$$t = \text{mean of process}$$

$$\sigma^2 = \text{variance of process}$$

Low, Moderate and High SCVs

- All arrivals have same rate of 10 per hour



Base Stock with Lost Sales

- Pure safety stock
- Seller makes one decision:
  1. Maximum finished goods inventory level
- Control logic for seller:
  – Start with inventory at max level
  – Order replacement after each (unit) customer sale
- Customer fulfilment process:
  – If demand and inventory level > 0, make sale; otherwise, lost sale
- Performance measures:
  1. Out-of-stock percentage
  2. Average inventory level

Optimal Base-Stock Policy

$$\max_{q_{\max}} TP = (p-c)(1-\pi_0)r_a - ch\bar{q}$$

where

$$\begin{aligned} q_{\max} &= \text{maximum inventory level} \\ p &= \text{unit sales price} \\ c &= \text{unit operating cost} \\ \pi_0 &= \text{probability out of stock} \\ r_a &= \text{demand arrival rate} \\ h &= \text{inventory carrying rate} \\ \bar{q} &= \text{average inventory level} \end{aligned}$$

Order Point with Lost Sales

- Safety + cycle stock
- Seller makes two decisions:
  1. Maximum finished goods inventory level
  2. Order point (minimum inventory level)
- Control logic for seller:
  – Start with inventory at max level
  – Order up to max level when level falls below min level
- Customer fulfilment process:
  – If demand and inventory level > 0, make sale; otherwise, lost sale
- Performance measures:
  1. Out-of-stock percentage
  2. Average inventory level
  3. Average number of orders

Optimal Order-Point Policy

$$\max_{q_{\max}, q_{\min}} TP = (p - c)(1 - \pi_0) r_a - ch\bar{q} - c_o \bar{n}_o$$

where

$q_{\max}$ = maximum inventory level

$q_{\min}$ = order point (minimum inventory level)

p = unit sales price

c = unit cost

π_0 = probability out of stock

r_a = demand arrival rate

h = inventory carrying rate

$\bar{q}$ = average inventory level

c_o = fixed cost per order

$\bar{n}_o$ = average number of orders