#### Rules

### Recall

Q: Avg # of jobs in the System

$$Q = \sum_{\hat{i}} Q_{\hat{i}}$$
 (15)

\* general response time

\* Interactive system.
(response time)

\* Bottleneck devices

$$X_{\text{max}} = \min\left(\frac{1}{D_{\text{max}}}, \frac{N}{D+2}\right)$$

Rmin = max(D, NDmax-Z)

# of 30bs, @

\* knee point on throughput

# $N^* = \frac{D+Z}{D_{max}}$ (99)

N < N\* -> no waiting

## Examples

1) Dcpv = 5 sec, N=17 Z = 18 sec,  $V_A = 80$   $S_A = 0.05 sec$ ,  $V_B = 100$   $S_B = 0.03 sec$ ,  $X_A = 17.7$   $S_B = 0.03 sec$ ,  $X_A = 17.7$ Response time ? (inter-active sys)

$$X_A = XV_A \rightarrow X = \frac{15.7}{80} = 0.19625$$

$$R = \frac{N}{x} - Z = \frac{17}{0.19625} - 18 = 68.62$$

a) For a time-sharing sys with disks A & B, the probabilities for Jobs completing the service Q the cpu were found to be eight to A, B.16 to B. The user think time is 5 sec. The disk service time = 30, 25 ms for A, B & 20 ms for the cpu. Using a machine repairman model with central server quelling subsys.

il For each job + Visit ratios

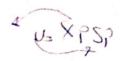
$$P_{CPU,0} = 1 - 0.8 - 0.16 = 0.04$$
 $V_{CPU} = \frac{1}{P_{CPU,0}} = 25$ 

$$V_A = \frac{P_{CA}}{P_{C_{10}}} = \frac{0.8}{0.04} = 20$$

$$V_B = \frac{P_{CB}}{P_{CO}} = \frac{0.16}{0.04} = 4$$

ii) total service demand for each

Bottle Dopu= VopuScpu= 0.5 sec Next > DA = VA SA = 0.6 sec device ) DB = VBSB = 0.1 sec



iii) If disk 4 is 60%, What'R

$$X = \frac{0.6}{0.6} = 1$$

iv) What's the avg response N time where there are 10 users (with same x in ill) ?

$$R = \frac{N}{x} - \frac{2}{2} = \frac{10}{1} - 5 = 580$$

V) Bottlenerk dev -> A

vi) min avg response time

= max (0.5+0,6+0.1,

10(0.6)-5) - 1.2 sec vii) max throughput

$$= min\left(\frac{1}{66}, \frac{10}{1.245}\right) = 1.61$$

viii) max possible disk A utilization.

3) consider the following

a) What changes in CPU Speed that would achieve response timelo

Rmin + max (D, ND max - Z)

$$D_{\text{max}} = \frac{10 + 25}{25} = 0.6 \text{ S}$$

Depu=0.6 But now DA is the bottleheck device

## DA = DCDU = 0.6 SEC

DCPU = VCPU SCPU\*

chang in speed = 
$$\frac{41.67 - 0.04}{41.67}$$

b) find the B. N device if i) CPU Speed is doubled 5 Scpu = 2 Scpu = 0.02 Sec D\* = 0.5 sec Dx = 0.8 Sec, DB=0.08 Sec KB.N 22) Disk tis replaced With a disk twice slow BN DA = 2 x 0.8 = 1.6 sec DCPU = 1 SEC , DB = 0.8 SEC 121) If memory size is reduced so that jobs make 20 move times to disks due to increased Page faults VB\* = 4+20=24  $\rightarrow D_B^* = V_B^* S_B = (24)(0.02) = 0.48$  $V_{CDU} = 1 + V_A + V_{B_{24}}^* = 45$  $D^*_{CPJ} = V^*_{CPJ} S_{CPJ} = (45)(0.04)$   $D^*_{CPJ} = V^*_{CPJ} S_{CPJ} = (45)(0.04)$   $D^*_{A} = 0.8 \text{ SeC}$   $D^*_{A} = 0.8 \text{ SeC}$