Introduction to Transportation Systems

PART II:

FREIGHT TRANSPORTATION

Chapter 15:

Railroad Terminals:

P-MAKE Analysis to Predict Network Performance

Terminals

- Terminal performance is a major determinant of network performance.

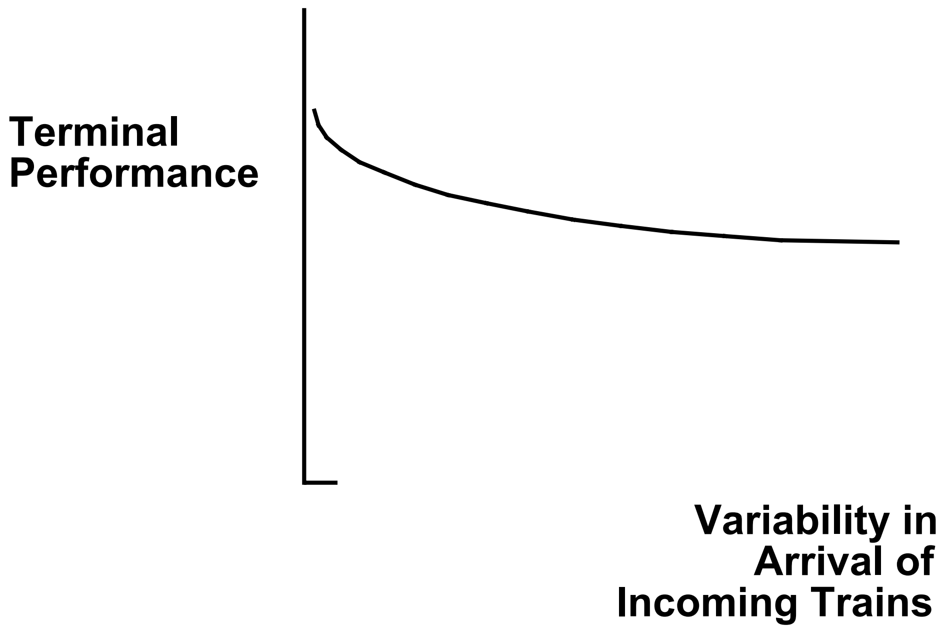
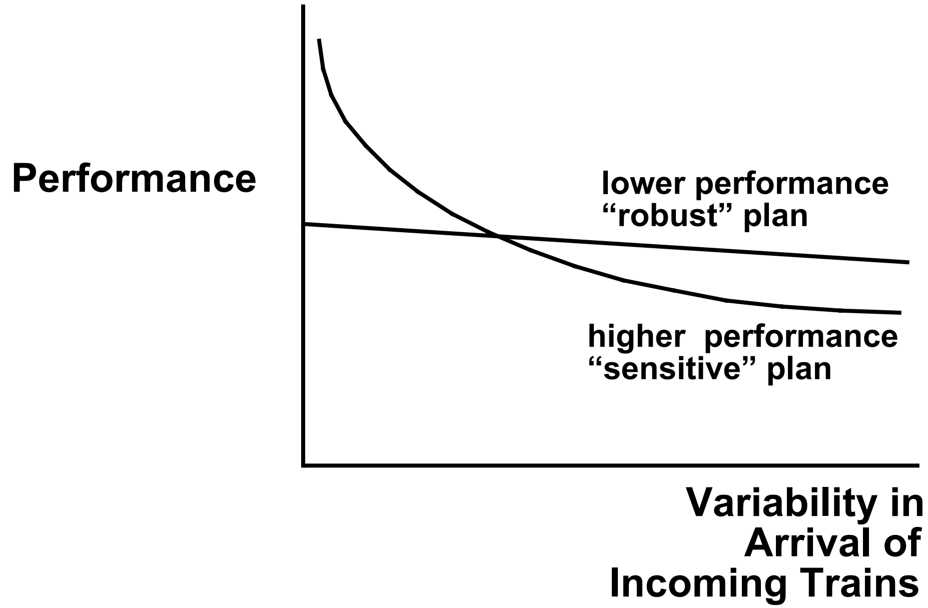


Figure 15.1

Terminal Performance: Another Look



Performance includes a measure of cost -- if one is measuring terminal performance not only on throughput of the terminal but also on the resources used -- robustness may involve a more conservative use of resources. It may involve having redundancy in the system.

Figure 15.2

LOS and Routing over the Rail Network

- Level-of-service in rail freight operations is a function of the number of intermediate terminals at which a particular shipment is handled.
- Empirical research shows the major determinant of the LOS is not the distance between origin and destination, but rather the numbers of times the shipment was handled at intermediate terminals, which is really an operating decision on the part of the railroads.

Direct Service

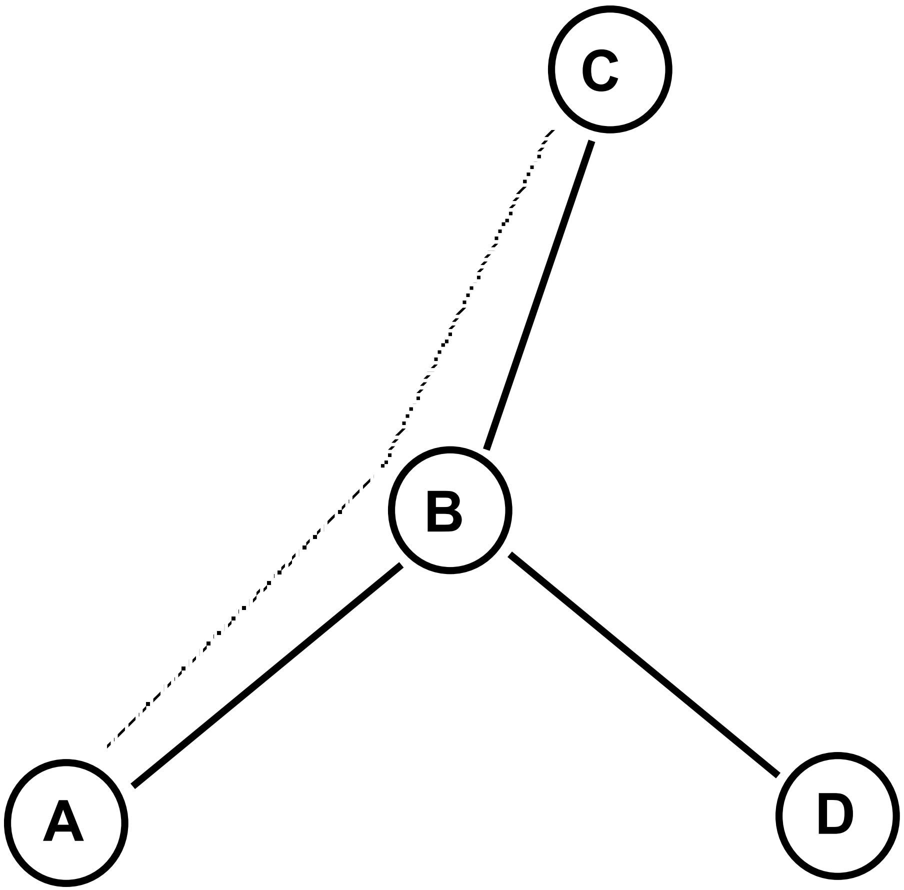
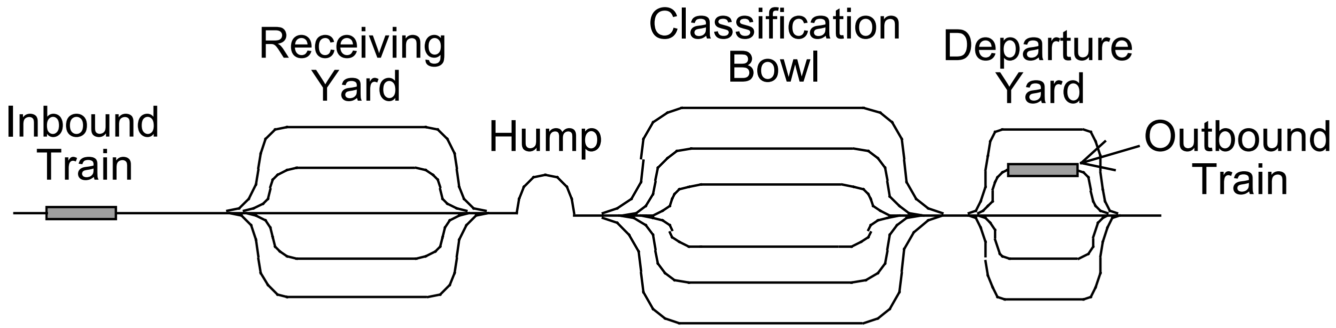


Figure 15.3

Terminal Operations

Classification Yard



A P-MAKE Function

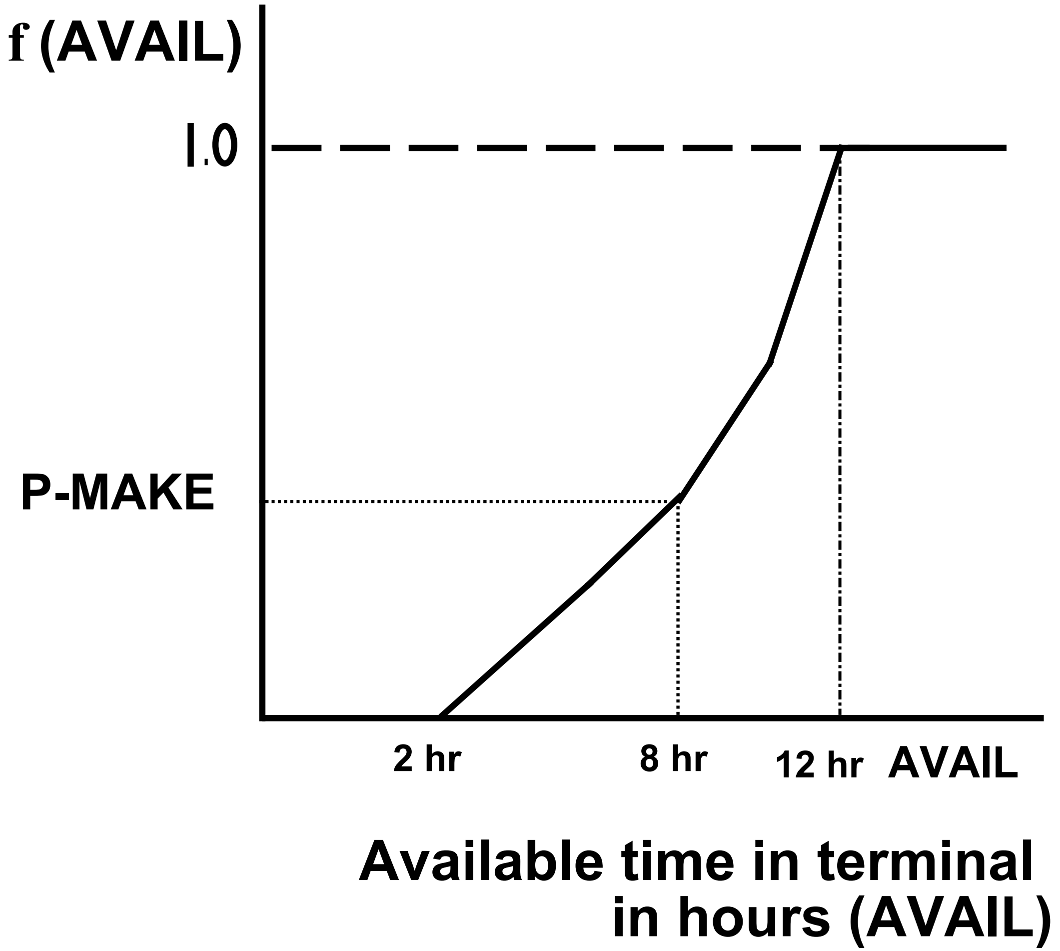


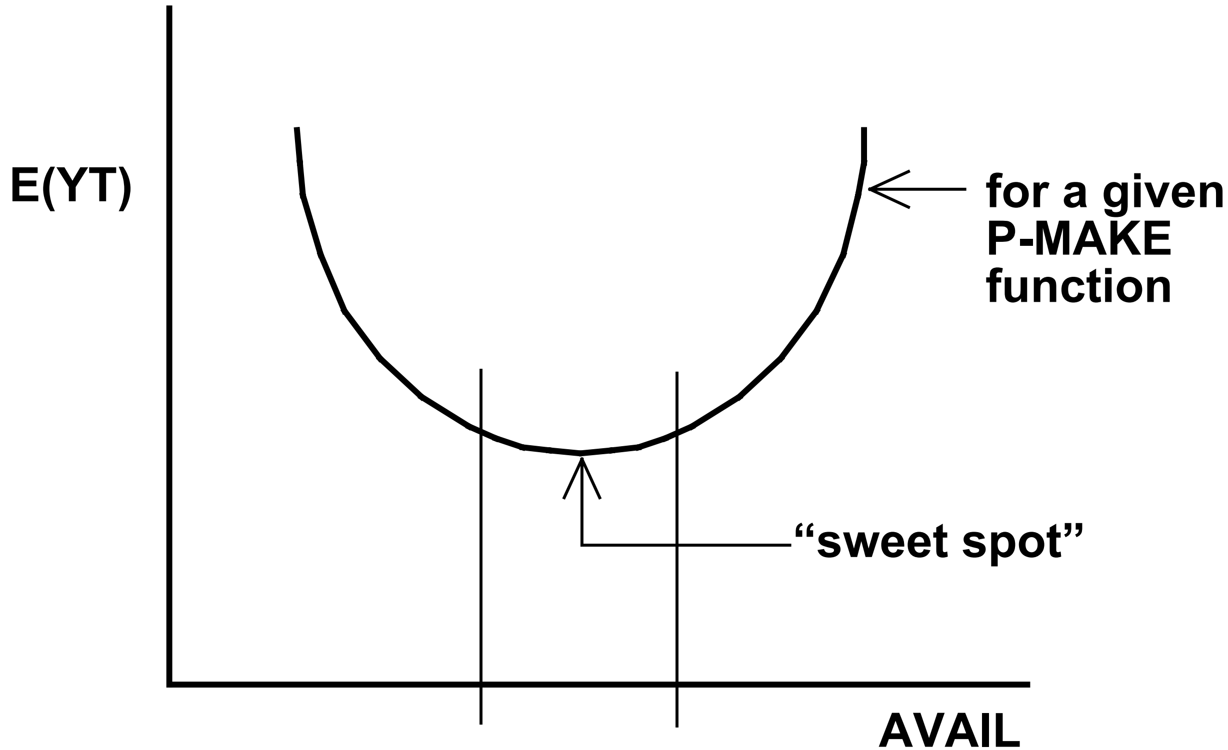
Figure 15.5

Average Yard Time

Now, average yard time -- E(YT) -- will be a function of the available time (AVAIL) to make that connection. In this model, E(YT) -- the average yard time -- will have two components -- the time spent in the yard if the connection is made, in which case, with probability P-MAKE, the terminal time is AVAIL. With probability (1 - P-MAKE), the car will spend (AVAIL + the time until the next possible train).

E(YT) = P-MAKE * (AVAIL)

+ (1 - P-MAKE) * (AVAIL + time until next possible train)



We can calibrate these curves and calculate an "optimal" AVAIL for the particular terminal.

Figure 15.6

Origin-Destination Performance

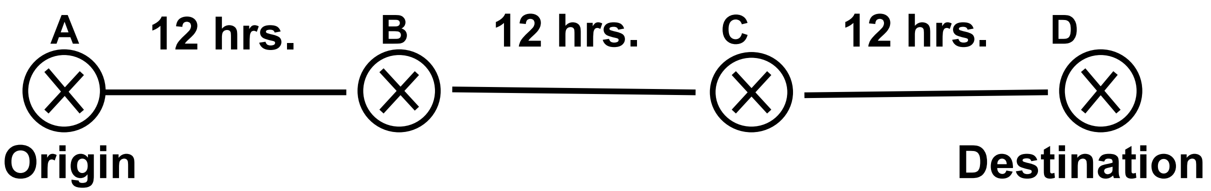


Figure 15.7

P-MAKE Functions

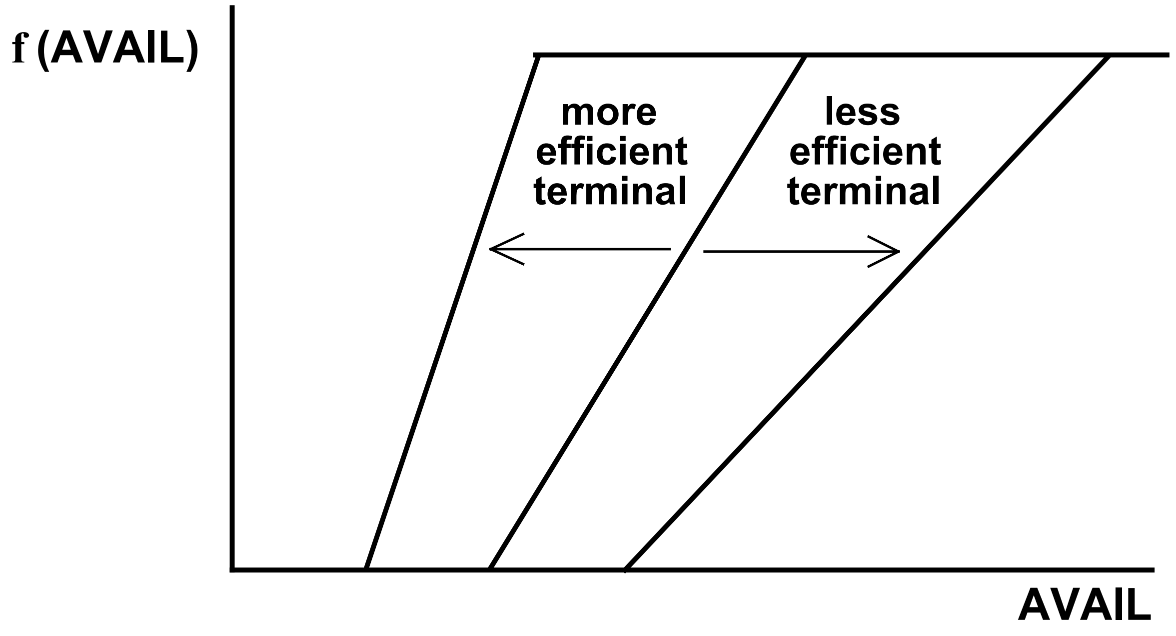


Figure 15.8

Another P-MAKE Function

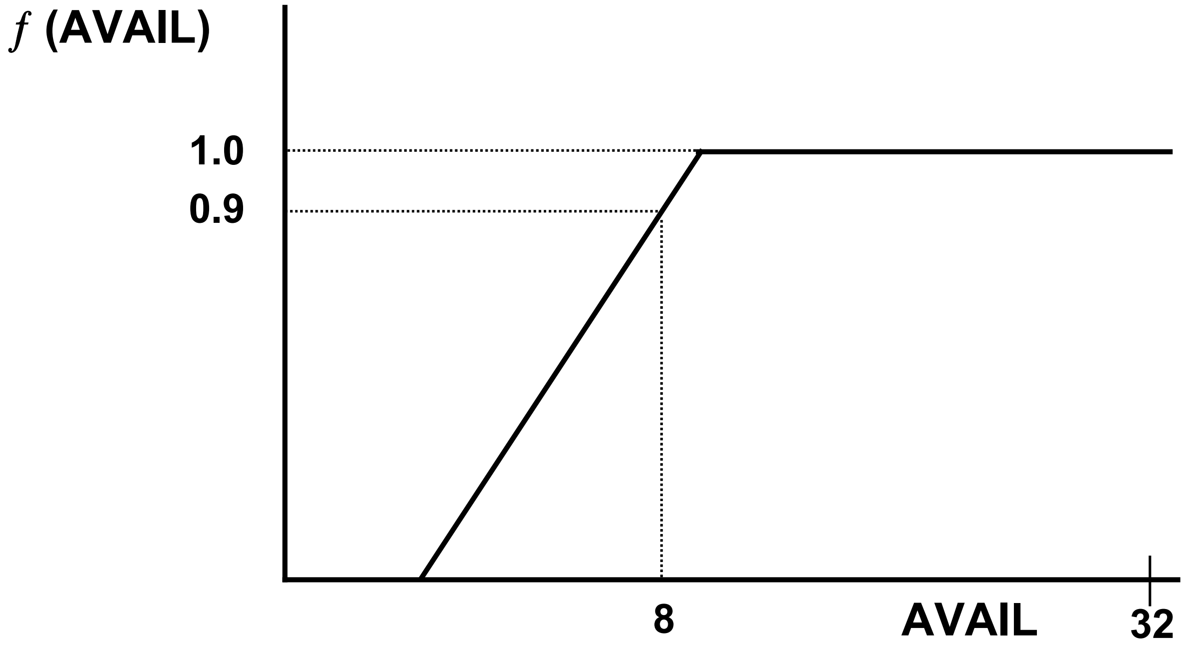
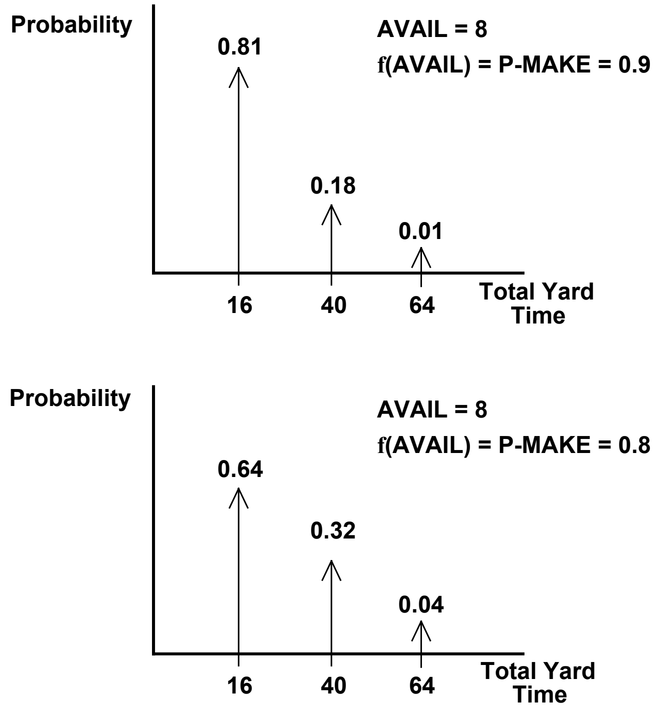


Figure 15.9

Missed Connection	Probability	Yard Time (for AVAIL = 8 for both yards)
0	$[f(AVAIL)]^2$	16
1	$2\ f(AVAIL)*[1-f(AVAIL)]$	40
2	$[1-f(AVAIL)]^2$	64

Total Yard Time as a f(Avail)



f(AVAIL) = P-MAKE = 0.9

Average O-D Time = 56.8

Variance O-D Time = 103.7

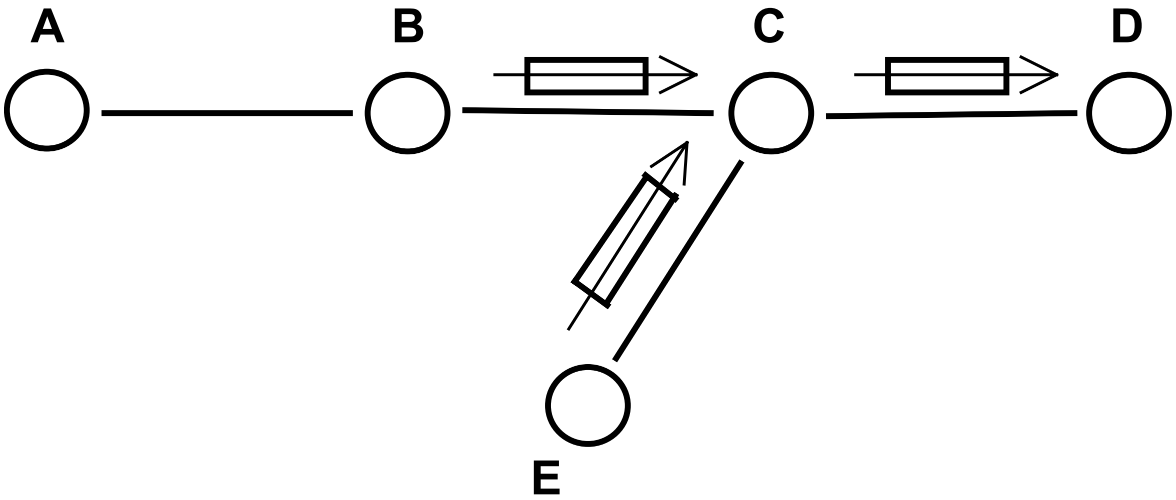
f(AVAIL) = P-MAKE = 0.8

Average O-D Time = 61.6

Variance O-D Time = 184.3

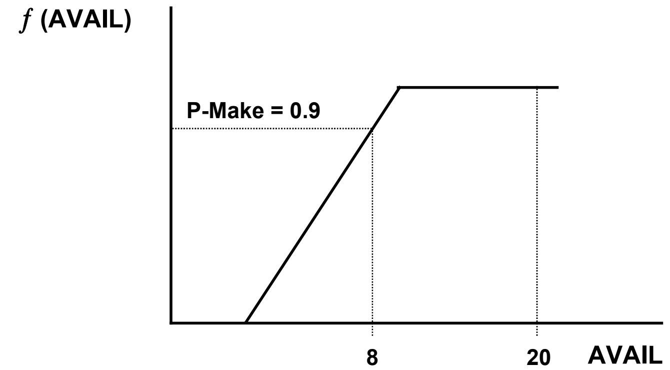
Figure 15.10

Available Yard Time

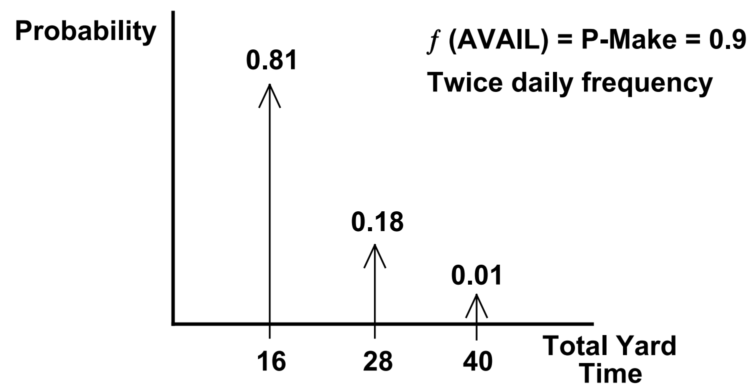


More Frequent Trains (1)

- P-MAKE Function



- Total Yard Time



Average O-D Time = Average Yard Time + 36 = 52.96

Variance O-D Time = 25.91

Figures 15.12, 15.13

More Frequent Trains (2)

- So, by having trains run twice a day, the average yard time and variance of yard time goes down.
- This system is a more expensive system, but provides a better level-of-service. This is the classic cost/LOS trade-off [Key Point 14].

Bypassing Yards

Total Yard Time with Bypassing One Yard

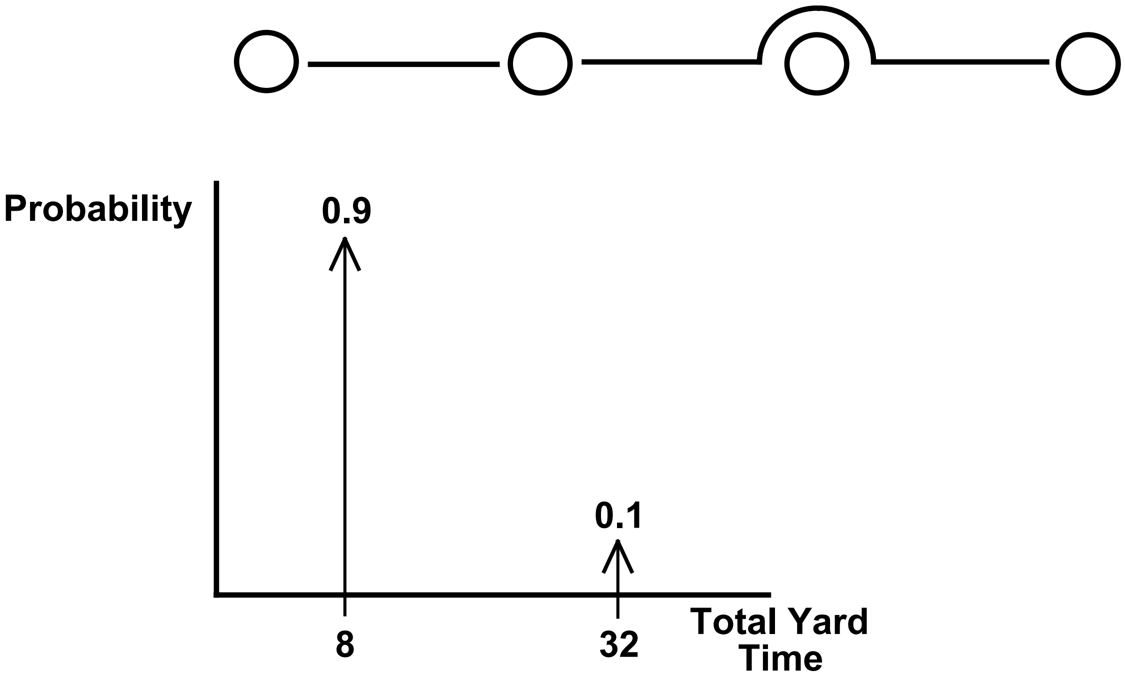


Figure 15.14