Bulk Arrivals

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"Customers" arrive in batches of size $K$, with batch arrivals forming a Poisson process with rate $\lambda$.

Service time for each customer has exponential distribution with mean $\frac{1}{K\mu}$, i.e., time to process the batch has mean $\frac{1}{\mu}$. 

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Continuous-Time Markov Chain

K = 3

Not a birth-death process!
Continuous-Time Markov Chain

This C-T Markov chain is equivalent to that for the M/E\(_K\)/1 queue!
Bulk Arrivals, with Random-Sized Batches

Let \( \lambda \) = arrival rate of batches
\( \alpha_k \) = probability that batch contains
k customers, \( k=1,2,3,... K \)
\( \mu \) = service rate for each customer
Balance Equations

\[
\lambda \pi_0 = \mu \pi_1 \\
\vdots \\
\left[ (\alpha_1 + \alpha_2 + \cdots) \lambda + \mu \right] \pi_m = \mu \pi_{m+1} + \sum_{k=1}^{m-1} \alpha_k \lambda \pi_{m-k}
\]

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