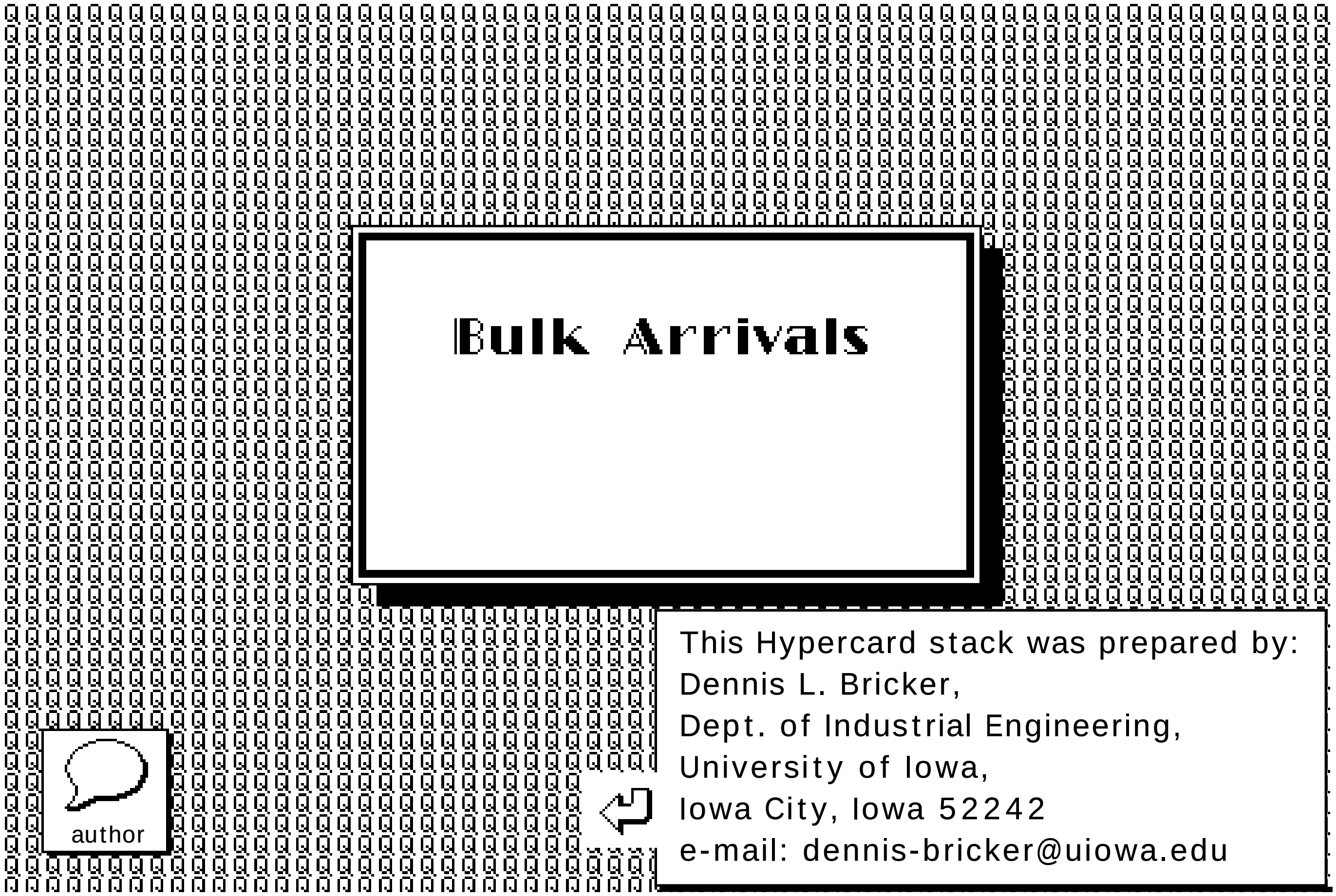


Bulk Arrivals

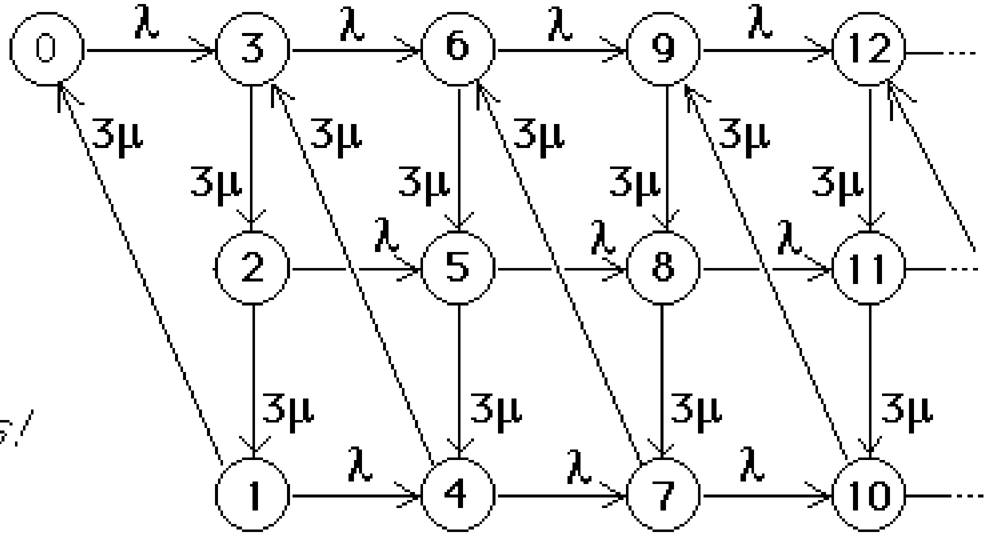
"Customers" arrive in batches of size K, with batch arrivals forming a Poisson process with rate λ

Service time for each customer has exponential distribution with mean $1/K\mu$

i.e., time to process the batch has mean $1/\mu$

Continuous-Time Markov Chain

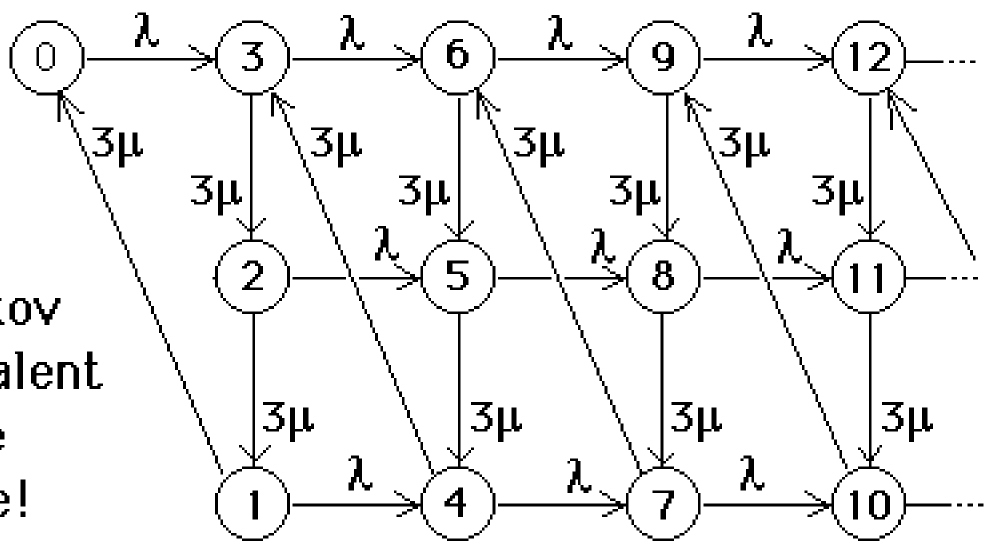
K=3



Not a birth-death process!

Continuous-Time Markov Chain

K=3



This C-T Markov chain is equivalent to that for the $M/E_k/1$ queue!

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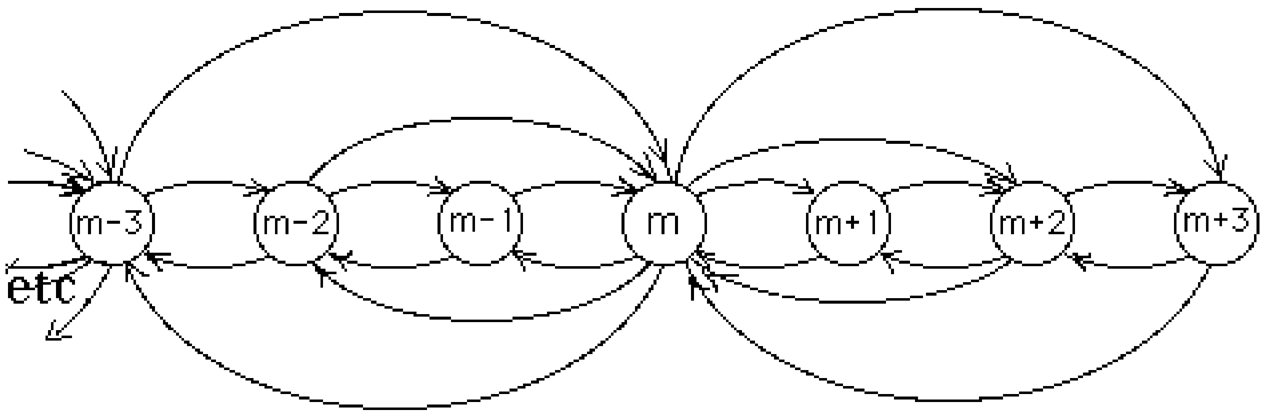
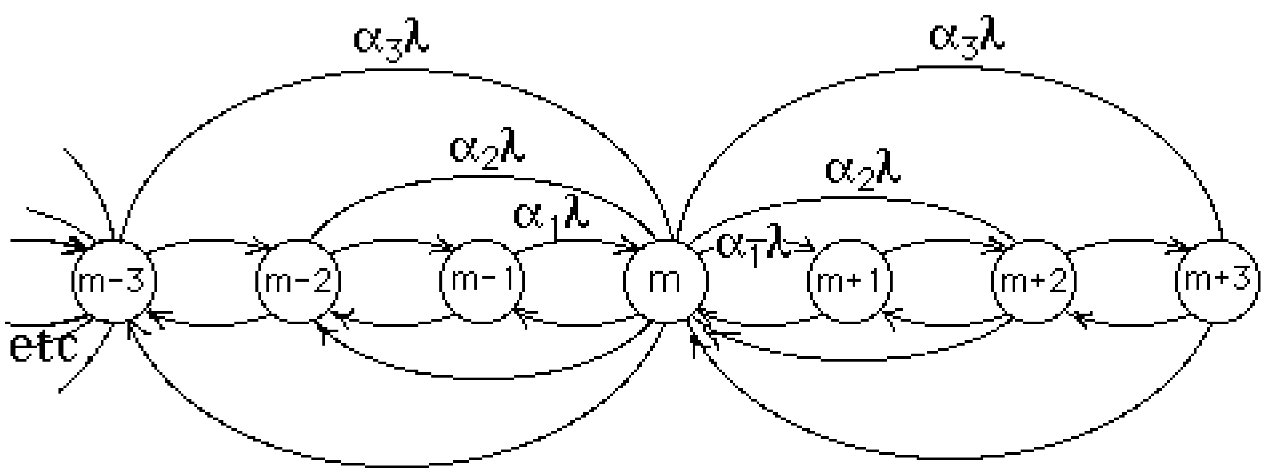
Bulk Arrivals, with Random-Sized Batches

Let λ = arrival rate of batches

α_k = probability that batch contains k customers, k=1,2,3,... K

μ = service rate for each customer





Balance Equations

$$\lambda \pi_0 = \mu \pi_1$$

$$\vdots$$

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