Predictable Queues

Fluid Models

Service Engineering
Queueing Science

Eurandom

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3. Supporting Material (Downloadable)

Gans, Koole, and M.: "Telephone Call Centers: Tutorial, Review and Research Prospects." *MSOM*.

Brown, Gans, M., Sakov, Shen, Zeltyn, Zhao: "Statistical Analysis of a Telephone Call Center: A Queueing-Science Perspective." Submitted.

Jennings, M., Massey, Whitt: "Server Staffing to Meet Time-Varying Demand." Management Science, 1996. - PRACTICAL

0. M., Massey, Reiman: "Strong Approximations for Markovian Service Networks." QUESTA, 1998.

1. M., Massey, Reiman, Rider: "Time Varying Multi-server Queues with Abandonment and Retrials", ITC-16, 1999.

2. M., Massey, Reiman, Rider and Stolyar: "Waiting Time Asymptotics for Time Varying Multiserver Queues with Abandonment and Retrials", Allerton Conference, 1999.

3. M., Massey, Reiman, Rider and Stolyar: "Queue Lengths and Waiting Times for Multiserver Queues with Abandonment and Retrials", Fifth INFORMS Telecommunications Conference, 2000

Contents

1. Predictable Queues in Practice

2. QED Staffing: Infinite-Server heuristics – see Jennings et al

3. A time-varying queue with abandonment and retrials

4. Strong Approximations / Models:

   Fluid – for "average" behavior

   Diffusion – for confidence bands (intervals)

5. Calculating the drift: Scalable Lipschitz Derivatives

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QED Staffing: State of Art (8/2003)

1. GI/**M**/N $N \approx R + \beta\sqrt{R}, \quad \beta > 0$

    - Conceptual: Erlang; **Halfin-Whitt**

    - Dimensioning: Borst, Reiman

2. Abandonment (Erlang-A, with $-\infty < \beta < \infty$)

    - Conceptual: Garnett, Reiman; Zeltyn; **Whitt**

    - Dimensioning: (Borst, Reiman, Zeltyn) in progress

3. Time-Varying   (Non-homogenous Poisson arrivals)

    - Infinite-server heuristics: Jennings, Massey, Whitt

    - Conceptual: (Massey, Rider) in progress

    - Dimensioning: ?

4. Skills-Based Routing:

    - Conceptual: Atar, Reiman; Gurvich (V-Model)

    - Dimensioning: **Borst, Seri** (General); Gurvich (V);

        Armony (Reversed-V)**;**

5. Service-Time Duration:

    - Conceptual: Whitt H2*/G; Jelenkovic, Momcilovic D
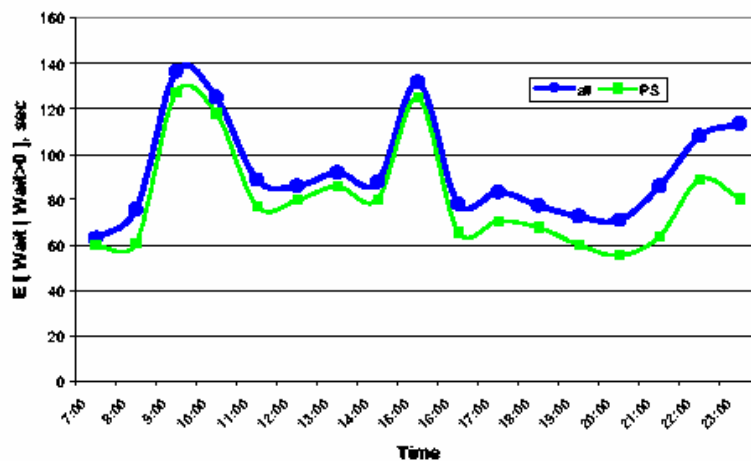
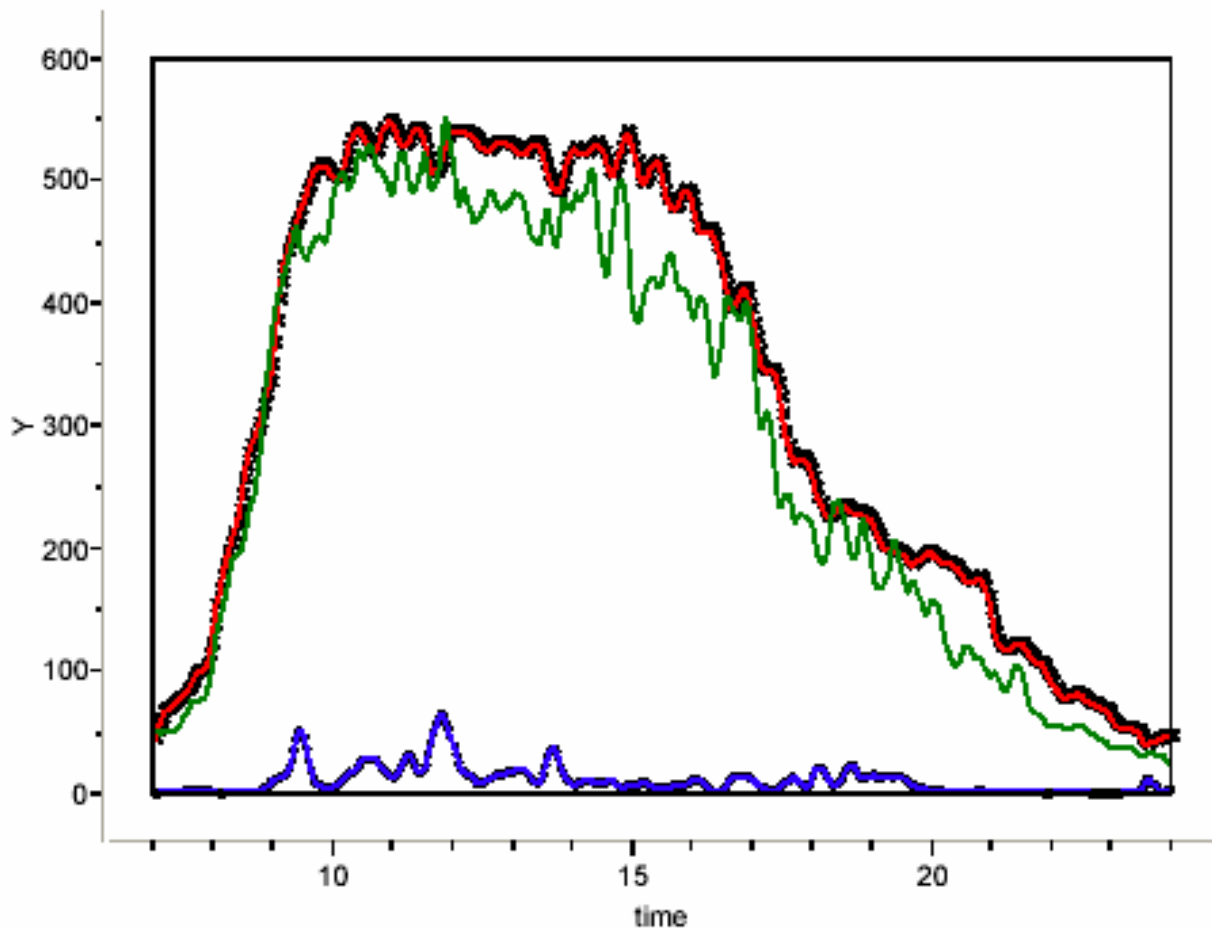# Time-Varying Queues: Predictable Variability

Arrivals
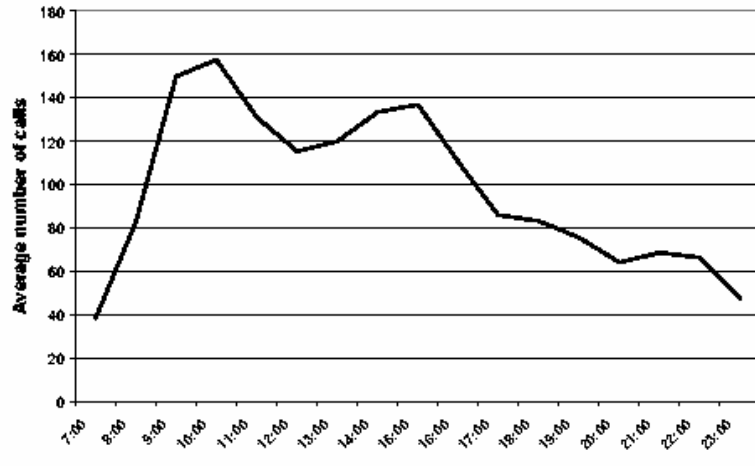
Queues
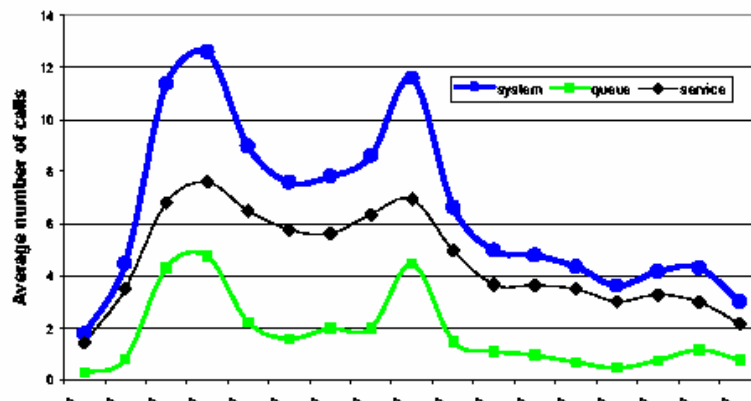
Waiting

Matching Supply and Demand (Wharton)

Efficiency Plots
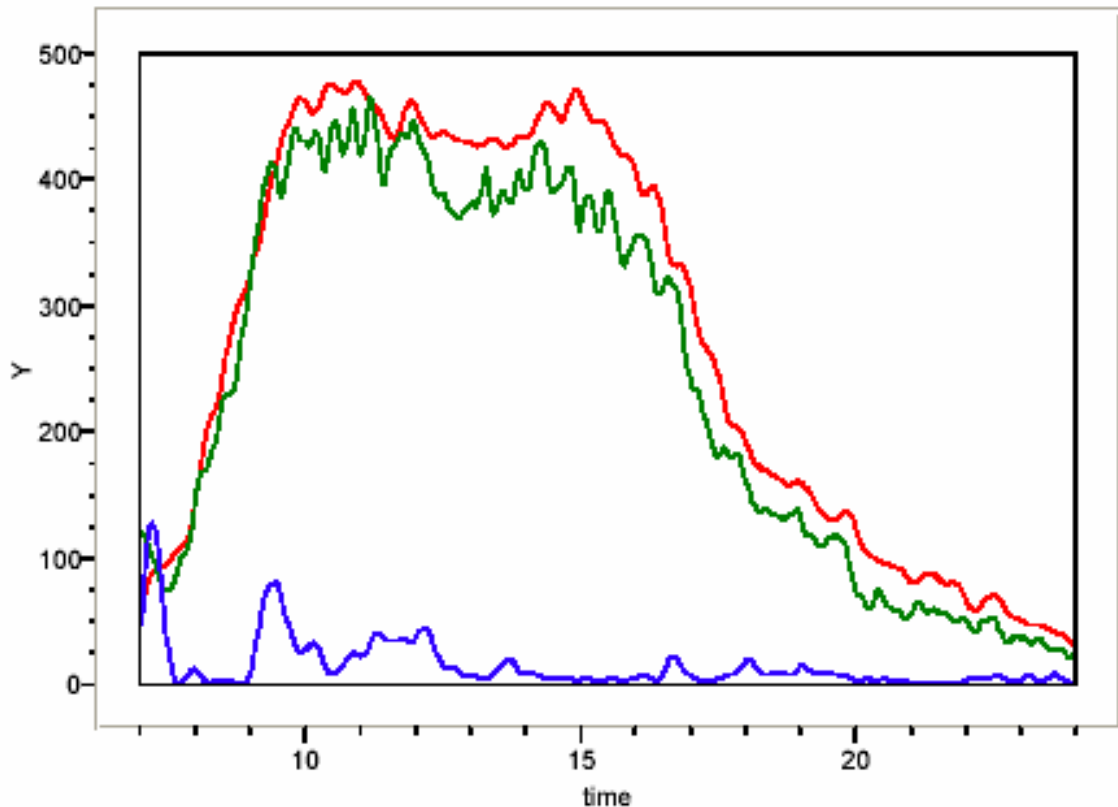### Showing Load and Staffing

Plot is for Monday 8/05/02

Y —— NumberAgents (s)
—— *load (s)*
—— AvgQueueWaitAll (s)

"Agents" = *Estimate* of number of agents on-duty at that time.
[In each 150 second interval an agent is estimated to be on-active-duty for the entire interval if (s)he is on the phone sometime in that interval.]

Staffing Matters (on Fridays, 7:00 am)

Efficiency Plots, cont

Plot is for Friday 8/02/02

Y — NumberAgents (s)
— *load (s)*
— AvgQueueWaitAll (s)

Note increased usage from 7-7:30 am (typical of Fridays).
Note increased average Queue-Wait during this time.
(Accompanied by a rise in abandonments to about 10%.)

Overall Utilization: 8/02/02 = 88%
                        8/05/02 = 89%