What is a "Service-Time" (Duration) ?

(http://ie.technion.ac.il/serveng/Lectures/ServiceFull.pdf)

Does it include after-call work?

Does it include whisper-time?

Does is account for Repeat Calls (Redials) ?

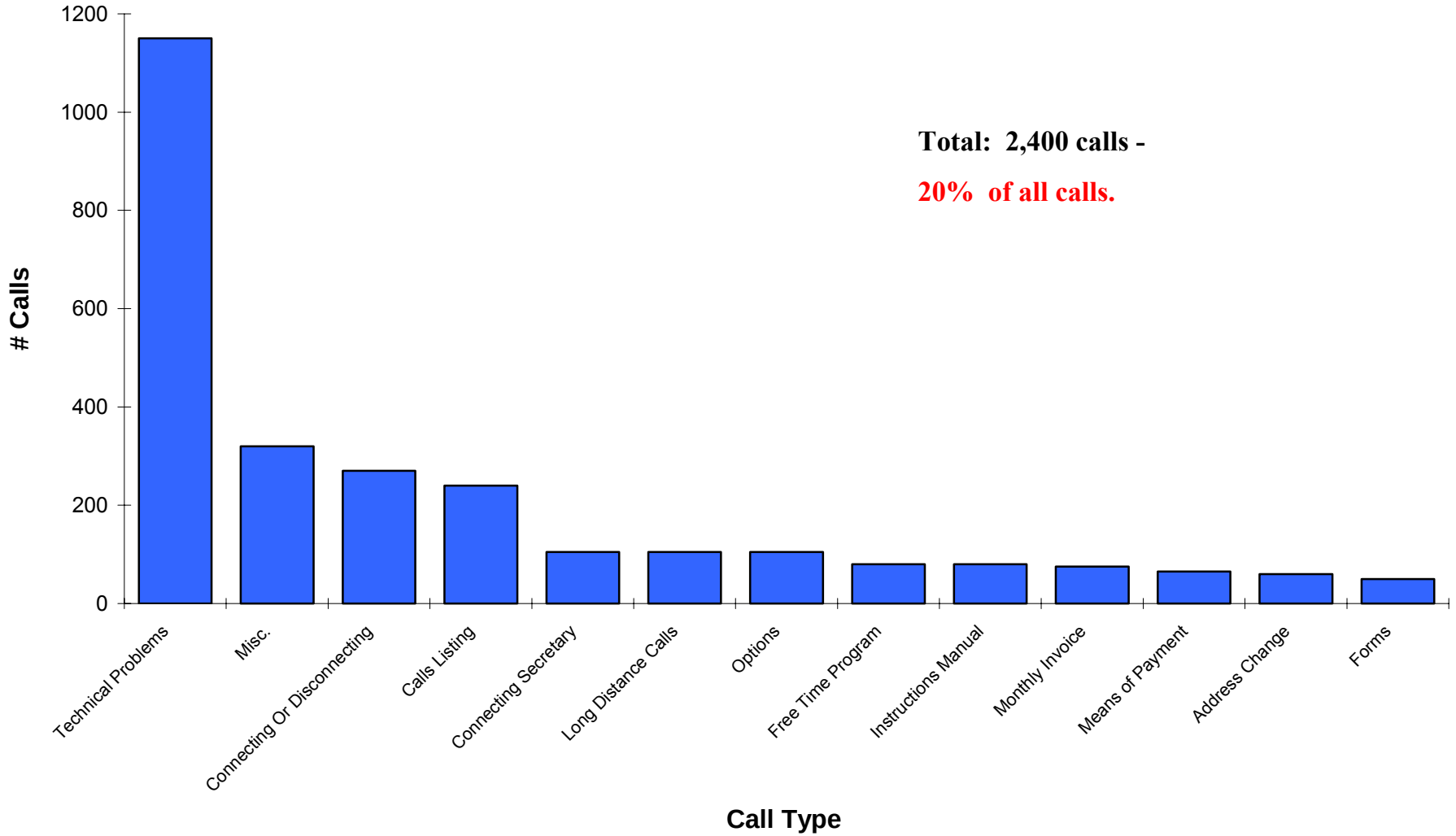
How to accurately estimate, predict; analyze, model ?

How affected by covariates:

- Experience and Skill of Agents (Learning Curve)
- Type of Customer (Service Type, VIP Status)
- Time-of-Day (or Congestion-Level)
- Environment: Incentives, Workload
- …

What is “Service Time”?

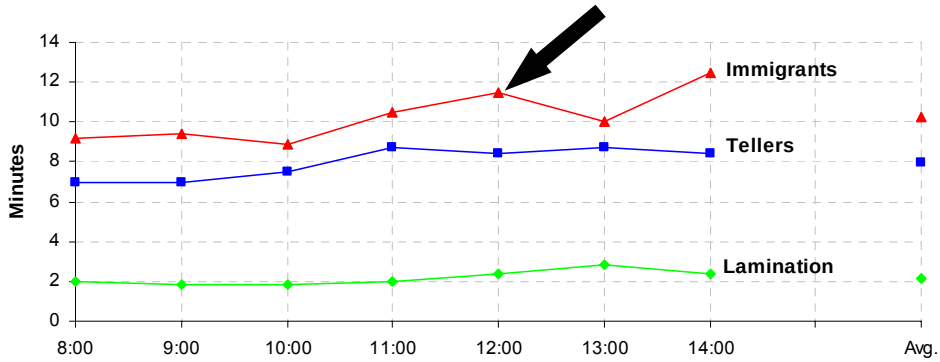
Bank Classification of “Continued – Calls”



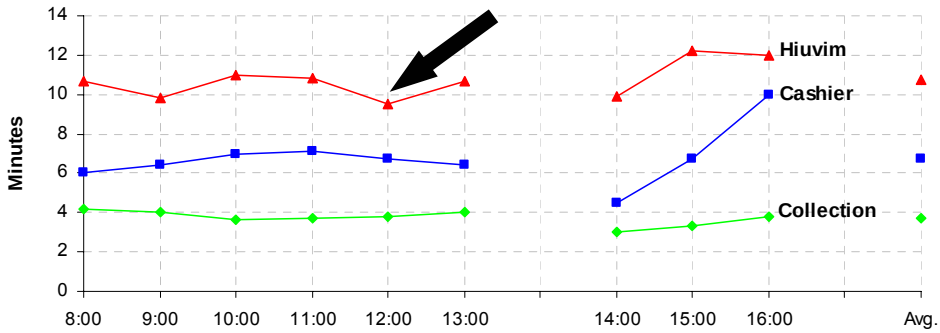
Total: 2,400 calls -

20% of all calls.

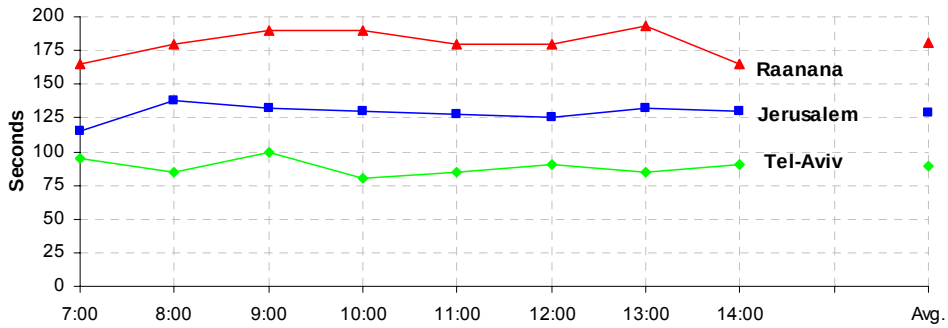
Average Service Durations Over The Day



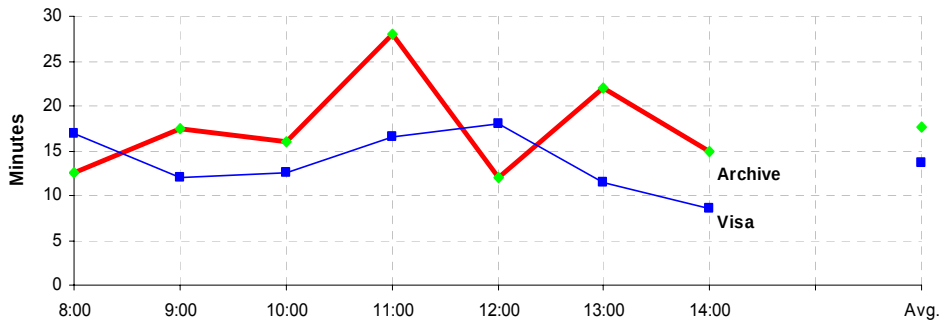
Time or State Dependent ?



3 Patterns



3 Branches Provide the Same Tele-Service

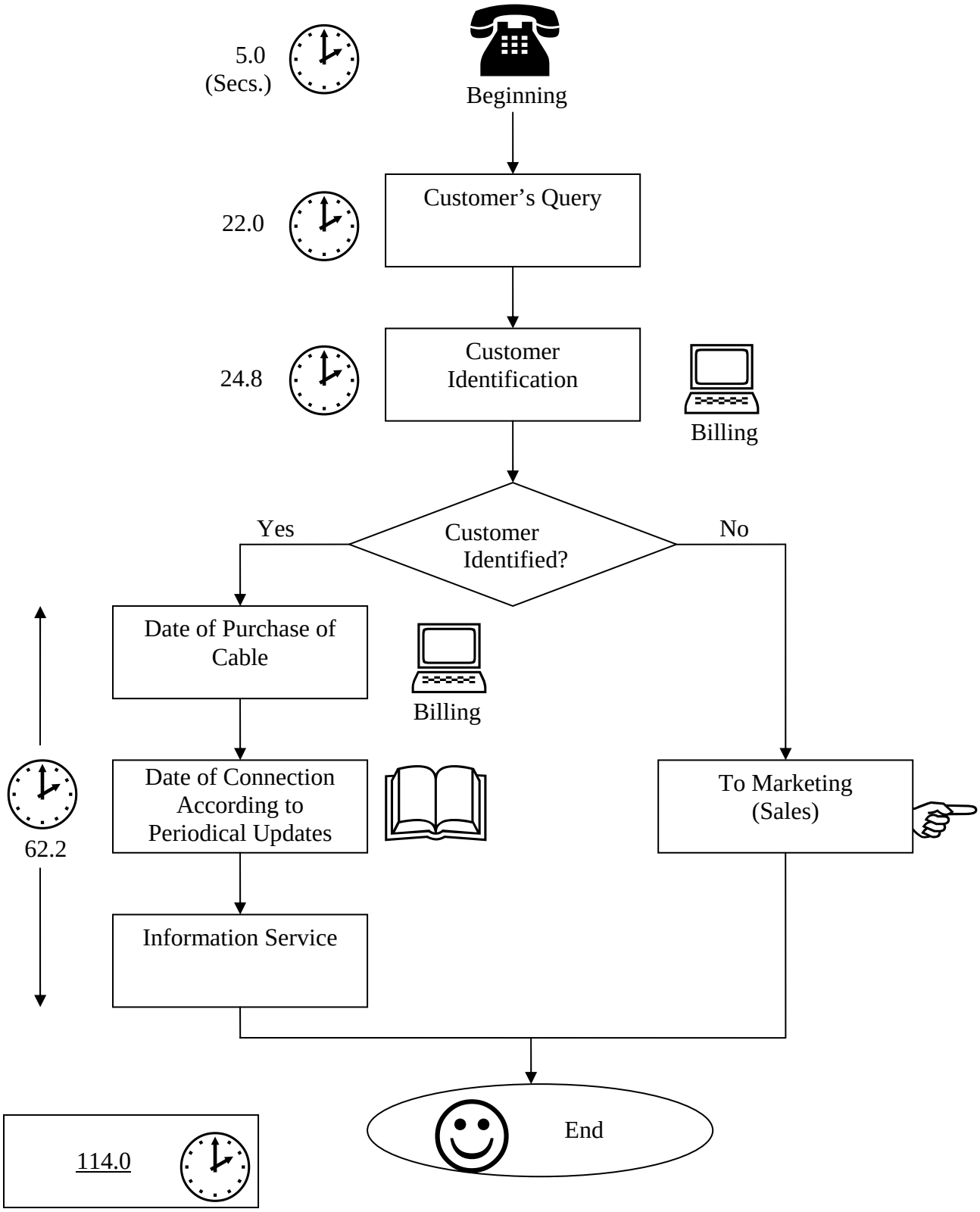


? Sample Size !

“Fluid” – view, but …

Service (Process) Design; Phase-Type Service

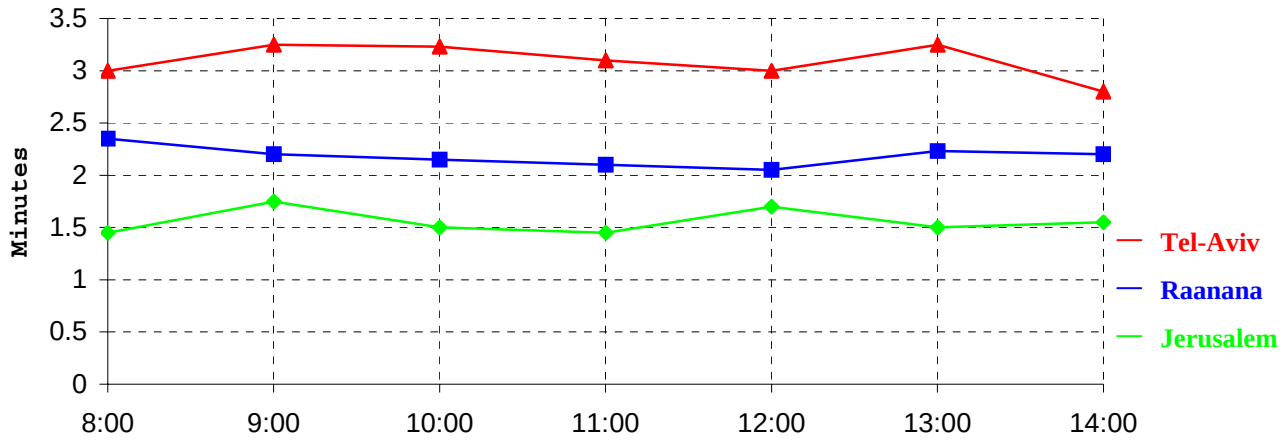
Late Connections



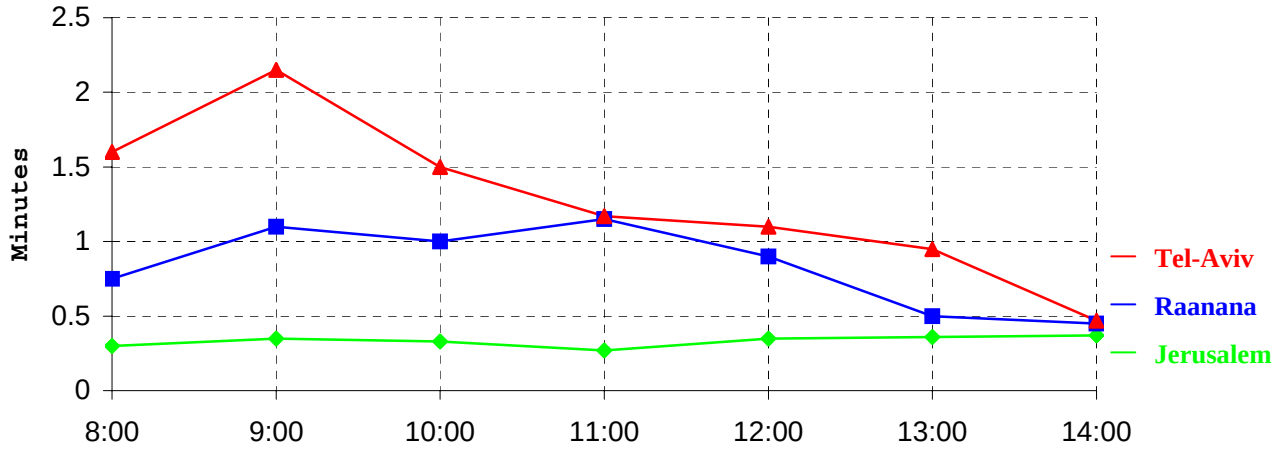
? **Where does human-service start / end (recall 144)?**
"Average" picture.

Service Performance

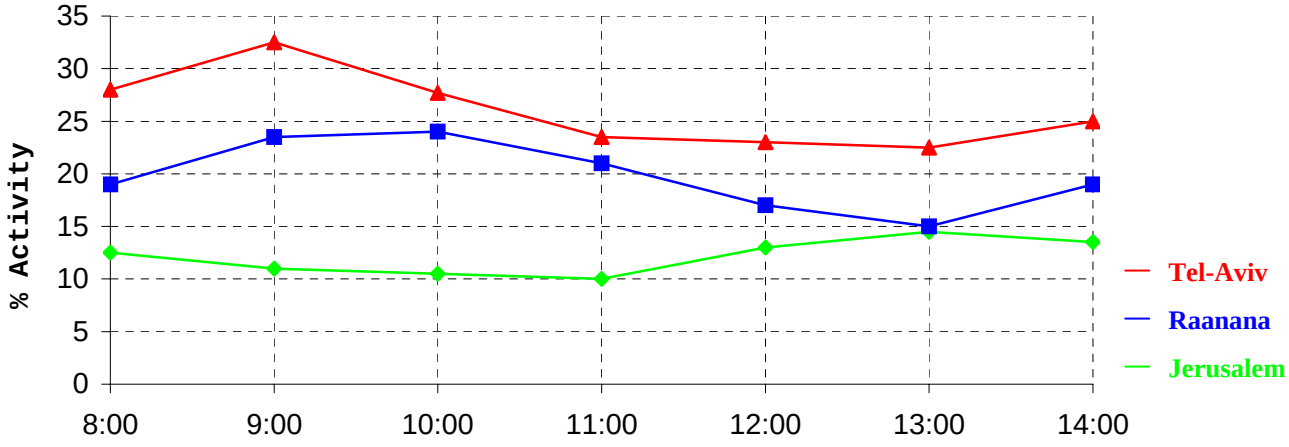
Service Time – Average:



Waiting Time – Average:



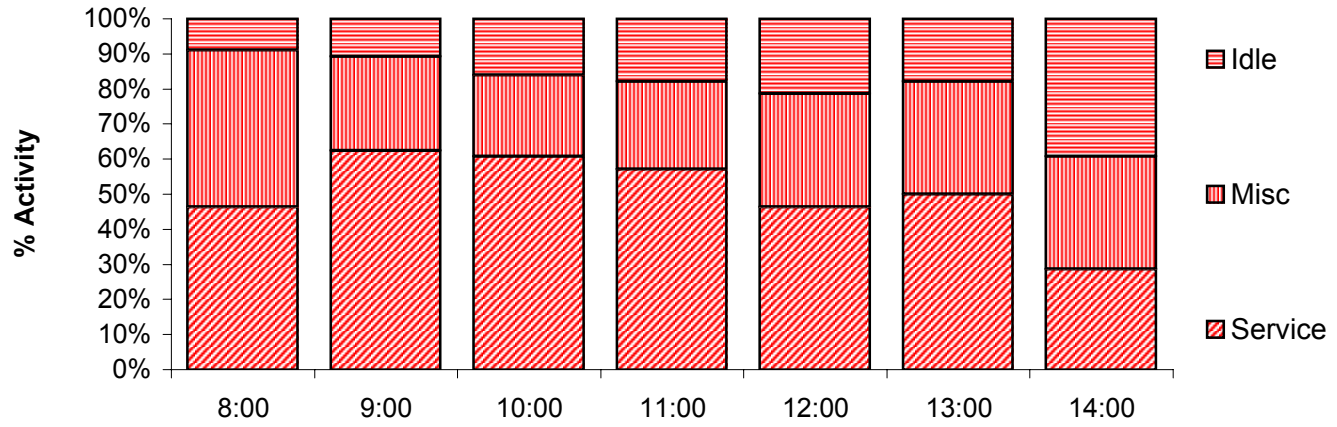
% Abandonment:



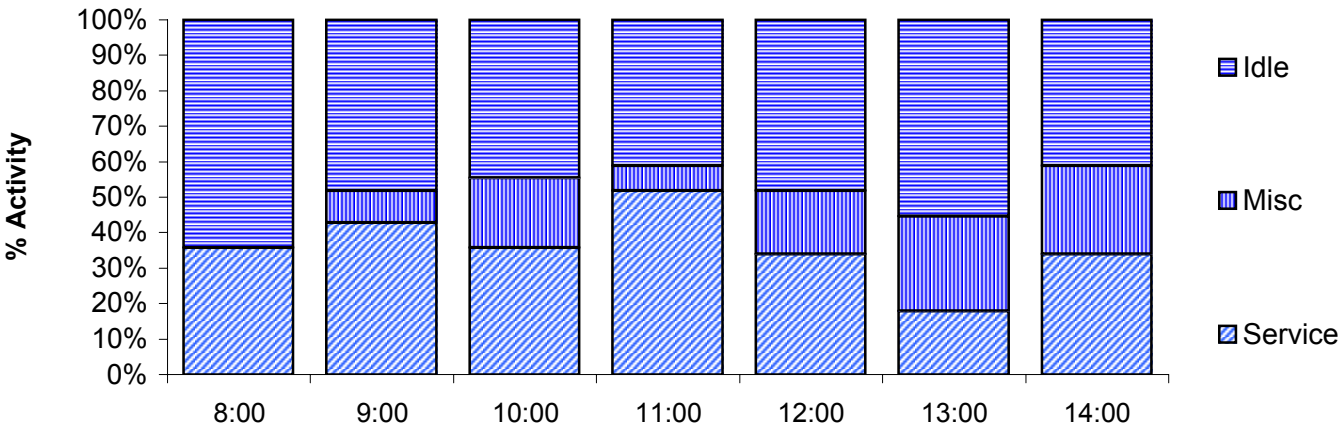
What is “Service Time” ?

Utilization Profile in 3 Call Centers Doing the Same Thing

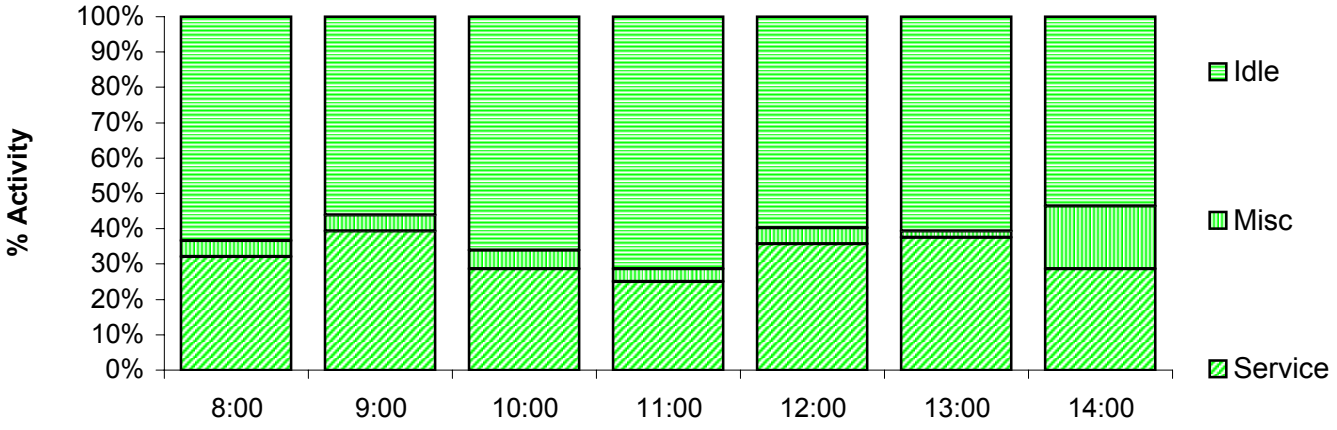
Tel-Aviv:



Raanana:



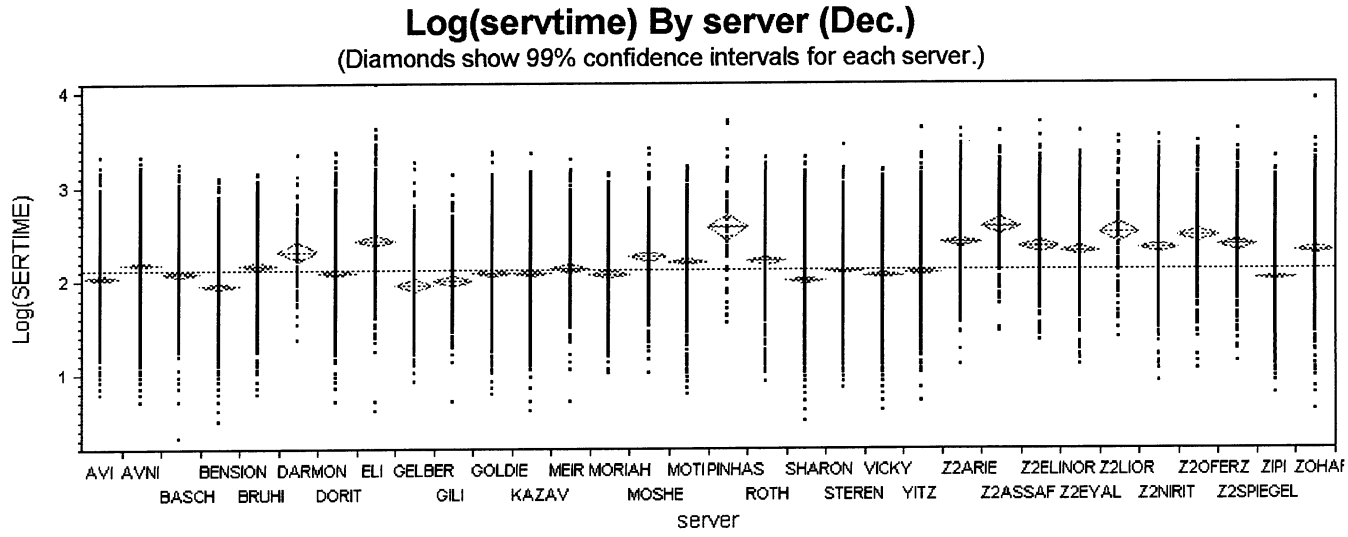
Jerusalem:



Heterogeneous Servers (Recall the Judges)

Example: Comparison of Service times among various servers.

If one breaks the service time down according to the individual servers, the differences are quite noticeable. Here is the situation in December.

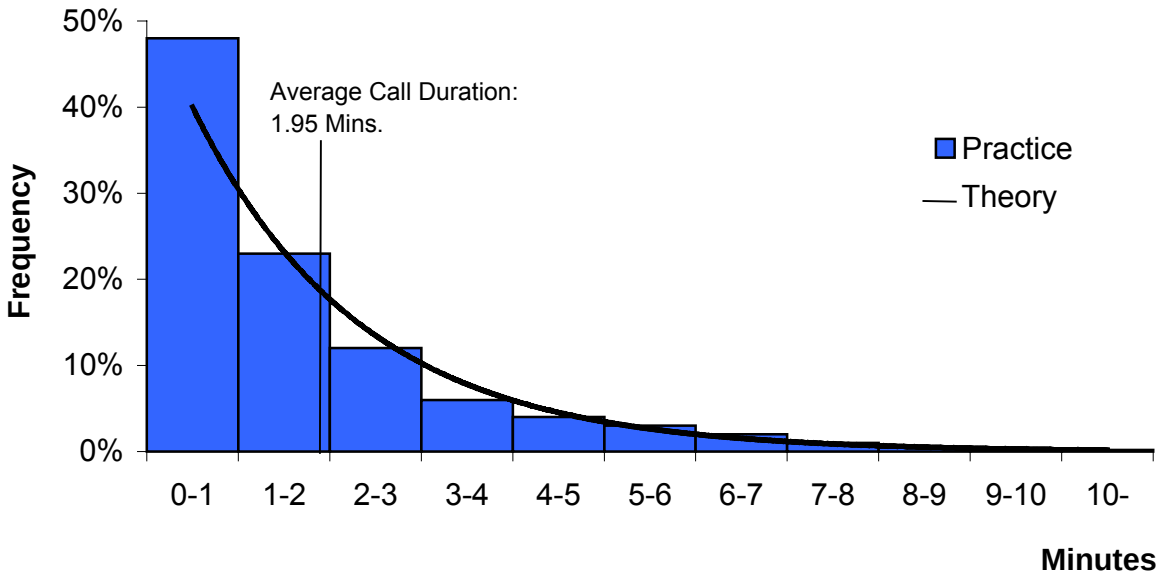


[----------]

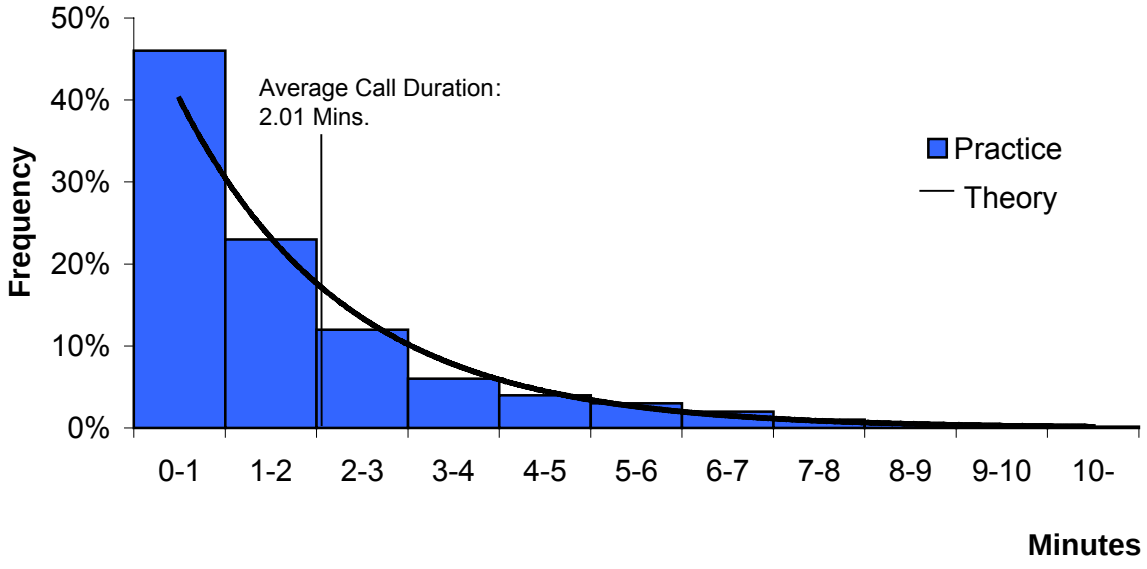
IN Servers

Phone Calls: Information

Call-Duration Frequency - North:



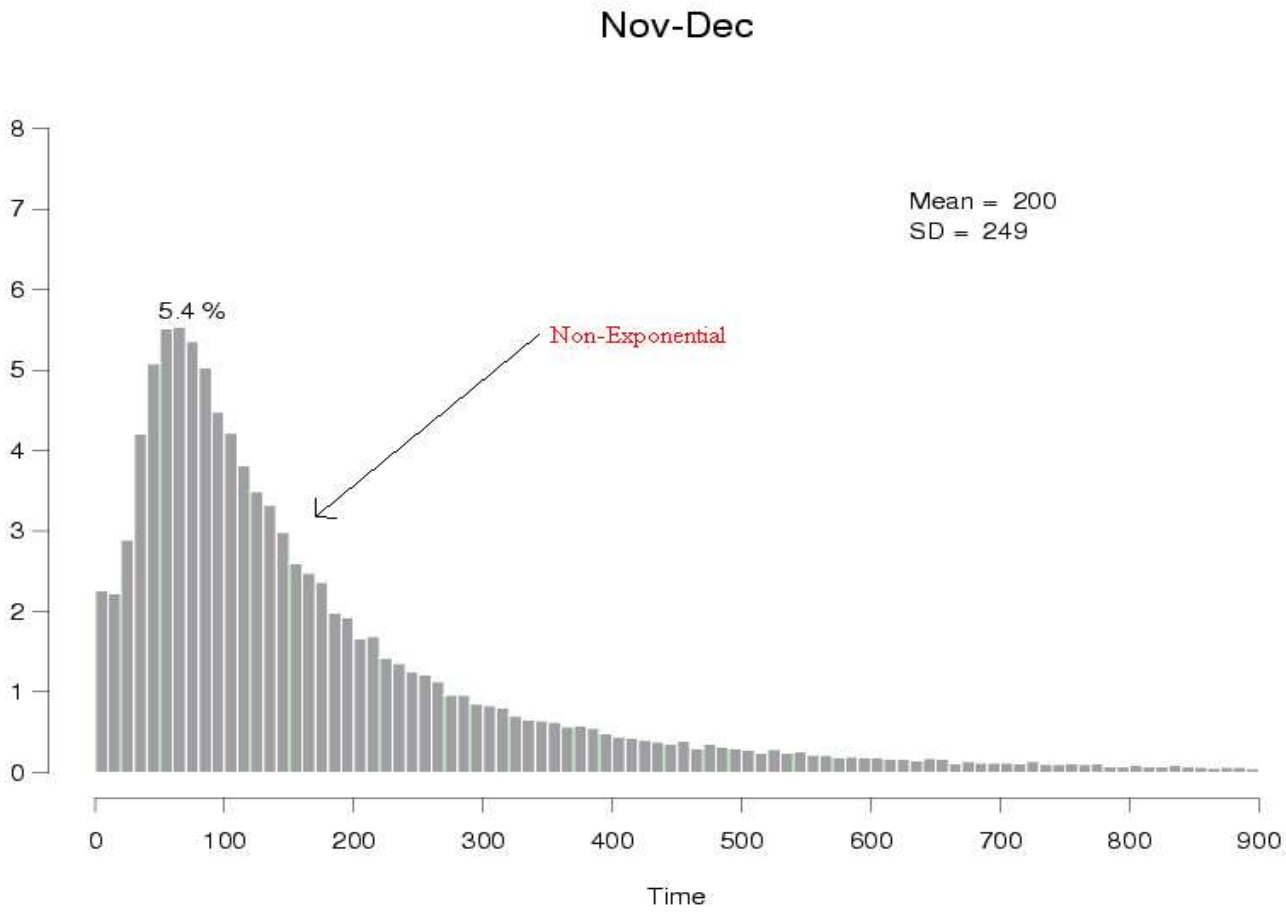
Call-Duration Frequency – Central:



Q. How to recognize "Exponential" when you "see" one?

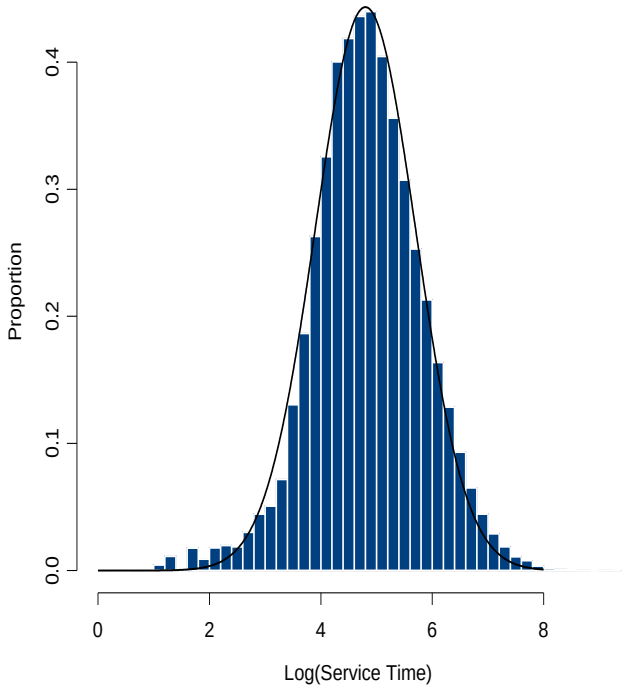
A. Geometric Approximation.

Figure 6: Histogram of Service Times (in seconds)



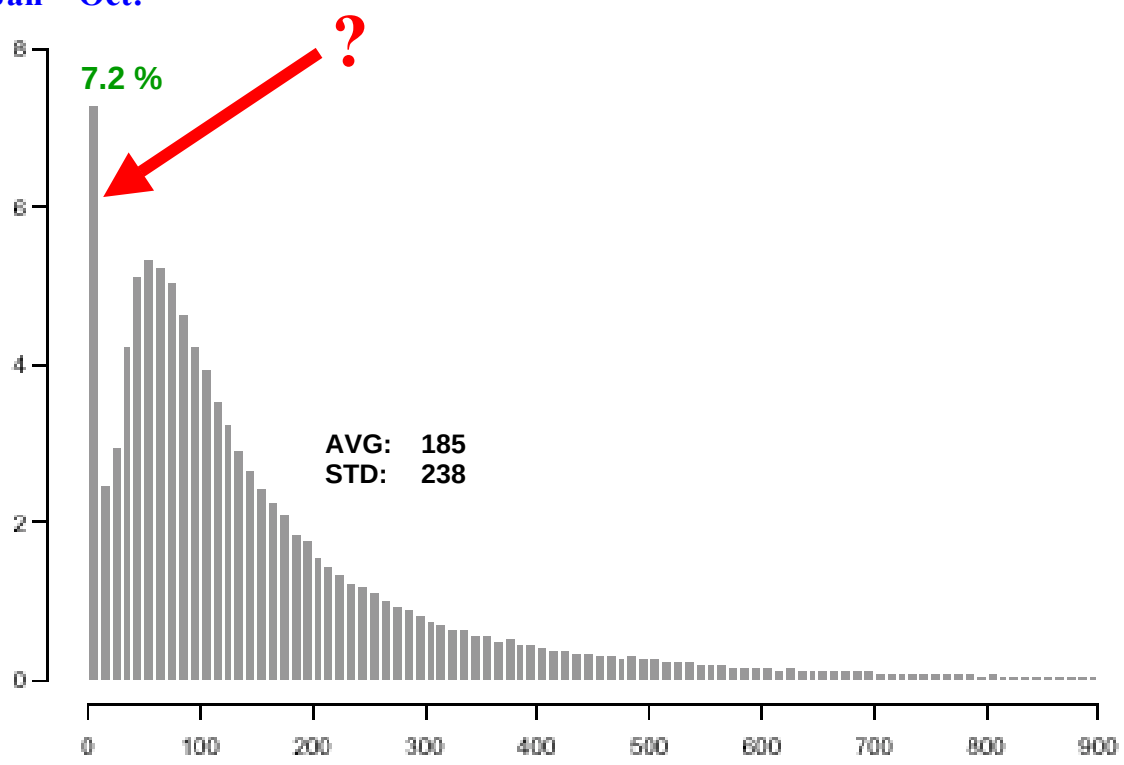
Lognormal Service Time

Figure 2: *Histogram of Log(Service Time) (Nov + Dec)*

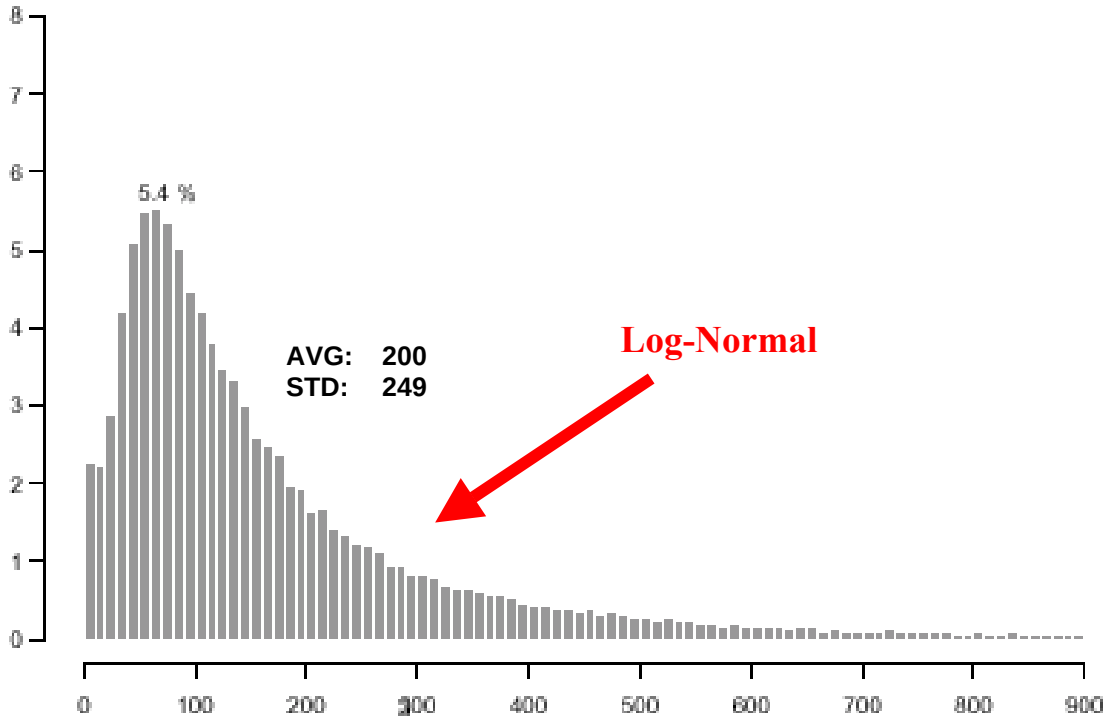


Beyond Data Averages
Short Service Times

Jan – Oct:



Nov – Dec:



Percent Calls w/Service < 10sec

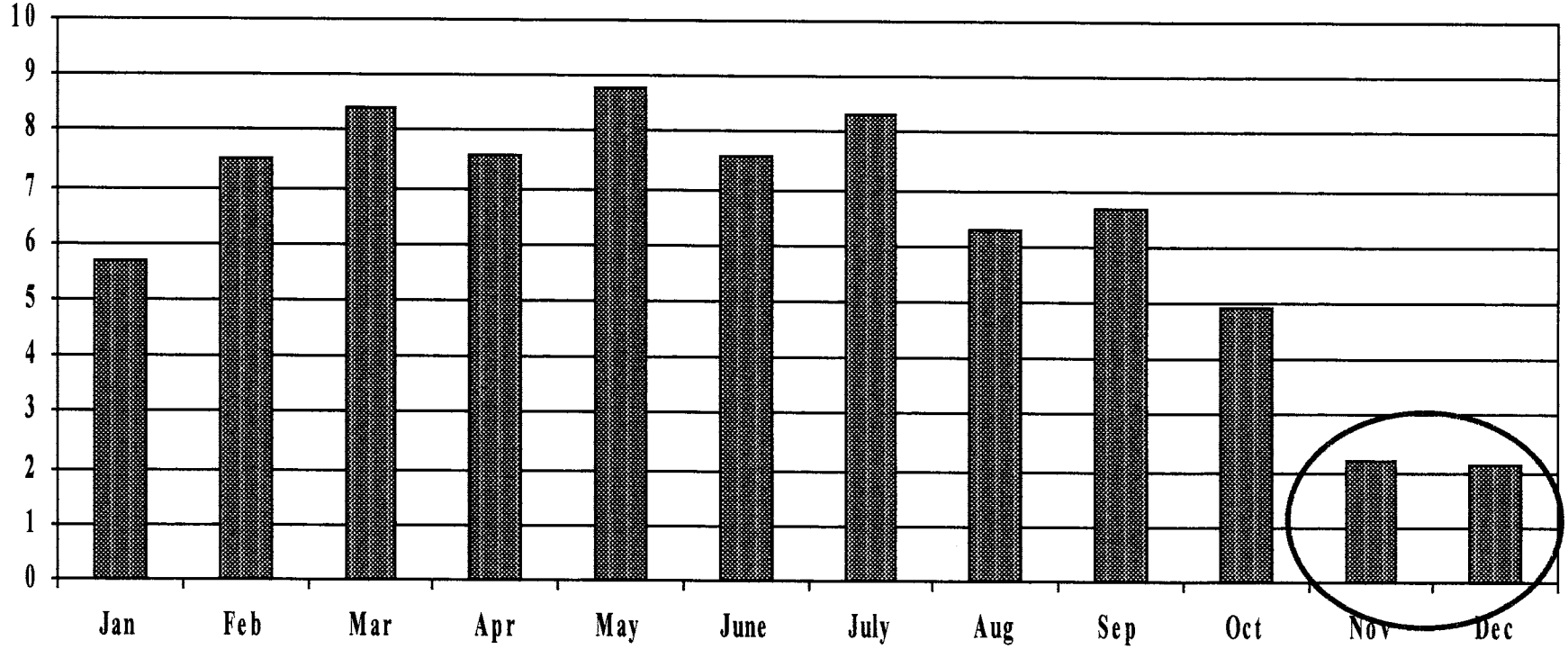


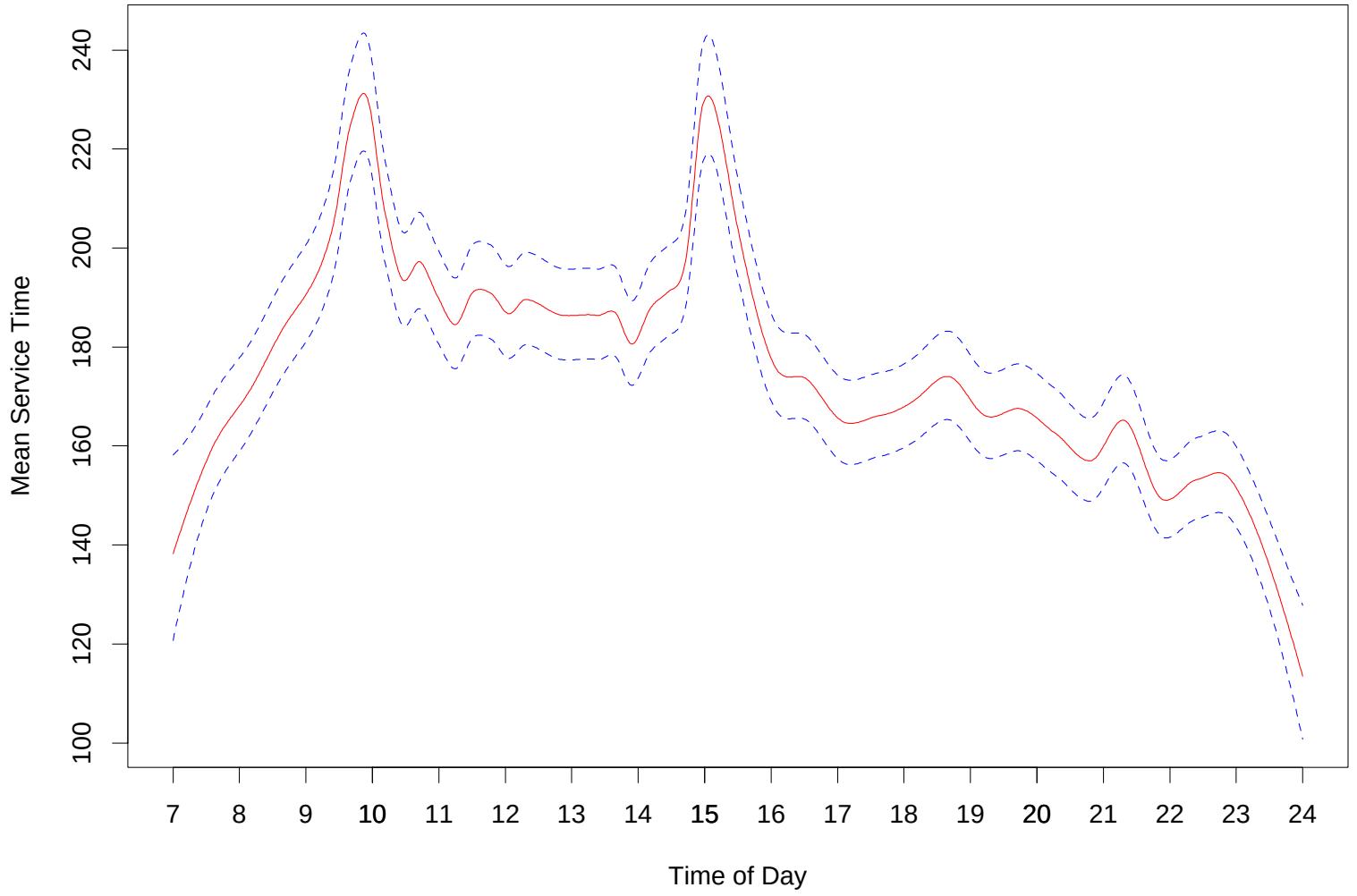
Table 52: Number of calls handled by an agent

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AVI	0	0	0	1117	2208	2019	2789	2710	1417	2026	2523	2395
AVNI	1493	1736	642	539	1786	2219	2092	2392	1156	1888	1988	2136
BASCH	999	1164	1708	1155	982	906	858	2185	1973	1055	1326	1242
BENSION	1283	1135	0	1053	1108	1016	1682	1298	1076	1303	1546	1176
DARMON	309	515	633	519	577	436	309	370	297	194	425	128
DORIT	696	1047	0	811	546	862	750	2228	1319	1384	1640	1605
ELI	387	508	777	447	560	436	395	458	416	363	502	352
GELBER	333	143	510	427	859	281	386	332	67	179	165	269
GILI	668	614	1155	803	1108	974	418	0	355	456	412	298
KAZAV	1995	1693	1240	1451	1731	2251	1737	1168	729	1570	1047	2038
MEIR	0	0	0	0	0	0	127	344	318	280	406	454
MORIAH	1360	1223	1591	1351	1866	1980	2416	2152	1526	1940	1793	515
PINHAS	79	40	359	244	31	311	422	241	143	105	51	63
ROTH	0	0	397	1292	1928	1967	1831	1749	1625	1914	1458	1038
SHARON	1985	1674	2780	1938	2563	2657	2537	2875	1803	1935	2532	2140
STEREN	0	1043	2294	1516	2163	2231	1423	2455	1672	709	2375	2568
TOVA	1923	1679	1562	1059	1464	1389	1890	1811	1361	1971	941	0
VICKY	895	0	0	0	1006	1378	1415	1674	1472	1582	1641	1990
YIFAT	1312	1901	1745	1305	1464	1076	780	90	1137	1315	0	0
YITZ	1771	1791	1402	1203	1355	1367	1009	69	705	1743	2420	2353
ZOHARI	891	1144	1398	1148	1479	1450	980	1494	1423	1359	1504	1094
Z2ARIE	0	0	0	0	0	0	0	56	225	315	432	534
Z2ELINOR	0	0	0	0	0	0	0	45	352	288	222	310
Z2EYAL	0	0	0	0	0	0	0	95	331	428	579	618
Z2IFAT	0	0	0	0	0	0	0	94	260	314	215	0
Z2LIOR	0	0	0	0	0	0	0	84	250	136	126	138
Z2NIRIT	0	0	0	0	0	0	0	116	327	474	387	545
Z2OFERZ	0	0	0	0	0	0	0	71	311	260	242	334
Z2SPIEGEL	0	0	0	0	0	0	0	71	311	260	153	322

Table 53: Number of calls with short service time

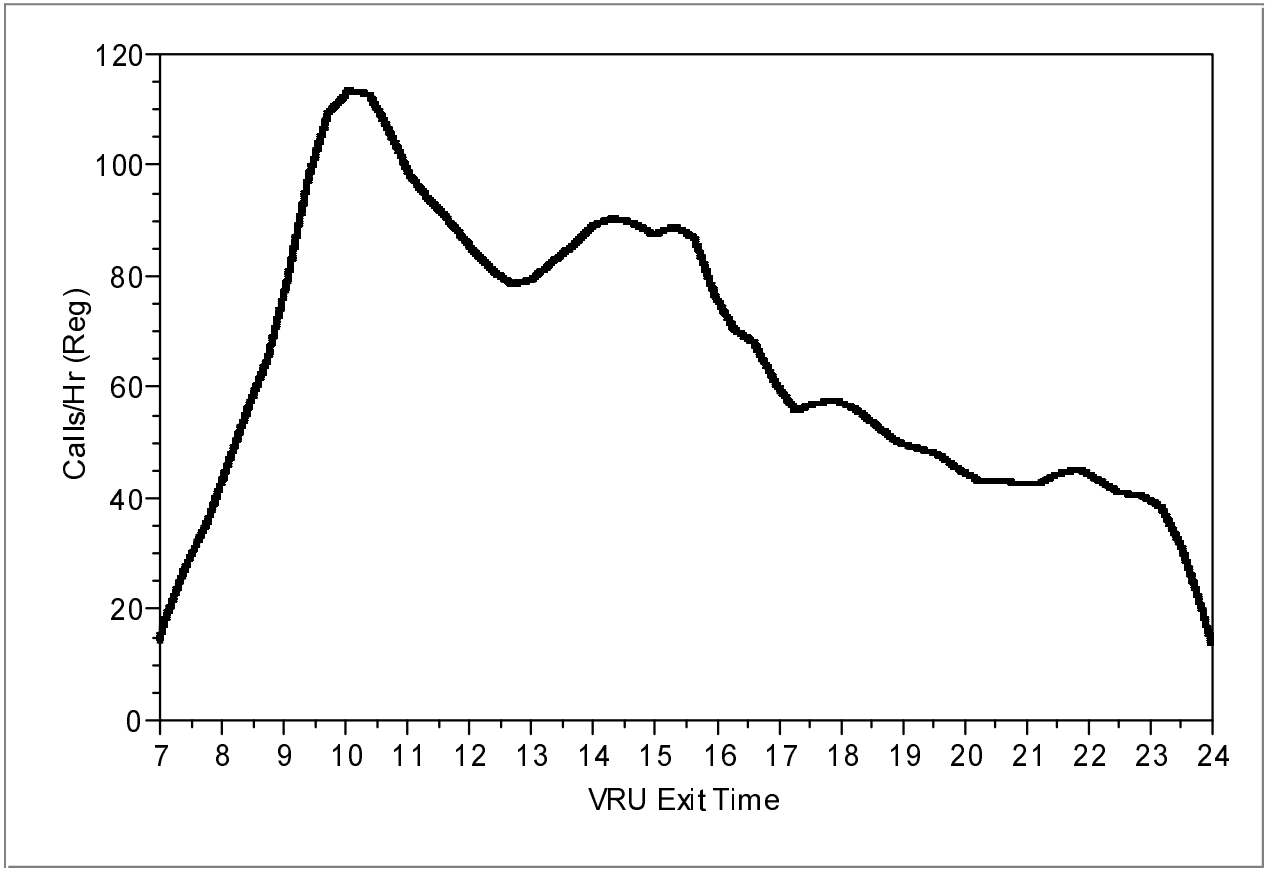
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MORIAH	233	230	356	290	614	695	865	597	490	455	4	1
AVI	0	0	0	47	111	144	295	221	121	76	35	26
AVNI	11	13	4	5	6	25	16	18	4	8	8	11
DARMON	2	11	8	9	10	7	1	0	1	1	0	0
ELI	9	7	10	12	22	18	15	4	8	3	6	5
KAZAV	57	40	48	44	48	63	40	27	15	18	4	6
MEIR	0	0	0	0	0	0	1	8	3	1	2	1
PINHAS	3	0	58	25	4	14	11	6	8	1	0	0
ROTH	0	0	10	10	36	21	43	25	32	31	3	6
SHARON	58	49	86	52	67	78	66	63	38	23	43	49
TOVA	52	163	269	132	231	193	100	109	207	190	6	0
ZOHARI	4	8	12	22	17	20	9	14	5	7	10	7

Figure 12: Mean Service Time (Regular) vs. Time-of-day (95% CI) ($n = 42613$)



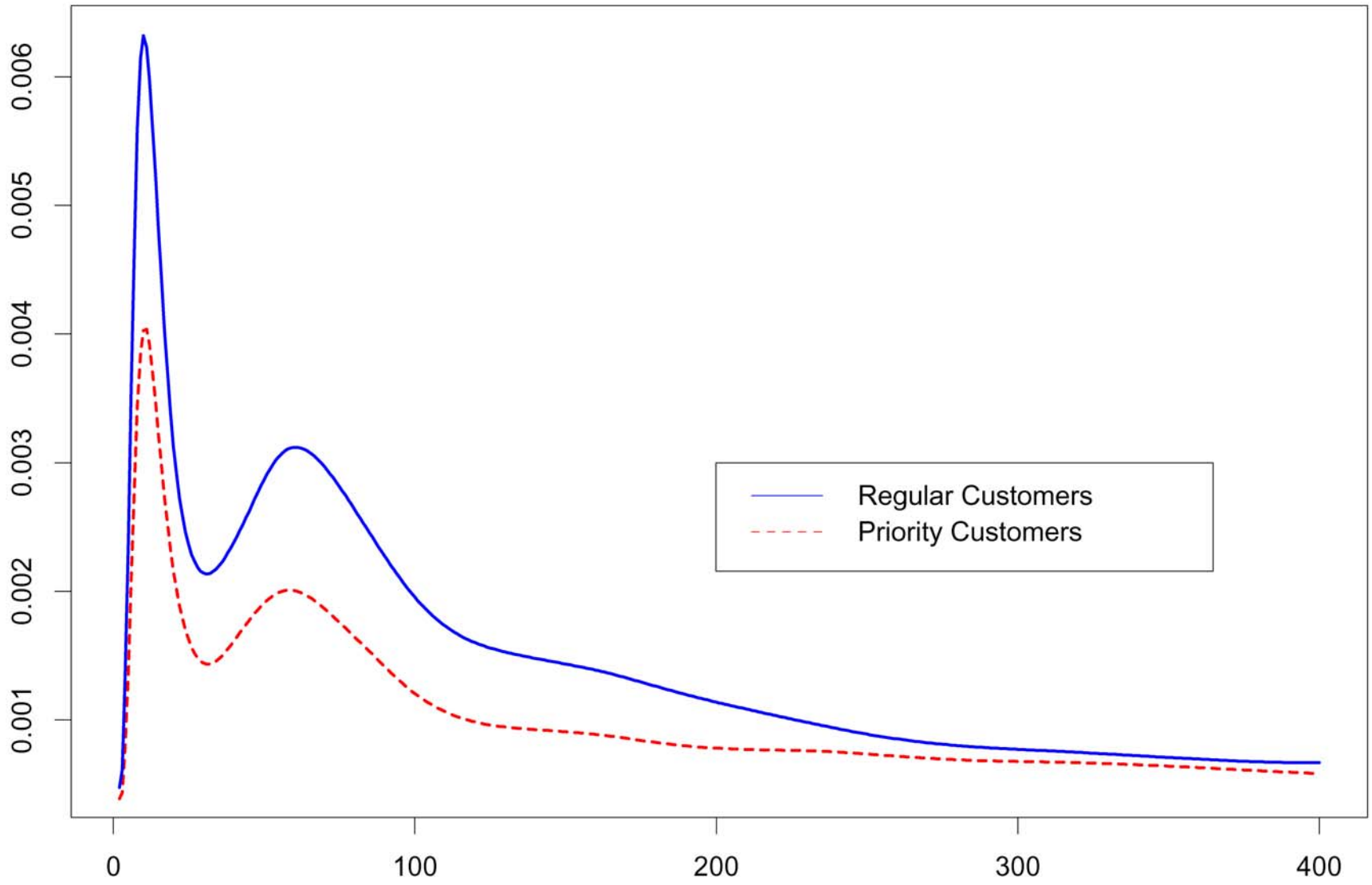
Arrivals: Inhomogeneous Poisson

Figure 1: Arrivals (to queue or service) – "Regular" Calls



Service Time

	Overall	Regular service	New customers	Internet	Stock
Mean	188	181	111	381	269
SD	240	207	154	485	320
Med	114	117	64	196	169


Hazard Rate: Empirical (Im)Patience
0.001
0.002
0.003
0.004
0.005
0.006
0
100
200
300
400
Regular Customers
Priority Customers

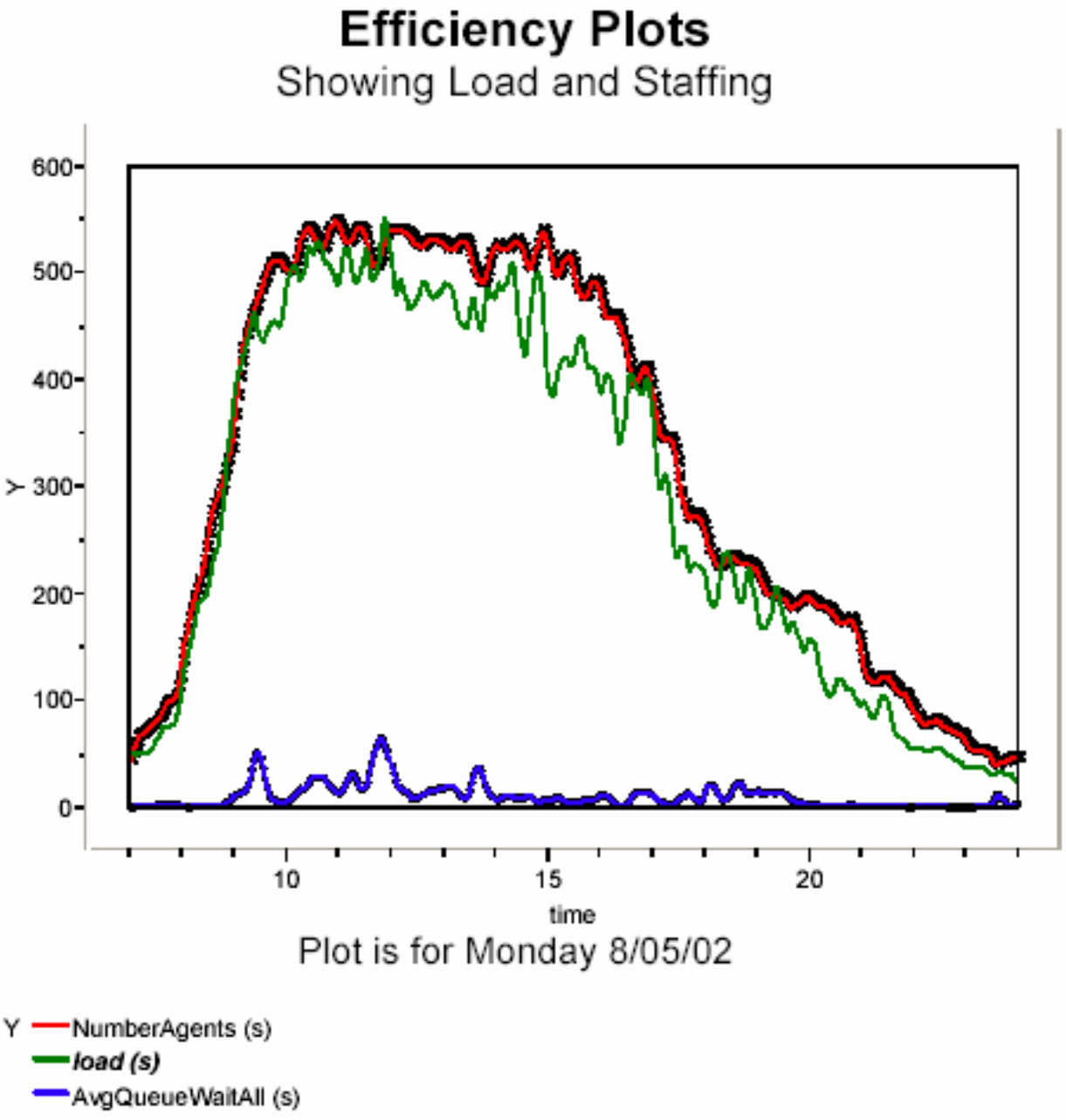
Workload

Suppose at time t, the arrival rate is $\Lambda(t)$ and the mean service time is $\nu(t)$, then the workload at time t is defined as

$$L(t) = \Lambda(t)\nu(t).$$

- the expected time units of work arriving per unit of time.
- primitive quantity in building classical queueing models and setting staffing levels.

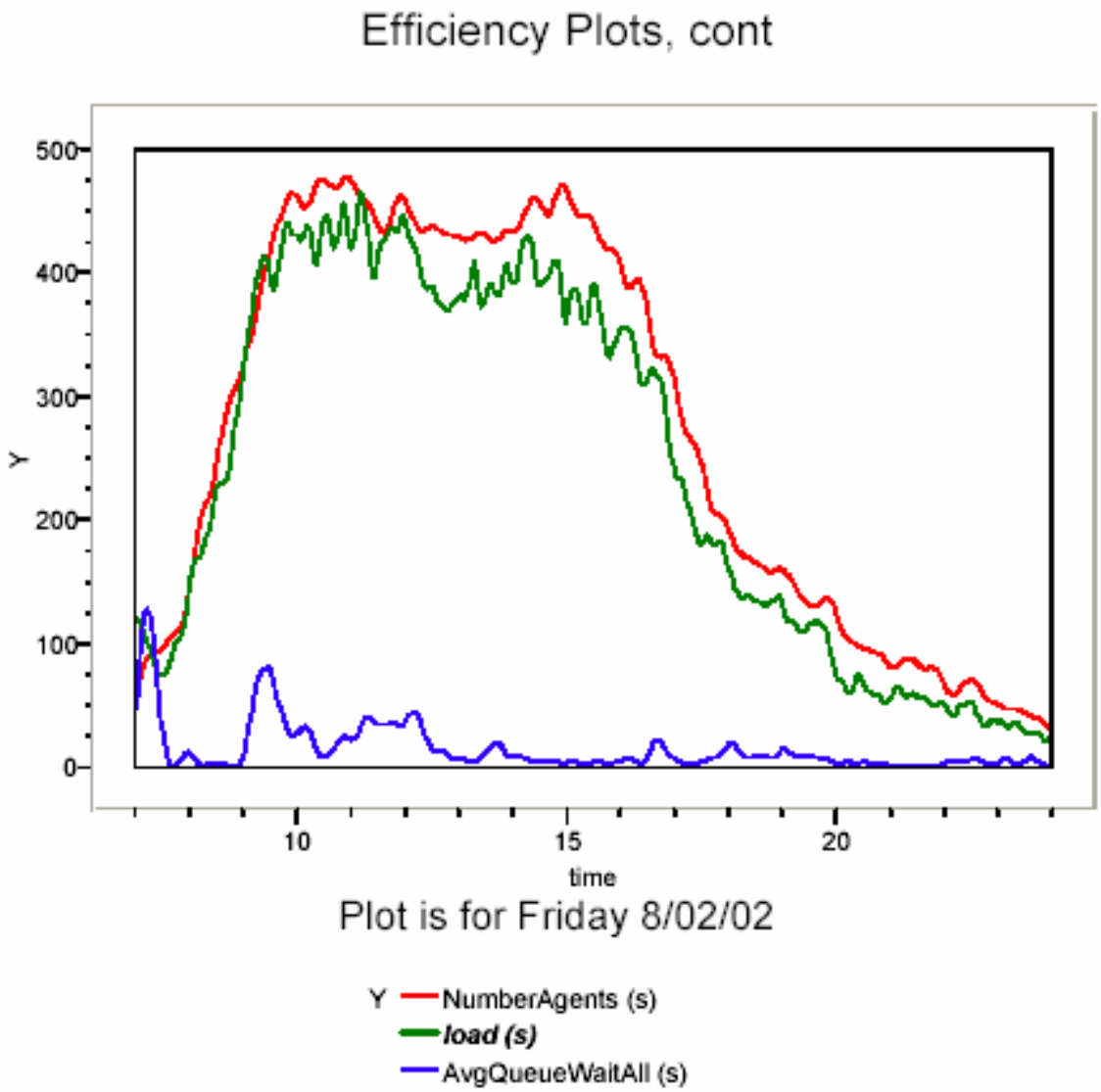
Time-Varying Workload (U.S. Bank)



"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.]

In Practice: Time-Buckets (15, 30, 60 min, by volume)

Staffing Matters (on Fridays, 7:00 am)

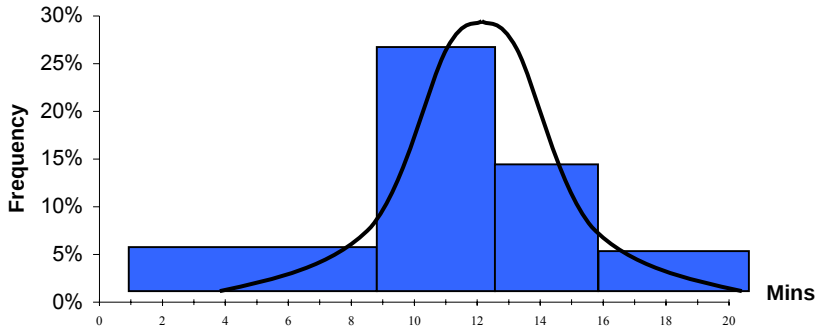


Note increased usage from 7-7:30 am (typical of Fridays).
Note increased average Queue-Wait during this time.
(Accompanied by a rise in abandonments to about 10%.)

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

Ambulatory Operations Time
Production of Health

Cystoscopy:

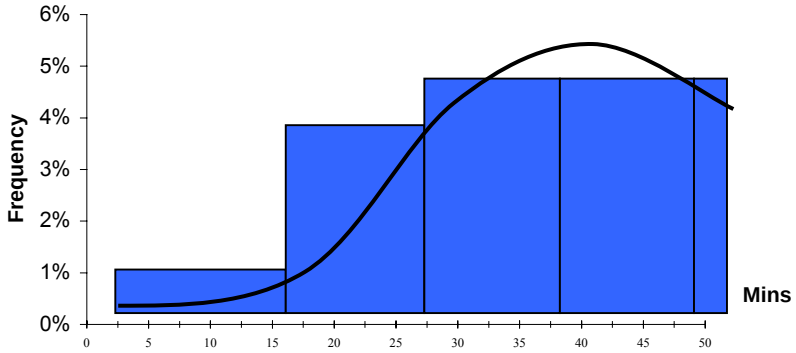


Practice
Theory

AVG: 11.33 Mins.
STD: 2.83 Mins.
N: 48

$4.1057 = \chi^2 < \chi^2_{0.95} = 5.991$ => Do not Reject

TURT / TURP:

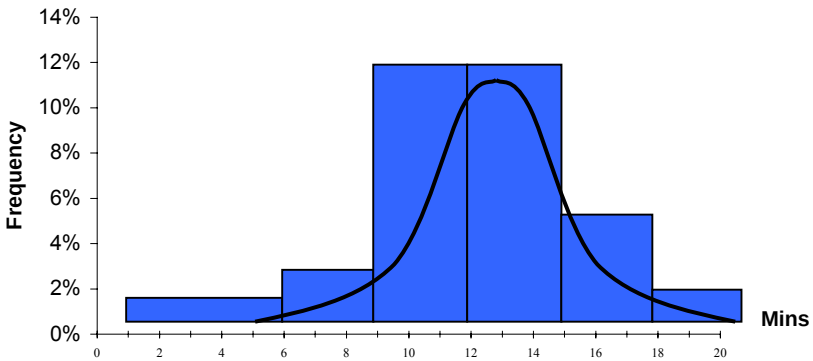


Practice
Theory

AVG: 37.1 Mins.
STD: 14.41 Mins.
N: 20

$0.5113 = \chi^2 < \chi^2_{0.95} = 5.991$ => Do not Reject

Curettage:



Practice
Theory

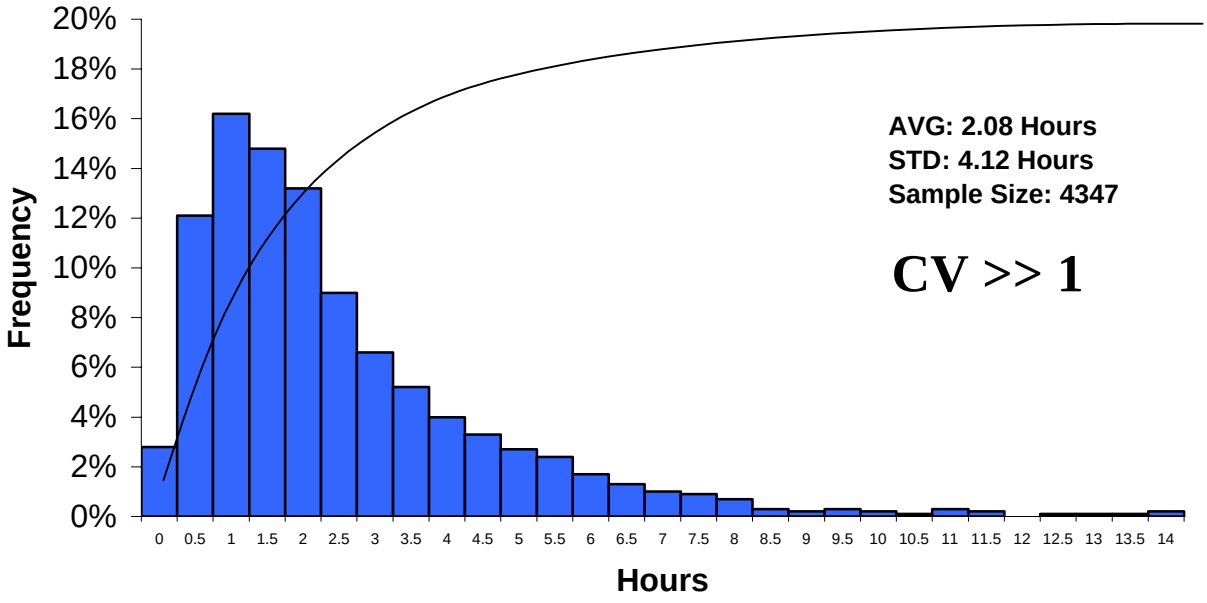
AVG: 12.08 Mins.
STD: 3.08 Mins.
N: 40

$2.4887 = \chi^2 < \chi^2_{0.95(6-3)} = 7.815$ => Do not Reject

CV << 1

Operations Time In a Hospital

Operations Time Histogram:



O1 O2 All Clear

Simulation Experiments with $M/G/100$ Queues in the *Halfin-Whitt* (Q.E.D) Regime

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‡ schwartz@ie.technion.ac.il

Draft of July 9, 2002

Industrial Engineering and Management, Technion, Haifa 32000, Israel

Dependence of performance on the service time distribution in the QED regime: M, D, LN

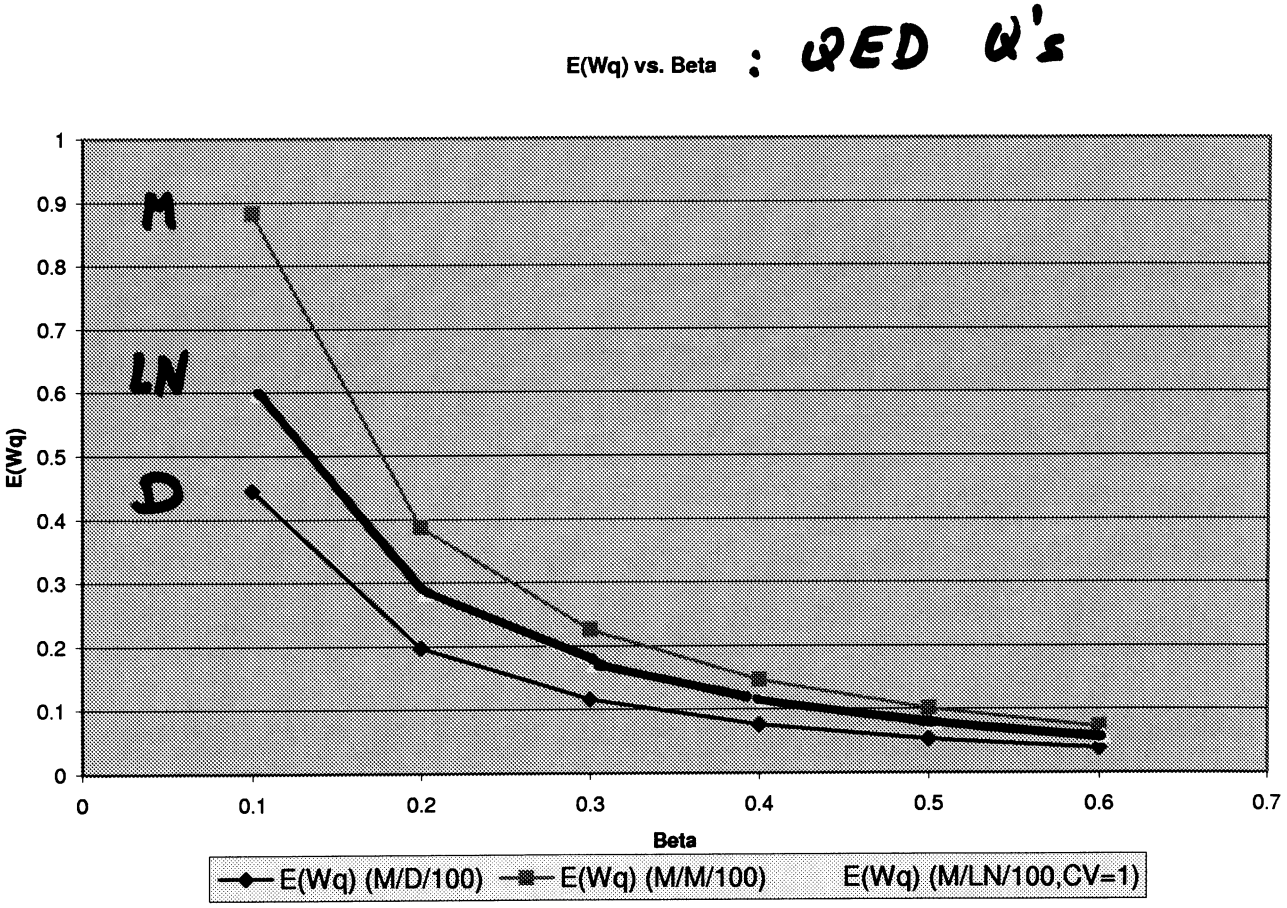

Figure 6: $E(W_q)$ vs. β ($M/M/100$, $M/D/100$ and $M/LN/100$ with $CV = 1$)