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Technical Assistance for Law-Enforcement Communications

Case Study Report 1

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James A. Mustain

June 15, 1979

Prepared for

U.S. Department of Justice
Law Enforcement Assistance Administration

by

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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ABSTRACT

Two case histories are offered as examples of the work being done with 27 state and local law-enforcement agencies by the Jet Propulsion Laboratory. The work is being done under a grant from the federal Law Enforcement Assistance Administration, to improve police communications systems. In one, use of the technique of queueing analysis shows several ways of improving time of response to inquiries made to the Texas Department of Public Safety from the field, principally for license-plate checks and for information on current wants and warrants from its officers and from other agencies, through a state multiple-switcher network. Another phase of the task was aid in developing design criteria for new, more efficient centralized switching equipment for the department. The other case history traces the application of JPL analysis techniques to the message-load problem experienced by the Nassau County (New York) Police Department in its dispatch center, showing that its communications could be improved by adding communications channels, not by adding people.

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I. INTRODUCTION

A. PURPOSE

This progress report covers a part of the technical assistance work for law-enforcement communications done by JPL under a JPL-Caltech grant from the federal Law Enforcement Assistance Administration, as part of the LEAA's overall program of assistance to law-enforcement and criminal-justice jurisdictions. The LEAA objective is to improve the effectiveness and efficiency of local and state agencies; one way of doing so is to apply modern techniques to the analysis of law-enforcement communications systems and to their improvement. The JPL-Caltech grant is directed to the analysis and improvement of dispatching functions, radio systems and statewide communications systems.

B. SCOPE OF REPORT

P.esented here are two illustrative examples of the JPL/Caltech approach to the problem, selected from among 27 projects that have been completed or are now under way: one for the State of Texas Department of Public Safety and the other for the Nassau County (New York) Police Department.

C. ACKNOWLEDGMENT

The authors wish to acknowledge the assistance of R. D. Kennedy in the preparation of this report.

II. BACKGROUND

A. LEAA TECHNICAL ASSISTANCE PROGRAMS

The JPL/Caltech program of technical assistance for law enforcement communications is one of several LEAA technical assistance programs for local and state jurisdictions.

1. Under one program, the Institute for Law and Social Research (INSLAW) has developed a computerized information-management system for prosecutors. This system, called PROMIS, also has a special juvenile-justice version. PROMIS is available to all interested agencies.

2. Under another program the National Clearinghouse for Criminal Justice Information Systems provides technical assistance in the transfer of information systems that have been developed in one agency to other agencies with similar needs.

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3.   Under LEAA sponsorship, the Associated Public Safety Communications Officers provide short-term assistance by members to agencies requiring technical help with police radio systems.

4.   SRI, Inc. assists local jurisdictions in planning 911 emergency calling systems, also with LEAA support.

B.   GOALS OF THE JPL/CALTECH TECHNICAL ASSISTANCE PROGRAM

1.   The first goal of the JPL/Caltech program is to develop within the support community (which consists of local law-enforcement agencies, consultants, vendors, educational institutions, professional societies, and government agencies and laboratories) a system for delivering technical assistance in communications to local agencies. The technical assistance encompasses analyzing existing systems, defining requirements for new systems and assisting in the selection of new systems or equipment.

2.   A second goal is to encourage and support the sharing of facilities by neighboring agencies that are individually too small to justify the acquisition of advanced systems that have the potential of improving service to the public and saving money.

C.   SCOPE OF THE PROGRAM

The Jet Propulsion Laboratory is initiating a technical assistance-delivery system by providing such assistance directly to local agencies and using the results of this activity to identify the kinds of assistance that are most useful and the best means of providing those kinds of assistance on a continuing basis. This step specifically includes training local agency personnel in the techniques involved so that they can apply them within their own agencies. The elements of this technical assistance are generally the following:

1.   Measurement of the elements of the dispatching function, such as call arrival rates, by time of day and day of week, length of telephone calls, average and peak loads on dispatchers, total time to final disposition, number and length of radio messages, total numbers of calls not requiring dispatch, etc.

2.   Analysis of the measured data to identify the points where improvements would be most effective and to define the requirements for a system to meet specified standards, such as maximum wait time for a caller or maximum wait time for access to a radio channel.

3. Design of a system to meet the specified requirements; this may be merely a better configuration of existing personnel and equipment, or may be a partial or complete new system.

4. Assistance in selection of new equipment, where new equipment is indicated. Help is provided in the preparation of Requests for Proposals (RFPs) or Requests for Quotations and in the analysis of the resulting proposals or quotations. The equipment to be procured may be complete computer-aided dispatch systems, mobile digital terminals, portable radios, or auxiliary equipment.

5. Communication Network Analysis, using statistical techniques to determine channel capacity under various conditions, including added capacity made available by the use of digital transmissions.

6. Assistance in the planning and analysis of regional networks to make the advantages of modern communications and digital technology available to jurisdictions that would not be able to justify their costs individually.

III. THE JPL/CALTECH APPROACH

The first step in developing a technical-assistance delivery system was to identify the agencies desiring technical assistance in connection with their police communications and dispatching operations. This was done through a survey and by informing the law-enforcement community of the program. Some 150 requests for technical assistance have been received to date.

The next step was to determine how many of these requests can be serviced within the available resources of the program, and to select a representative group of agencies of different sizes and with a wide geographical distribution. This selection was also made to include agencies with a broad range of requirements as a basis for developing tools and techniques appropriate to differing requirements. Requests were reviewed with LEAA, which approved selections.

Implementation of the program consisted of applying the concepts outlined above to the selected agencies as a test under field conditions. Results of the technical assistance efforts are being analyzed to ascertain their effectiveness and to devise ways in which they may be improved.

Since a goal of the program is to develop capabilities within the support community, including local agencies themselves, the next step was to disseminate the results of the preceding steps as widely as possible through seminars and workshops for members of the community. These seminars and workshops in turn resulted in better definition of needs through feedback from participants; succeeding workshops and seminars were modified to focus more sharply on the specific requirements of community members.

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In addition to the seminars and workshops, the specific tools found to be effective--especially analytical procedures and computer programs--were disseminated to requesting agencies.

The final step, now under way, in this approach is to assemble and analyze the results of the whole program to determine how well it has met its goals. The major question here is whether or not the program has resulted in the development of an independent system for delivery of technical assistance of the kind intended by the program.

IV. PROJECT DESCRIPTIONS

The best way to illustrate how the JPL/Caltech program operates is to give some examples. From among 27 projects that have been completed or are now under way, two have been selected for this progress report: one for the State of Texas Department of Public Safety, and the other for the Nassau County (New York) Police Department.

A. MESSAGE SWITCHER FOR THE TEXAS DEPARTMENT OF PUBLIC SAFETY

In 1977 a joint study by the Texas Department of Public Safety (DPS) and JPL determined that the lowest-cost solution to improving the performance of the statewide Criminal Justice Telecommunications System would be to replace its multiple regional switchers with a single-switcher data base facility at Austin. Since this would be a major procurement requiring many months to effect, DPS requested further assistance from JPL under the newly established technical assistance program sponsored by LEAA.

There were two parts to this project: to assist the DPS in preparing a Request for Proposals (RFP) for the new message-switching facility, and to use the techniques of queueing analysis to find the best interim measures to improve the response time of the existing system durng the wait for the new one. In the course of this analysis, DPS personnel were to be trained in the use of the techniques so that they could perform similar studies in the future.

1. ANALYSIS

A team of DPS officers was assigned to the RFP generation task. One day was spent in discussing a complete outline prepared by a JPL team member and in identifying typical contents of each section of the outline. RFPs that had been used to procure switchers in other states were presented and discussed. The DPS team members were assigned sections of the RFP to write; they called on other specialists within DPS for information as needed, especially to ensure that all requirements were met.

When drafts of the various sections had been prepared they were reviewed by the entire team and revised as suggested by the reviews. After a few cycles of drafting and revision the RFP was completed and submitted to the appropriate state agency for completion of the procurement process.

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For the queueing analysis, two members of the DPS Data Processing section were assigned to work with the JPL team. A JPL team member presented a tutorial on queueing theory and its application to the DPS problem. A set of equations relating to this problem was developed, and the DPS team then set these equations up on the DPS IBM 370/155 system and used them to analyze various options for improving the response time of the existing switcher system.

The equations written to apply queueing theory to the DPS communications network constitute a model of the network. With such a model one can estimate the nature of queues (the number of inquiries waiting for access to the data base and their wait times) through the network. By changing the network configuration being modeled (e.g., the number of lines, line speed, characteristics of the switcher) one can estimate the effect of such changes on the real system. Different rates of message arrival can be input to the model to see what the effect is on wait times. In the DPS model, the following parameters are assigned numbers for each run of the model:

a.   Line Speeds--the speed of the multidrop line and the speed of lines between the switcher and the data base computer.

b.   Protocol--the overhead characters necessary to establish communication, the turnaround time required on a line, bits per character, etc.

c.   Message lengths--the numbers of input and output characters in the messages.

d.   Computer service times--the times required by the computer to handle the messages.

e.   Traffic volumes--the number of messages per second handled by each part of the network.

f.   Method of handling queues at the data base computer-- whether to hold the lines to allow only a specified number of messages across them until a response is sent back, or to open the lines to let the messages come across as fast as the lines can handle them.

These parameters were input from a terminal, so it was relatively easy to make new runs with changed parameters.

The network being modeled is shown in Figure 1. The Austin switcher shown in the diagram is the switching computer that handles the message traffic from multidrop lines and from lines connected to the regional switchers. A message is initiated at a terminal; when it reaches the Austin switcher it is routed across the high-speed lines to the data base computer. After the data base computer has processed the message the response travels back across the high-speed lines to the switcher, which routes it to the terminal that originated the message.

INPUT FROM MULTIDROP → SWITCHER →   (DATA BASE (WITH LINES TO SWITCHER)

AUSTIN SWITCHER   DATA BASE COMPUTER
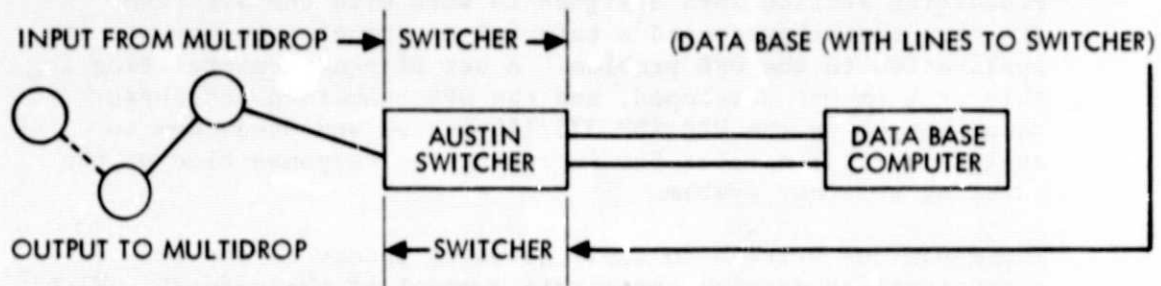
OUTPUT TO MULTIDROP ← SWITCHER ←

Figure 1. Schematic Diagram of Texas Network

For the queueing analyses, the drivers-license data base was used because it was showing the highest queueing time. The switcher also services the criminal-history data base in the data base computer. Nine different options were analyzed for the lines between the switcher and the data base computer:

a.   Single 1800 baud
b.   Single 2400 baud
c.   Single 4800 baud
d.   Dual 1800 baud
e.   Dual 2400 baud
f.   Dual 4800 baud
g.   Single 1800 baud with open queueing
h.   Single 2400 baud with open queueing
i.   Single 4800 baud with open queueing

In addition, four different switcher options were analyzed.

a.   A single switcher using the current line polling scheme.
b.   A dual switcher using the same scheme.
c.   A single switcher using an interrupt polling scheme.
d.   A dual switcher using interrupt polling.

In reality, only the first of the switcher options was available (the present configuration), because it would be too expensive to add a second switcher or to change the software to permit interrupt polling when a new system is to be procured. Nevertheless, these other options were examined to see what their effects would be on the system's response time.

The results of the analysis of the drivers-license data base are summarized in Table 1. In this table the column "Queue Type" indicates how many messages are allowed across the lines to be processed at one time. In this case the number is either three or six, or else there is no restriction on the number (open queueing). The column headed by the symbol "ρ" indicates an estimate of the degree of utilization; that is, what percentage of the time the data base computer is actually processing messages.

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Table 1. Drivers License Data Base Performance

	Configuration			Msg./Sec. = .12 Msg./Day = 10,350		Msg/Sec. = .24 Msg./Day = 20,700	
Option	No. of Lines	Line Speed	Queue Type	ρ	Total Queue (sec)	ρ	Total Queue (sec)
1	1	1800	MT=3	58%	11.6	100%+	---
2	1	2400	MT=3	50%	8.2	98%	minutes
3	1	4800	MT=3	39%	5.3	78%	14.4
4	2	1800	MT=6	28%	5.1	57%	7.0
5	2	2400	MT=6	24%	4.2	49%	5.3
6	2	4800	MT=6	19%	3.7	38%	3.6
7	1	1800	OPEN	37%*	4.8	74%*	9.0
8	1	2400	OPEN	37%*	4.1	74%*	7.6
9	1	4800	OPEN	37*	3.6	74%*	6.8

*Data Base computer utilization only--all other utilizations are for the data base facility (the data base computer and the lines between the switcher and the data base computer act as a unit).

Option 1 is the current configuration. It is clear that there is a problem, especially at the higher message rate, when the computer is saturated. Increasing the speed of the single line brings some improvement, but much less than if another 1800-baud line is added. As a practical matter, this facility has had difficulty with 2400-baud lines and the only options other than Option 1, the present system actually available, are 4 and 7. Option 4, adding another 1800-baud line, is clearly the best choice among these options.

2.   RESULTS

The results of the analysis of changing the switcher configuration are shown in Table 2. In this table the column headed "ρ" indicates the utilization of the switcher plus the lines to the data base computer, as a percentage. The total message load is higher than shown in Table 1 because the switcher is handling messages for all the data bases in the data base computer, not solely the drivers-license data base as is Table 1. The column headed "tpoll" indicates the time required to poll the input lines and to get the message into the switcher to be serviced. With the present system, this time is a major portion of the total switcher queue time.

As the table shows, performance would be dramatically improved by any of the options other than the present system (Option 1), and especially by adopting an interrupt-driven polling scheme. However, as noted above, these options are too expensive in the circumstances. The results are of interest in cases where a new system is being considered.

Table 2. Switcher and Line Performance

Option	Configuration No. of Servers	Configuration Poll Scheme	ρ	Msg./Day = 104,000 tpoll (sec)	Msg./Day = 104,000 Total Queue (sec)	ρ	Msg./Day = 2C8,000 tpoll (sec)	Msg./Day = 2C8,000 Total Queue (sec)
1	1	PRESENT	48%	23	28	96%	minutes	minutes
2	2	PRESENT	24%	14	18	48%	16	21
3	1	INTERRUPT	48%	1.5	6.0	96%	1.5	25
4	2	INTERRUPT	24%	1.5	5.5	48%	1.5	5.8

Finally, the model was used to evaluate overall system performance (total response time seen by a user at a remote terminal) for combinations of options from Tables 1 and 2. The results are shown in Table 3. It is clear that use of either of the best two options (4 and 7) from Table 1 has little effect on overall performance, while changing the switcher to an interrupt-driven polling scheme (Options 3 and 4 from Table 2) results in sharp reductions in response time. The switcher is obviously the bottleneck. It should be pointed out that adopting either Option 4 or Option 7 for the lines does improve average response time somewhat, even with the present switcher; the average response time with the present configuration (not shown in the table) is about 40 seconds.

Table 3. Overall System Performance

Data Base (From Table 1)	Switcher (From Table 2)	Avg. Response Time (Seconds)	Peak Response Time (Seconds)
OPTION 4	OPTION 1	33.1	MINUTES
OPTION 7	OPTION 1	32.8	MINUTES
OPTION 4	OPTION 3	11.1	32.0
OPTION 7	OPTION 3	10.8	34.0

This analysis illustrates the value of a queueing model in identifying parts of a network where improvements will have the most effect, and in comparing different options to determine which are most cost-effective.

B. NASSAU COUNTY DISPATCHING WORKLOAD ANALYSIS

The steps taken in Nassau County clearly illustrate the system approach advocated by JPL throughout the grant. It would be helpful to summarize this approach briefly before continuing.

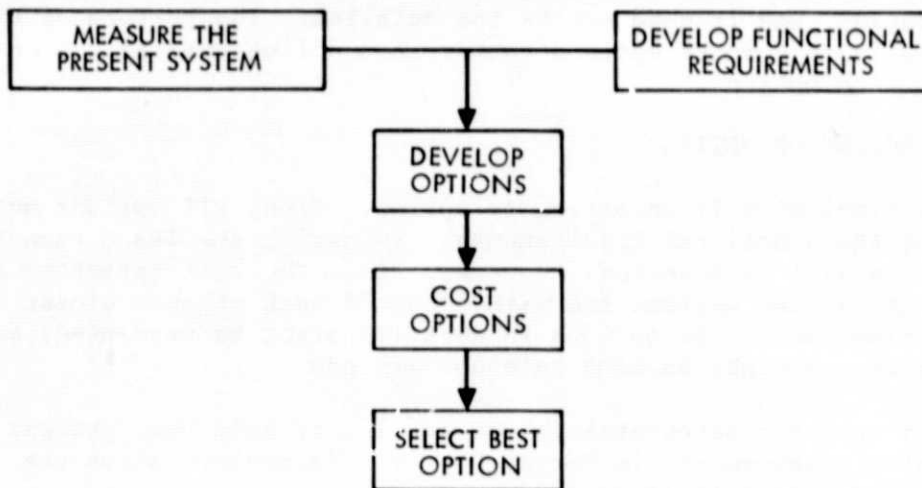The approach consists of several steps, as shown in Figure 2.

```
┌──────────────────┐                    ┌──────────────────────┐
│   MEASURE THE    │                    │  DEVELOP FUNCTIONAL  │
│  PRESENT SYSTEM  │                    │    REQUIREMENTS      │
└──────────────────┘                    └──────────────────────┘
            │                                   │
            └───────────────┬───────────────────┘
                            ▼
                  ┌──────────────────┐
                  │     DEVELOP      │
                  │     OPTIONS      │
                  └──────────────────┘
                            │
                            ▼
                  ┌──────────────────┐
                  │       COST       │
                  │     OPTIONS      │
                  └──────────────────┘
                            │
                            ▼
                  ┌──────────────────┐
                  │   SELECT BEST    │
                  │     OPTION       │
                  └──────────────────┘
```

Figure 2. System Approach

1. ANALYSIS

The first step is to measure the present system. This is a
vital step, yet it is frequently omitted. Proper measurement of
the system will indicate where problem areas exist and will show
where problems will be first encountered as the load on the
system increases.

DEVELOPMENT OF FUNCTIONAL REQUIREMENTS

While the system is being measured, functional requirements are
developed. This is another step that is often overlooked. The
functional requirements spell out exactly what a system is
expected to do. For instance, functional requirements might
state that a system must be able to handle a peak load of 100
incoming phone calls per hour with 90% of the calls being
answered in less than than 10 seconds. It is important that the
functional requirements specify only <u>what</u> the system is to do,
not <u>how</u>. For instance, the functional requirements should not
state that a computer-aided dispatch system will be used. To
state how a system will perform as part of the functional
requirements will limit the possible options and may exclude
otherwise highly satisfactory alternatives.

3. DEVELOPMENT OF OPTIONS

The third step is to develop options. In this step alternative
system concepts such as manual systems, CAD systems, distributed
systems, etc. are defined (it is assumed that all options
developed in this step will meet the functional requirements).

4.   DEVELOPMENT OF OPTION COSTS

In the fourth step a rough estimate of the cost of each option
is developed. The cost should be derived over the desired
lifetime, and it need not be too detailed. The purpose of this
step is to compare options rather than define precisely a cost
for each option.

5.   SELECTION OF OPTION

The final step is selecting an option. Since all options must
meet the functional requirements, ordinarily the least expensive
option will be selected. However, since the cost estimates are
rough, if two options are within 10% of each other a closer
examination of the options in question might be warranted, and
the choice might be made on other grounds.

This report concentrates on the results of Step One, present
system measurement, in Nassau County. Subsequent steps are
under way as this is written.

In Nassau County the analysis was carried out jointly by members
of the Nassau County Inspection and Planning Bureau and JPL,
with support from the Nassau County Communications Division.

Dispatching in the Nassau County Police Department, which covers
the entire county, begins with 911 calls from the public. Calls
are received by the complaint board operators (CBOs), who
determine whether a dispatch is necessary. If it is, the CBO
fills out a dispatch card with the pertinent details and places
it on a moving belt. The card carries an indication of the
precinct concerned, and one of the two dispatchers assigned to
each pair of precincts picks up the card and dispatches the
incident (allowing for priorities and the availability of
units). This is a typical mode of operation for many
dispatching systems.

The questions to be answered by the workload analysis were the
following:

a.   What is the current load on the dispatch system?

b.   Is the present number of CBOs and dispatchers adequate for
     current load conditions?

c.   What increases in system loading can be tolerated without
     a significant increase in response time, and which element
     is likely to be saturated first?

The same basic technique used in the Texas analysis, queueing
theory, was applied here. First, however, it was necessary to
make some measurements of the system in operation. The whole

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operation was divided into identifiable functions, and the mean service time for each function was determined. At the same time the mean arrival rate for each function, the average number of times the function occurs per unit of time, was measured. The arrival rate was measured for each hour over a span of hours representing high and low periods, and for each day of the week. Measurements were made by listening to tapes of the transactions and timing them or, where necessary, by direct observation and timing with a stopwatch.

All of the functions performed by each person can be combined to estimate the utilization of that person. From this utilization estimate, and with the use of certain simplifying assumptions, average waiting times and average queue times can be estimated for various loads on the system. Table 4 shows these estimates for the Nassau County system.

All of the queue times are added to make the total queue time for a dispatch; this is the time from the first ring of the incoming call to the end of the dispatcher's radio transactions with the patrol unit. It is shown in column 11 of Table 4.

As the table shows, service times are expected to remain relatively constant for any rate of incoming calls; it takes about the same time for the CBO to handle a call whether it is a busy or a slack period, and the same for the dispatchers. The effect of the arrival rate appears in the wait times, and consequently in the queue times. Service times vary for different calls, of course, but the average service time per call is not significantly affected by the work load.

The peak arrival rate of calls actually observed during the measurement period was 102 per hour (on a Friday evening); rates typically were in the range of 50 to 75 calls per hour. The wait times and queue times shown in the first seven columns for higher rates were extrapolated by means of a queueing equation.

In the Nassau County dispatching center there were six CBOs. It is clear that the CBOs are seldom overloaded, even with 100 calls arriving per hour, since they are essentially answering each call on the first ring. Even if the rate went to 175 calls per hour the average wait time would be only 3 seconds. The dispatchers also are not heavily loaded on the average, even at the highest observed rate (that is, they are picking up the dispatches from the belt with only a few second's delay). The wait times for the radio channel begin to increase even during moderate call-rate periods, however, and with an arrival rate of 100 calls per hour the wait time for a radio channel is already excessive and about to become unacceptable at an arrival rate of 125 calls per hour.

Table 4. Nassau County Timing Measurements

1	2	3	4	5	6	7	8	9	10	11
Total Number of Incoming 911 Calls per Hour	PSAP E(tw)	PSAP E(ts)	PSAP E(tq) (2+3)	Belt E(ts)	Dispatcher E(tw)	Belt/Dispatcher E(tq) (5+6)	Radio Channel E(tw)	Radio Channel E(ts)	Radio Channel E(tq) (8+9)	Total Queue (4+7+10)
25	---	61	61	14	---	14	4	28	32	107
50	---	61	61	14	1	15	9	28	37	113
75	---	61	61	14	1	15	19	28	47	123
100	---	61	61	14	2	16	37	28	65	142
125	1	61	62	14	4	18	92	28	120	200
150	1	61	62	14	6	20				
175	3	61	64	14	10	24				
200	6	61	67	14	16	30				
225	11	61	72	14	25	39				
250	20	61	81	14	45	59				
275	42	61	103	14	112	126				
300	118	61	179	14						

$E(tw)$ = average waiting time (seconds)

$E(ts)$ = average service time (seconds)

$E(tq)$ = average queue time = $E(tw) + E(ts)$ (seconds)

NOTES:

1. Figures for columns 2-4 assume 6 CBOs.
2. There is no wait for the belt -- service time is constant.
3. Columns 5-11 apply to the worst case.
4. --- indicates durations less than 0.5 seconds.

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The shape of the curves in Figure 3 reflects this; up to a moderate arrival rate the queue time rises very slowly, and then it starts to climb steeply and soon becomes excessive. The figure shows clearly that the CBOs and the dispatchers are not heavily loaded at the observed arrival rates and could in fact handle twice the rate before beginning to experience trouble. The radio channel, on the other hand, is beginning to back up at just over 50 calls per hour and would be completely blocked at fewer than 150 calls per hour. The curve for total queue time is simply the sum of the other three queue times along any vertical line on the graph, and it is obvious that it is the radio channel that is driving up the total queue time.

6.   RESULTS OF ANALYSIS

These findings were of considerable interest to the Nassau County department, as it helped to quantify specific 911 station requirements and the relationship of current radio-channel loading to overall system performance.

To reduce excessive delays in a queueing situation it is necessary to reduce the utilization of servers. This can be done by reducing the number of functions performed by a server (reducing the arrival rate) or reducing the average amount of time spent on each function. The three principal ways to accomplish such reductions are to improve procedures, improve equipment, and add servers.*

Improving procedures can affect both arrival rate and service time. For example, an agency that requires CBOs to handle inquiries at a walk-in window could transfer that function to a clerk if the CBOs were overloaded. This would reduce the number of functions performed by the CBO, and if the function were a long one, average service time might also be reduced.

Improved equipment can often reduce average service time. A manual filing system for local wants and warrants could take an excessive amount of time to reference. An updatable microfiche could cut the reference time in half. Whether or not the gain would justify the cost would, of course, depend on the circumstances in each agency.

Adding servers (personnel or radio channels) would improve queueing times since the total number of arrivals would be split among a larger number of servers, and the average number of arrivals per server will be decreased.

The information obtained by applying these techniques has given the Nassau County Police Department some valuable insights into the critical areas of its dispatch center. It is now proceeding with the subsequent steps described above.

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*In queueing theory a server is a single point at which a function is performed. A single incoming telephone line is a server, as is a radio channel. People, e.g. CBOs and dispatchers, also are servers.
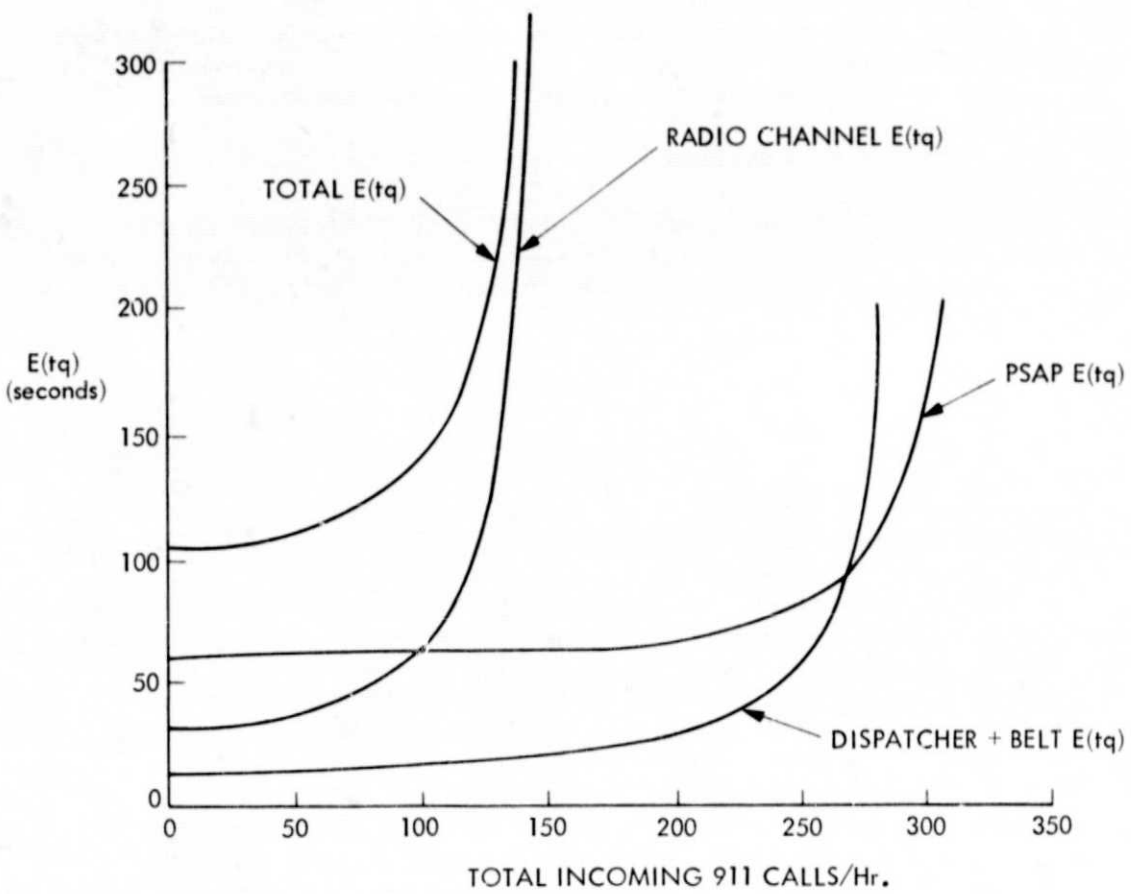
Figure 3. Nassau County Queueing Patterns

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APPENDIX A: LIST OF JPL/CALTECH PROJECTS FOR LEAA

Agencies currently or recently served under the JPL-Caltech grant for
assistance in improving law-enforcement communications:

State of Nevada Department of Law Enforcement Assistance (state
    switcher)
Texas Department of Public Safety (state switcher)
Nassau County Police Department, New York (computer-aided
    dispatch (CAD)/dispatch center analysis)
Bismarck Police Department, North Dakota (radio specifications)
La Grande Police Department, Oregon (radio)
City of Aspen Communications Center, Colorado (dispatch analysis)
San Diego County Sheriff's Department, California (dispatch analysis)
Alameda County Sheriff's Department, California (dispatch analysis)
State of Oregon Law Enforcement Data System (switcher)
Snohomish County Police Staff and Auxiliary Service Center, Washington
    (CAD)
La Crosse Police, Sheriff and Fire Departments, Wisconsin
    (radio/dispatch)
State of Connecticut Division of Communications (multi-agency radio)
Walworth County Police, Wisconsin (radio/dispatch)
Richardson Police Department, Texas (radio)
Lincoln County Sheriff, Montana (radio)
Raleigh/Wake County Emergency Communications Center, North Carolina
    dispatch analysis)
St. Charles County Sheriff's Department, Missouri (radio/dispatch)
Harris County Sheriff's Department, Texas (radio)
Savannah Police Department, Georgia (CAD)
State of Missouri, Division of Information Systems (state switcher)
Fayetteville Police Department, North Carolina (radio/dispatch)
Greenville County Law Enforcement Center, South Carolina
    (radio/dispatch)
Jefferson County Police Department, Kentucky (radio)
Consolidated City of Jacksonville Sheriff's Department, Florida
    (dispatch/mobile digital terminal feasibility)
St. Mary's County Communication Center, Maryland (dispatch analysis)
Orange County Criminal Justice Council, California (multi-agency
    consolidation feasibility)
Howard County Police Department, Maryland (radio/dispatch)

Information on these or other LEAA assistance programs my be obtained
from:

                    Wayne Holtzman
                    Director
                    Systems Development Division
                    NCJISS-LEAA
                    Washington DC   20531