AMCROSS MESSAGE TRAFFIC ANALYSIS

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ABSTRACT

The American Red Cross (ARC) provides many valuable services. One such service is to provided 24-hour emergency communications for members of the U.S. Armed Forces and their families worldwide. AMCROSS is the communications network supporting this service. AMCROSS is managed by EMERCOMM, a unit of the Armed Forces Emergency Services (AFES) branch of the ARC. Due to tightening Department of Defense budget constraints, subsidies received by AFES are shrinking. This situation deems it necessary to evaluate the existing operations for possible enhancing modifications.

This project conducts performance analysis and system modeling to quantitatively understand important characteristics and patterns involving AMCROSS message flow. This understanding helps define an origin from which performance benchmarking and system improvement can evolve.

The performance analysis quantitatively describes the message activity flowing in, out, and through the AMCROSS system, thus, establishing several viable message-handling metrics. The system modeling focuses on incoming telephone operating margins. The operating margins are determined with a mathematical model applying multi-channel queuing theory. The modeling results showed adequate telephone resources exists for current peak-hour conditions; however, increased caller traffic could leave customer service below acceptable standards. Model sensitivity analysis identifies potential cost savings for shortening the time required for an operator to receive a caller's message.

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1. Introduction

1.1 Background

Some of the many valuable services provided by the American Red Cross (ARC) are 24-hour emergency communication service, casework management, and financial assistance for the members of the U.S. Armed Forces and their families worldwide. These activities are conducted under the leadership of the Armed Forces Emergency Services (AFES) organization. The AFES network includes the National Headquarters and more than 200 stations in military installations. The recent movements to down size the Department of Defense (DoD) have been felt within the AFES organization and the organizations that fall within it. One such organization operates the emergency communications network, AMCROSS. AMCROSS serves ARC chapters (domestically and abroad), blood centers, and the Northern Virginia based National Headquarters. AMCROSS is operated by the Emergency Communications (EMERCOMM) unit of the AFES division at National Headquarters ("Frequently Asked Questions," 1990). The tightening DoD budget constraints reduce the subsidies that help financially support the EMERCOMM services. To alleviate the impact of a reduced budget, more efficient ways of conducting business must be examined. However, before intelligent modifications can be made or reduced-funding battle plans drawn, a systematic analysis of principle operational components is necessary. One such component instrumental in conducting the EMERCOMM services is the AMCROSS network. The principle function of AMCROSS is to send messages between military families in the continental United States and service personnel located around the world. AMCROSS is also used to send disaster welfare bulletins as well as general and administrative information.

This project supports AFES with the arduous task of optimizing current operations while preserving the expected services delivered to military personnel and their families. The process of modifying any part of the AMCROSS system is best served by a systematic and methodical approach. System effectiveness is the measuring stick for determining if, and to what degree, modifications are required. Evaluation of system effectiveness is a culmination of various parameters that include availability, dependability, performance, personnel quantity, personnel skill level and personnel job function. This project focuses on performance characteristics and personnel quantities for specific AMCROSS functions. The performance characteristics and staffing profiles will help decision makers become aware of what areas merit modification most, if any. Organizational-enhancing modifications are made apparent by describing the organization's day-to-day activity patterns and are justified by potential cost savings. Performance assessment requires identification of key organizational elements and sources of sample data for analysis to begin. Two types of data are typically collected to support system evaluation, Success-data and Maintenance-data. Success-data constitute information covering system operation and utilization on a day-to-day basis, while Maintenance-data covers events involving scheduled and unscheduled maintenance (Blanchard & Fabrycky, 1990, p. 115). This project employs the success-data type for characterizing and analyzing organizational performance. Characterizing existing performance serves two functions. First, it provides a benchmark for measuring system effectiveness so modifications can be analyzed for impact. Second, it serves as a baseline for similar operations not currently developed. The organizational performance impacts the system's effectiveness, that in turn, identifies areas for possible modification. The data to support a decision to modify any part of the organization should include a life cycle cost (LCC) analysis.

LCC is the total cost to acquire, own, and dispose of a system over its entire life. The information gleaned from LCC analysis is used differently depending on where in the life cycle it is conducted. For instance, during the Concept Exploration/Definition phase, the LCC analysis is focused on identifying cost drivers, evaluating relative LCC differences among competing alternative concepts, and developing the estimate(s) supporting the operational concept. During the Development phase, LCC is used to track the baseline cost impacts due changes in the design. However, in the Utilization and Support phase where this project focuses, LCC is used to consider impact of modifications, and value engineering proposals and product performance agreements. Regardless of when the LCC analysis is conducted, more confident decisions will result. A thorough LCC analysis was not conducted as part of this project. Therefore, any cost savings analysis presented in this report should be considered incomplete. Nonetheless, the correlation between performance enhancements and potential cost savings remains valid. LCC issues that should be considered with any process/equipment modification are addressed in Section 4.2, Future Studies, of this report.

Due to the size and number of functions conducted by AFES and EMERCOMM, a system was defined with boundaries drawn around the AMCROSS network. The AMCROSS "system" is an application of the abstract definition of system given by Hicks, "a set of interacting components that operate within a boundary for some purpose" (1993). This defined system allows focused analysis on the principle functions conducted by AMCROSS - receiving, processing, and sending messages.

The remaining portion of Section 1, Introduction, covers an overview of the AMCROSS network in order to identify the key elements used in the AMCROSS message flow process. Following the network overview are subsections on personal contributions and currently existing AMCROSS performance information. A brief discussion on the process for selecting this project completes Section 1.

Section 2, Analysis, begins with a discussion on System Engineering methodology and how it applies to this report and the AMCROSS system. Section 2 continues with a description on how data was collected and reduced for building a message traffic matrix (used to describe message handling patterns). Next, Section 2 presents an in-depth review of multi-channel queuing theory and how it was applied to model runs for the purpose of describing measures of effectiveness for the inbound telephone message traffic. Section 2 is completed with a discussion on the Mean Service Rate (MSR) analysis used for projecting potential cost savings for shortening the operator-caller service rate.

Section 3, Results, provides an outline and guidelines on reading the charts used to display plotted data. Following the guideline section are message flow comparisons and observations of the identified key AMCROSS elements. Here, message quantities flowing in, out, and between the key AMCROSS elements are plotted over a 24 hour period. Percentage breakdowns are given for total messages handled daily and for total messages handled by shift. Section 3 also includes the results breakdown for the queuing model runs under peak-hour to twice peak-hour conditions. Section 3 closes with the results from analyzing MSR sensitivity and shows how cost savings might be realized through shortening the time a telephone operator collects information from a caller.

Section 4, Conclusion, provides a results summary, a short discussion on evaluating changes to the AMCROSS system, and areas for future studies.

1.1.1 AMCROSS Network

The AMCROSS network is important to understand for the purpose of analyzing how, when and in what quantity messages enter and leave the

AMCROSS system. The AMCROSS network consists of four interdependent systems as illustrated in Figure 1-1. Regular telephones (voice) and Easylink are avenues of communications between the ARC chapters and the AMCROSS facility. AUTODIN is a digital communications link between military bases and the AMCROSS facility. Message traffic flows in both directions on all communication links. The four communications links included in the AMCROSS system are:

1. Regular Telephones
2. AT&T Easylink
3. AUTODIN
4. Message Switch

This project and report is based on the configuration and operation of the AMCROSS network as it existed during the fourth quarter of 1995. At that time, several studies were being formulated that are likely to replace or modify sections of the AMCROSS network. These studies include:

- Implementing the Defense Messaging System (DMS) that will eventually replace the AUTODIN link (Olson, 1996).
- Conducting a Corporate Information Management (CIM) project that will evaluate options for service delivery, critique AFES processes, and recommend viable technologies that serve within the DoD structure (Olson, 1996).
- Constructing a data communications network, Cross-Net, that will provide National Headquarters connectivity to the 8 regional offices (Davis, 1996).

Regardless of the data communication networks being studied and their eventual impact on the AMCROSS network, the need for telephones as a means of passing messages is not expected to end.

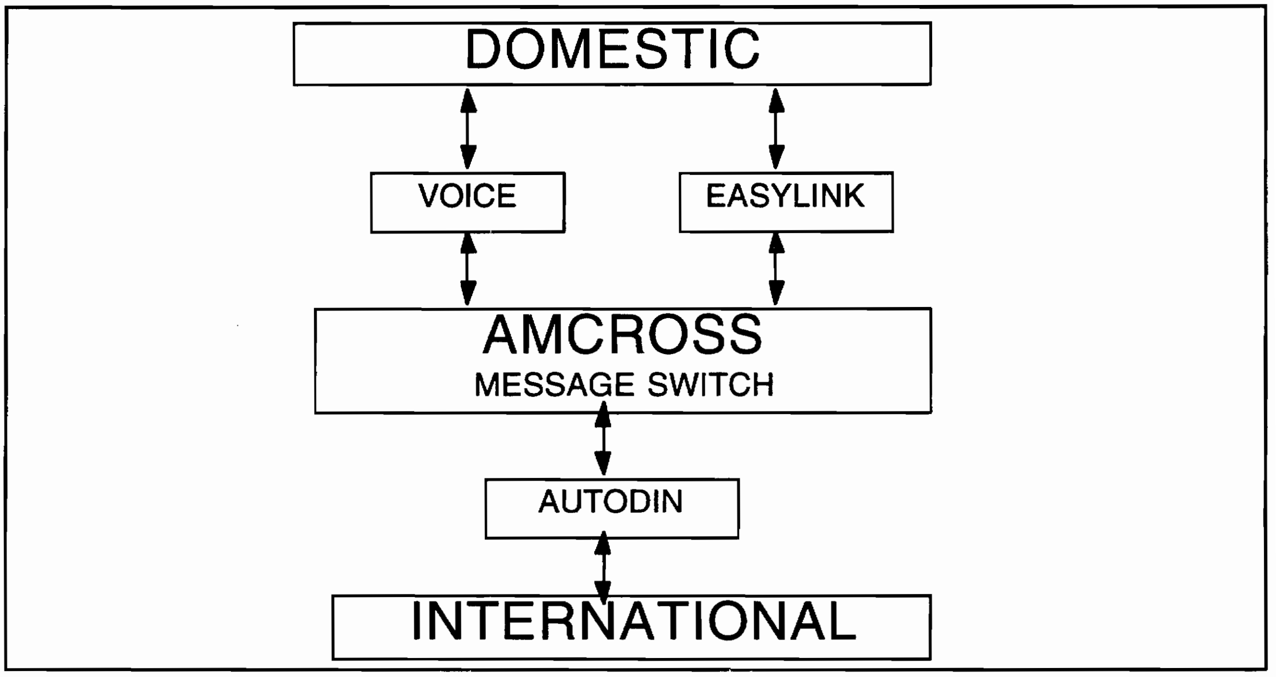

Figure 1-1 AMCROSS Network

1.1.1.1 Regular Telephones

Most Chapters have access to AT&T Easylink; however, many chose to use the telephone to interface with the National Headquarters staff. This fact causes EMERCOM to staff a phone room with individuals to take verbal messages and type them into a database for processing. A number of telephone service providers are used to maintain high reliability. There are 10 lines that are divided for separating inbound and outbound traffic.

1.1.1.2 AT&T Easylink

Easylink is an electronic mail service provided by AT&T. This is a domestic only service that allows chapters to communicate with one another and the National Headquarters. The service uses commercial telephone lines and specialized hardware for input and receipt of messages. The hardware consists of Whisper Writers or Whisper Screens. The Writers are keyboards with built-in printers connected to modems with programmable features. The Whisper Screens add a terminal to the collection of Whisper components. Easylink provides forced delivery and automatic redirection in the case of unsuccessful message delivery ("Emergency Communications Briefing, " 1992).

1.1.1.3 AUTODIN

AUTODIN is a part of the Department of Defense telecommunications network. AUTODIN provides digital connectivity to thousands of military installations and naval ships around the world. Two connections are made with AMCROSS, one with Ft. Detrick and one with Andrews A.F. Base. Encryption (KG84) devices are used to provide security over the network.

1.1.1.4 Message Switch

The message switch and its backup consists of customized software that runs on an HP9000 computer. This system was brought on-line in February 1995. It provides a much greater compute capacity than the previous system; however, the report generating capability is virtually untapped. This system captures the flow of message activity and was used to a large extent for a data source on this project.

The following two sections discuss what information this project and report contributes and what information is currently available.

1.2 Contributions

The goal for the project is to provide analysis in three areas:

1. Analysis that quantitatively describes the flow of message traffic, in, out and through the AMCROSS organization. This analysis was done focusing on activity within a day. Time units, shifts, and hours were chosen to give fidelity to the results and observations.

Resulting information from the message traffic analysis includes the following:

- Understanding of how and when communications occur with AMCROSS i.e., do chapters typically use the telephone or Easylink
- Benchmarking for establishing productivity metrics
- Insight for resource allocation (e.g., people, telephones, computers) optimization based on typical traffic volume
- Logic for preferred network node connectivity if a distributed architecture were ever adopted

2. Analysis that quantitatively describes AMCROSS incoming telephone operating margins under loaded conditions. Waiting lines are formed when callers cannot be serviced. Understanding the margins on figures of merit for queuing theory can prepare AMCROSS for sudden increases in call volume as well as help target performance goals for optimizing the time required for collecting caller information.

   Resulting information from the AMCROSS incoming telephone operating margins analysis is as follows:

   - Probability of immediate service
   - Average length of queue
   - Mean number of calls in the system
   - Mean wait time
   - Probability that callers must wait

3. Analysis that quantitatively describes the potential cost savings for shortening the inbound telephone message handling time. This analysis

describes the financial dividends returned over time flowing from the reduced MSR.

1.3 Information Currently Available

Currently, information gathered on AMCROSS message traffic entails gross quantities of message activity for large periods of time or message-specific information used for locating a message once created and logged in the system. These extreme data sets fail to provide the type of information needed for supporting decisions on revising daily operations e.g., can third shift activities be transferred to another location or what activities typically happen when and to what extent.

Currently, all AMCROSS telephone conversations dealing with emergency messages are recorded and archived for 30 days for the purposes of discrepancy resolution. However, no synthesized information exists for providing decision support on telephone traffic margins. The statistics captured on telephone traffic are purged on an hourly basis from a personal computer. The personal computer displays configuration information (e.g., roll-over times and lines in use) on the monitor, but is not logged for later analysis.

1.4 Topic Selection

My participation in this project grew from conversations with fellow Virginia Polytechnic Institute students who had recently finished a consulting exercise for AFES as a class project. These students informed me of the potential opprotunities for analytical support in the area of AFES's communication systems. My graduate studies focused on communication and information systems; I therefore pursued the opportunity in hopes of a match. I was directed to Professor Ken Harmon, Director of the Virginia Tech. Industrial and Systems Engineering Program at the Telestar campus in Northern Virginia. Professor Harmon had a working relationship with several AFES leaders. His relationships with these leaders enabled me to receive introductions to key

AFES personnel that shared their dilemmas associated with shrinking budgets. Numerous meetings took place between myself, AFES leaders and Professor Harmon in the process of defining and scoping this project. The Manager of EMERCOMM, Rick Davis, gave final authorization to access various data bases and data sources to initiate the analysis.

2. Analysis

2.1 Methodology

The systems engineering goal is to develop and maintain a system that will meet the user's need with minimum cost. The goal is met through system design and system improvement. The systems approach provides the dividends of full customer satisfaction by investing resources (e.g., time, people, money) early in the design phase and in post delivery operations. In other words, the cost of solving problems is much less expensive when dealt with earlier than later and follow up ensures continued success. The systems approach includes analysis that quantitatively describes the system for purposes of trade decisions and performance evaluation. One way of evaluating performance is through modeling. A model may be a physical model of the system or a mathematical model of the system characteristics. The mathematical model is valuable when identifying the relationships between parameters under the control of the engineer/operator and elements of the system affected by these parameters.

The system engineering process includes the System Use and Sustaining Support phase as shown in Figure 2-1. The System Use and Sustaining Support phase involves adjustments to optimize system performance after delivery (Blanchard & Fabrycky, 1990, p. 27). Adjustments to the system can be expected even when development was completed with full customer satisfaction. User's needs change as well as the environment encompassing the system. The mechanism for flowing these adjustments back into the system is referred to as a feedback loop. Feedback loops are used to control and/or to improve system performance.

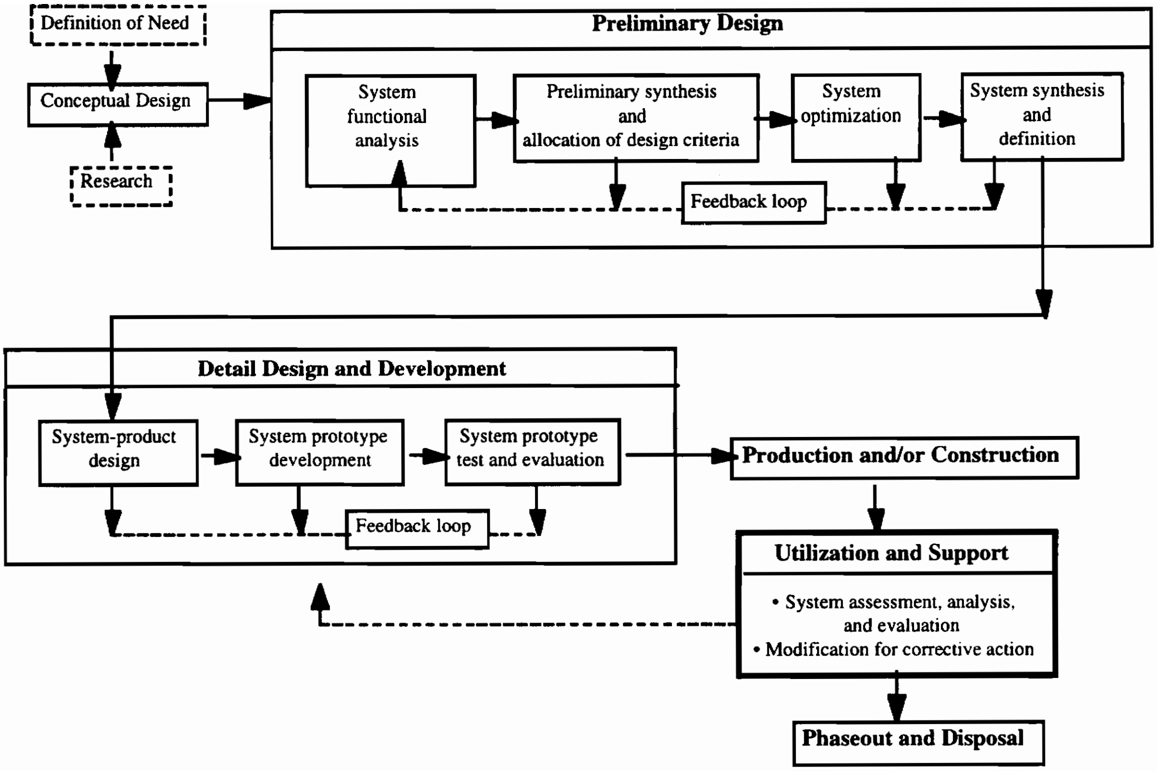

Figure 2-1 The System Life Cycle Process

(Blanchard & Fabrycky, 1990, p. 22)

The system improvement feedback loop is initiated by analysis of system performance data. System performance data enables quantitative insight to the characteristics of the system. Volume, throughput, frequency, inputs, and outputs are but a few of the values that can be used to describe a system's performance. Performance analysis can be used to determine if system limitations are growing closer due to the post delivery environment dynamics. Environmental dynamics may influence the operating margins originally designed for a system and therefore require post delivery evaluation.

This project employs the Systems Engineering Process concepts addressed above by taking a system in existence (AMCROSS) and working with the customer to identify areas for possible modification. Viable system modifications may develop from the performance analysis conducted as part of this report. This project supports the modification (feedback) process by benchmarking several AMCROSS performance measures. These measures are based on the current AMCROSS operations. The performance of key AMCROSS components are analyzed to determine the quantity and time that messages enter, get transferred, and are sent out during the course of an AMCROSS day (24 hours). These performance measures are candidate metrics for charting system progress and/or identify areas for greater analysis.

The application of mathematical modeling is demonstrated with incoming telephone traffic analysis via multi-channel queuing theory. This traffic analysis is important because over 30% of the messages entering the AMCROSS system start with a phone call. This major artery of communication deserves performance-analysis attention so that margins in call capacity can be understood. The capacity margins yield information on the number of phone lines/staff personnel required to service the incoming calls. Too few phone lines/staff personnel leave the customer waiting for long periods of time before getting service. Too many phone lines/staff personnel represent cost that are no longer tolerated with a decreasing operating budget.

From the statistics gathered from the message traffic switch, peak hour traffic volume was used as an input to the queuing model runs. These model runs provided output data that were plotted and used for evaluation. Increased volume conditions were also run through the model and compared with current peak hour conditions to identify condition sensitivity. The queuing model was also used for a sensitivity analysis on the MSR. Manpower requirements, a typical cost driver, are translated to cost savings and are projected over a five year horizon.

2.2 Data Collection

The required understanding for producing value-added information was obtained by cascading introductions and interviews. The AFES leadership shared their mission goals of system optimization. Interviews with operations managers led to conversations with technical support personnel. Each level of organization provided bits and pieces of valued information. Literature collected from visits to the ARC Headquarters enabled the establishment of meaningful dialog during the meetings. Acronyms and accepted jargon routinely surfaced creating obstacles to effective communications.

With persistence and genuine support from key EMERCOMM staff, advances were made toward capturing raw data to reduce and evaluate. Data that is resident on an off-line computer, typically used to ensure archived data integrity, was the source for the raw data collected. This off-line computer is fed from an on-line relational database, Sybase, that collects all message traffic entering and transferred across AMCROSS. SQL routines were written to extract sample data from the off-line Sybase system. Modifications to existing AMCROSS software routines were made to facilitate hourly collections. Downloads to a DOS formatted PC diskette from the Unix operating system were done using a File Transfer Protocol (FTP). The PC formatted diskette was translated to Macintosh formatted data to parse, filter, concatenate, evaluate and plot using the Excel 5.0 application.

2.3 Message traffic within AMCROSS

The data set analyzed for developing the message traffic matrix, involved over 1000 messages that contained up to 5 transfers. A transfer occurs when the same message is passed to another location. Locations are defined as any one of 11 following possibilities:

1. AUTODIN
2. EMS (Easylink) Out
3. EMS (Easylink) In
4. Phone Out
5. Call back

6. File without action
7. AFRU Editor
8. Domestic Editor
9. International Editor
10. Phone In
11. Service Editor

Some locations are not viable selections for routing and therefore where not included in the Results section. Each message had 6 fields of data. This translated into a 3000 X 6 matrix that grew with each computation. This amount of data was extremely cumbersome for manipulation on the home computer. However, disaggregating the data across several files served as an acceptable work-around solution. Macros were created in Visual Basic to expedite the repetitive analysis across the massive data set. A copy of one such routine is presented in the Appendix A. A Message Transfer Matrix was built using the acquired data. The Message Transfer Matrix is the key element for mapping message movement across AMCROSS. Due to the size, (11 rows X 44 columns) the results were put into Appendix B. An outline of the data reduction process that supported the creation of the Message Transfer Matrix follows:

1. Parse the raw data so columns and rows of file records are aligned.
2. Write filter logic to extract message records that were passed to other organizations (not just processed and terminated).
3. Transfer the qualified data to the created organizational fields that initiated the transfer along with the transfer time.
4. Use step 3 results to populate a created shift field, where:

   Shift 1 = 07:30 - 04:30

   Shift 2 = 04:30 - 11:30

   Shift 3 = 11:30 - 07:30

5. Populate the appropriate organization field on the Message Transfer Matrix according to shift.
6. Repeat steps 3, 4 and 5 until all combinations have been processed (11 iterations).
7. From the results of step 5, build a similar matrix based on percentages (not absolute values).

2.4 Inbound Telephone Traffic Queuing Model

Queuing theory, the term for waiting line analysis, can be traced to the work of A.K. Erlang, a Danish mathematician. His work pioneered the sizing of trunk lines to accommodate long-distance calls between telephone company exchanges (Held, 1994, p. 52). Queuing theory is similar to many other types of mathematical theory in that it is based upon a series of assumptions. Those assumptions are in the area of distribution of arrivals and the time required to service each arrival. Distribution of arrivals and the time to service them are normally represented as random variables. The most common distribution used to represent arrivals is the Poisson distribution. The Poisson is a discrete distribution used to approximate the binomial. The Poisson distribution is applicable when the opportunity for occurrence of an event is large but when the actual occurrence is unlikely (Blanchard & Fabrycky, 1990, p. 243). The Poisson distribution is described by the following equation:

$$P(n) = ((\lambda)^n e^{-\lambda}) / n! \qquad 0 \leq n \leq \infty$$

where:

$P(n)$ = probability of n arrivals
λ = mean arrival rate
$e = 2.71828$
$n! = n$ factorial $= n \times (n-1) \times \ldots \times 3 \times 2 \times 1$

Equation 1

The common distribution used to represent service times is the exponential distribution described by the following equation:

$$f(n) = (1/\mu)\, e^{-n/\mu} \qquad 0 \leq n \leq \infty$$

where:

f(n) = function of n
μ = mean service rate
e = 2.71828
n = a call

Equation 2

A multiple channel single phase model was implemented for the analysis. Pictorially, the multiple channel single phase operation can be represented as shown in Figure 2-2

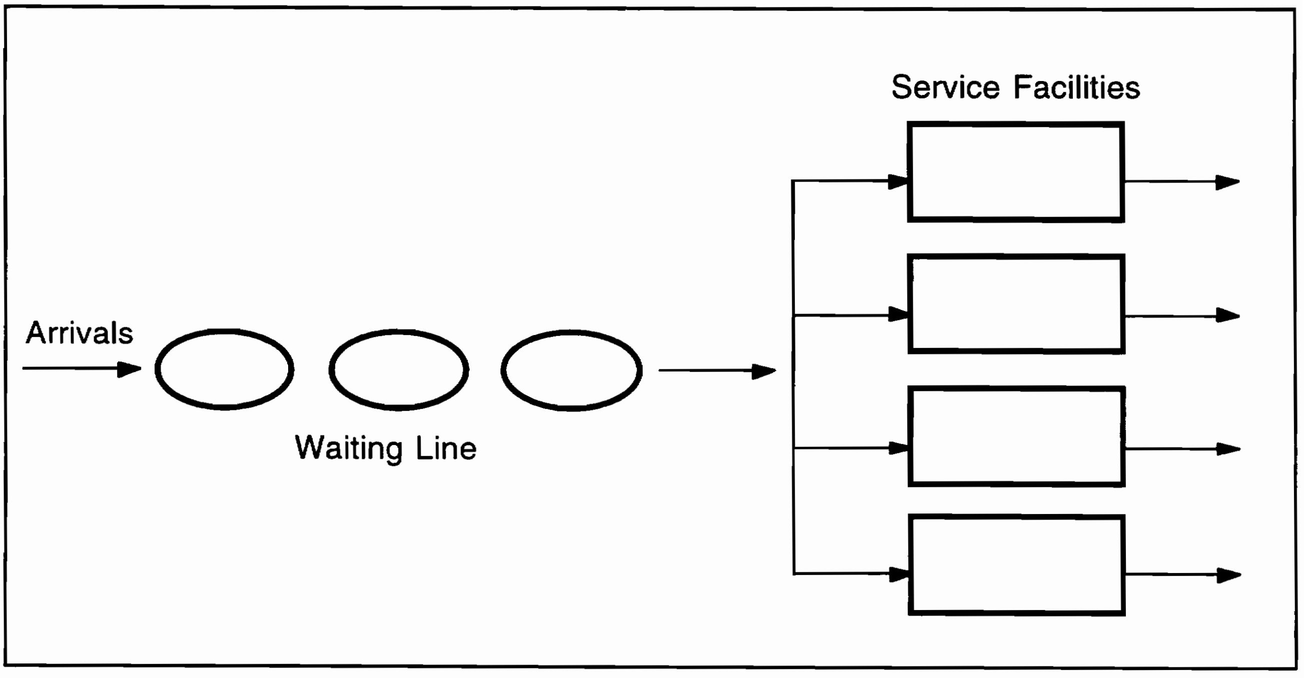

Figure 2-2 Basic components of waiting line system

In the multiple-channel case the service facility will have c service channels, each capable of serving one unit at a time. An arriving unit will go to the first available service channel that is not busy. If all channels are busy, additional arrivals will form a single queue. Once a busy channel completes service and becomes available, it accepts the first unit in the queue for service. Steady-state probabilities are defined in the following manner:

$P_{m,n}(t)$ = probability that there are n units waiting in queue and m channels are busy at time t.

where:

m can only be an integer between 0 and c, and n = 0 unless m = c.

For Poisson arrival and exponential service situation the following equations govern the process:

$$P_{c,n} = P_{0,0}\,(\lambda/\mu)^{c}\,(1/c!)\,\rho^{n}$$

$$P_{m,0} = P_{0,0}\,(\lambda/\mu)^{m}\,(1/m!)$$

$$P_{0,0} = 1/\left[((\lambda/\mu)^{c}(1/c!)\,\rho^{n}[\,1/(1-\rho)] + {}_{r=0}\Sigma^{r=c-1}((\lambda/\mu)^{r}(1/r!))\right]$$

where:

$$\rho = \lambda / (\mu c)$$

Equation 3

The average length of queue is defined by the following equation:

$$m_m = P_{0,0}\,[(\lambda/\mu)^{c+1} / (c-1)!\,(c-\lambda/\mu)^{2}]$$

Equation 4

The mean number of units in the system is defined by the following equation:

$$n_m = m_m + \lambda/\mu$$

Equation 5

The mean wait time is defined by the following equation:

$$w_m = m_m / \lambda$$

Equation 6

The probability that an arriving unit must wait is defined by the following equation:

$$P_{0,0}\ (\lambda/\mu)^c\,[(1/(c!\ (1 - \rho))]$$

Equation 7

Equations were programmed into spread sheet cells and the cells were linked accordingly. A sample output is shown in Table 2-1. Any parameter can be changed and the resulting impacts to the system seen. For the purpose of this analysis, each figure of merit was calculated as a function of the number of telephone lines.

Table 2-1 Sample Telephone Traffic Model Output

Lines	P 0,0	Avg. que length	Mean units in sys.	Mean wait time	Average delay	Prob. of wait	Lambda	Mu	Roh
1	-3.285714286	-651.5320997	-647.2463854	-1085.886833	-1078.743976	4.285714286	0.6	0.14	4.28571429
2	-0.363636364	-149.5480779	-145.2623636	-249.2467965	-242.1039394	2.922077922	0.6	0.14	2.14285714
3	-0.061946903	-6.321112516	-2.03539823	-10.53518753	-3.392330383	1.896333755	0.6	0.14	1.42857143
4	-0.005910023	-17.44576736	-13.16005307	-29.07627893	-21.93342178	1.163051157	0.6	0.14	1.07142857
5	0.007937426	4.016648429	8.302362715	6.694414049	13.83727119	0.669441405	0.6	0.14	0.85714286
6	0.011930968	0.898443018	5.184157304	1.49740503	8.640262173	0.359377207	0.6	0.14	0.71428571
7	0.013177172	0.282725075	4.56843936	0.471208458	7.6140656	0.179059214	0.6	0.14	0.6122449
8	0.013577928	0.095249191	4.380963477	0.158748651	7.301605794	0.082549299	0.6	0.14	0.53571429
9	0.013706504	0.031974702	4.317688988	0.053291171	7.196148313	0.035172173	0.6	0.14	0.47619048
10	0.013746796	0.010393693	4.296107979	0.017322822	7.160179965	0.013858258	0.6	0.14	0.42857143
11	0.013758966	0.00322925	4.288943536	0.005382084	7.148239227	0.005059159	0.6	0.14	0.38961039
12	0.013762483	0.000953348	4.286667634	0.001588913	7.144446056	0.001716026	0.6	0.14	0.35714286
13	0.013763451	0.000266841	4.285981126	0.000444734	7.143301877	0.000542576	0.6	0.14	0.32967033
14	0.013763704	7.07916E-05	4.285785077	0.000117986	7.142975129	0.000160461	0.6	0.14	0.30612245
15	0.013763767	1.78145E-05	4.2857321	2.96909E-05	7.142886834	4.45363E-05	0.6	0.14	0.28571429
16	0.013763782	4.25796E-06	4.285718544	7.09659E-06	7.142864239	1.16384E-05	0.6	0.14	0.26785714
17	0.013763786	9.68171E-07	4.285715254	1.61362E-06	7.142858756	2.87224E-06	0.6	0.14	0.25210084
18	0.013763787	2.0978E-07	4.285714495	3.49633E-07	7.142857492	6.71296E-07	0.6	0.14	0.23809524
19	0.013763787	4.33893E-08	4.285714329	7.23155E-08	7.142857215	1.4897E-07	0.6	0.14	0.22556391
20	0.013763787	8.58107E-09	4.285714294	1.43018E-08	7.142857157	3.14639E-08	0.6	0.14	0.21428571

2.5 MSR Sensitivity Analysis and Cost Savings Projections

The multi-channel queuing model was used to determine the sensitivity of the MSR (mu) for the purpose of identifying the critical thresholds for enhancing system performance. Understanding the increase in performance necessary to impact system effectiveness helps to set realistic goals that can be targeted and obtained. The inbound telephone arrival rate (lambda) is driven by events outside the control of EMERCOMM; however, the rate that calls are handled is, to some degree, controllable. The sensitivity analysis was conducted with the assumption that 1 minute was the most EMERCOMM wanted the caller to wait before being serviced. This one minute served as the constraint to identify performance breakpoints. The modeled scenario was for peak-hour arrival rates (18 calls/hour) with mu varying from 0.1 to 1.0.

The incentive to pursue change is heavily influenced by the potential financial return. Therefore, once the thresholds for increased MSR were identified, a cost savings projection was conducted. The premise for cost savings comes from reducing the manpower required to staff the inbound telephone lines through improved performance. The cost savings analysis uses Equation 8 given by Fleischer to identify future financial gains over time (5 years) (1984). A typical operator's salary with a 3% annual increase was used to make the cost savings projections.

$$F = A\,[\,(((1+i)^{n}) - 1)\,/\,i\,]$$

where:

F = Amount of cash flow at end of nth period. Equivalent future value (measured at end of nth period) of prior cash flows.
A = Cash flow, or equivalent cash flow, occurring uniformly at the end of every period for a specified number of periods.
n = Number of compounding periods (each of which is assumed to be of equal length): the length of the "study period". Life of investment.

Equation 8

3. Results

3.1 Results Overview

Results of the analysis are presented in the following order:

1. Message traffic flowing into and out of AMCROSS using:
   - AUTODIN
     - Ft. Detrick
       Andrews A.F. Base
   - AT&T Easylink (EMS)
   - Telephones (Voice)
2. Message transfers within AMCROSS from each location during each shift:
   - AUTODIN
   - Easylink
   - Telephone
   - AFRU Editor
   - Domestic Editor
   - International Editor
   - Service Editor
3. Inbound telephone traffic queuing statistics with capacity margins
   - Probability of immediate service
   - Average length of the queue
   - Mean number of units in the system
   - Mean waiting time
   - Traffic load impact on caller wait time
   - Probability that an arriving call must wait
4. MSR sensitivity and cost savings projections

3.2 Reading the graphic results

Plots of the numerical results are shown in the following section. The formats used were line charts and combination bar and line charts. Line charts are used for showing the results of messages coming in and out of AMCROSS. The vertical axis indicates the quantity of messages while the horizontal axis indicates the hour of day. The data series are identified by the key on the right of each chart. Average total quantities are listed above the series key. Line charts are also used for showing the results of the queuing model runs. For the queuing model runs, the vertical axis indicates the percent of time, number of calls, factor greater than peak hour conditions, or minutes depending on the chart. The horizontal axis indicates the number of telephone lines. At least two data series are plotted on each chart, one for the peak-hour conditions (identified from inbound telephone message data) and the other for twice the peak hour. This was done to highlight the nonlinearity affects of the load conditions and give insight into the capacity margins. A logarithmic scale was used for one results chart to allow more data series comparisons. The MSR sensitivity analysis and cost savings projections also use the line charts. The staffing chart plots MSR vs. the number of operators for peak-hour conditions. The projected savings chart plots savings vs. time.

The combination bar and line charts are used to present results for the message traffic patterns within AMCROSS. The left vertical axis is always used to indicate percent of transfers by shift. The right vertical axis is used to show percent of total transfers for the sender (regardless of shift). The horizontal axis indicates the receiver of a given transfer. Not all possibilities are shown, only the ones that showed activity i.e., messages received through AUTODIN only get forwarded to the Domestic Editor or the Service Editor. The data series plotted as a bar indicates shift (1st, 2nd, 3rd). The data series plotted as a line indicates percent of total value.

3.3 Message traffic flowing into and out of AMCROSS

The data set from which the results were derived came from averaging data collected 24 hours a day for 1 week (excluding weekends). Comparing AUTODIN message traffic involving Ft. Detrick and Andrews Air Force Base from Figure 3-1 and Figure 3-2 respectively, shows that late first shift through the third quarter of second shift are the predominate activity periods. Very similar volumes of traffic are passed to each military installation (approximately 200), although messages received from Ft. Detrick are 40% less. As shown from comparing Figure 3-3 and Figure 3-4, Easylink, used as a communication link with domestically located chapters, is implemented more than the telephone for passing messages. There is a greater difference in the outbound message traffic volume than the differences in the inbound traffic volume (244 messages outbound vs. 182 messages inbound). The Easylink outbound traffic volume is higher than the inbound traffic volume during the afternoon; however, inbound traffic volume is higher than outbound between 2100 to 0800. Figure 3-4 shows that the outbound telephone traffic volume peaks at 0900 and falls through 0800. From Figure 3-4, it is clear that the call backs are few in number but rise to their highest levels between 1800 and 2100. Figure 3-4 also shows that Inbound telephone calls are highest in the mid afternoon (1200 to 1800) and fall to 2 to 3 calls through the third shift hours.

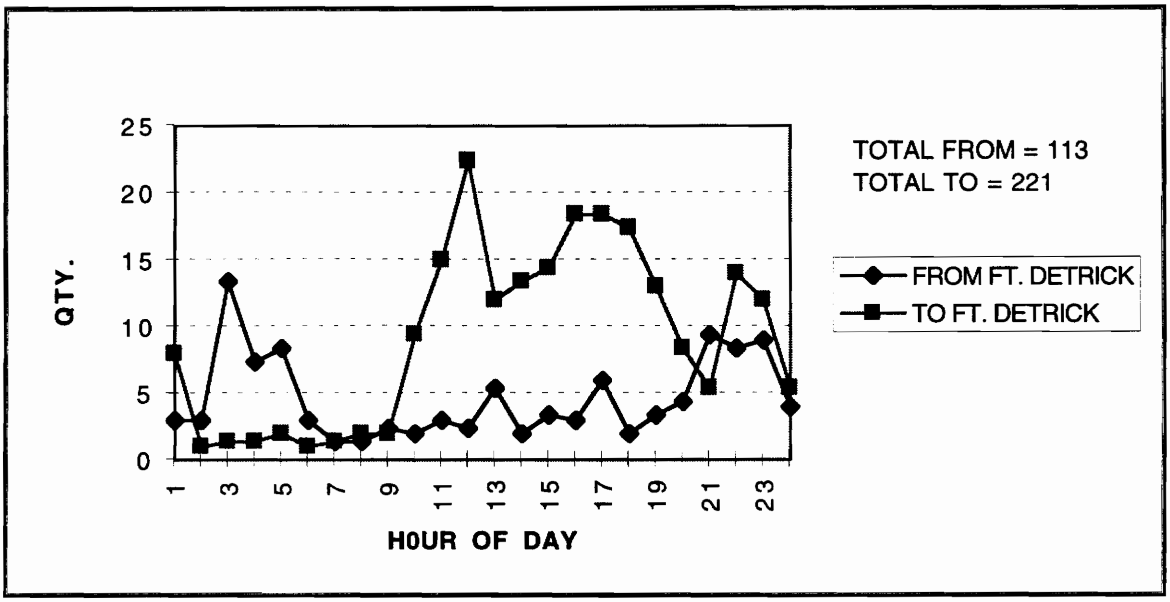

Figure 3-1 Fort Detrick Message Distribution

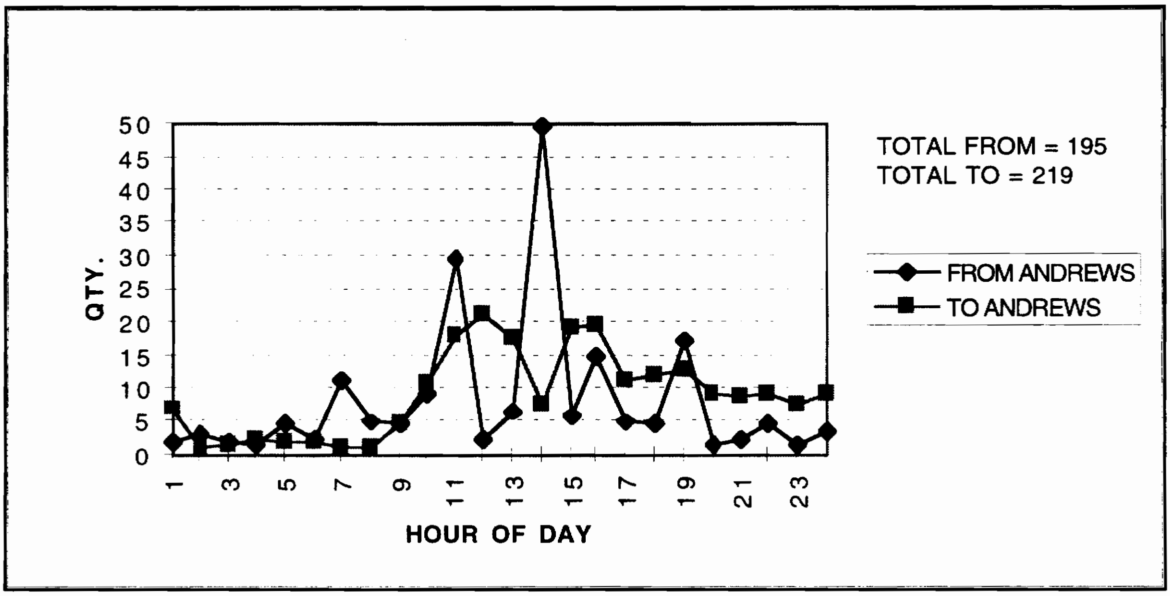

Figure 3-2 Andrews A.F. Base message distribution

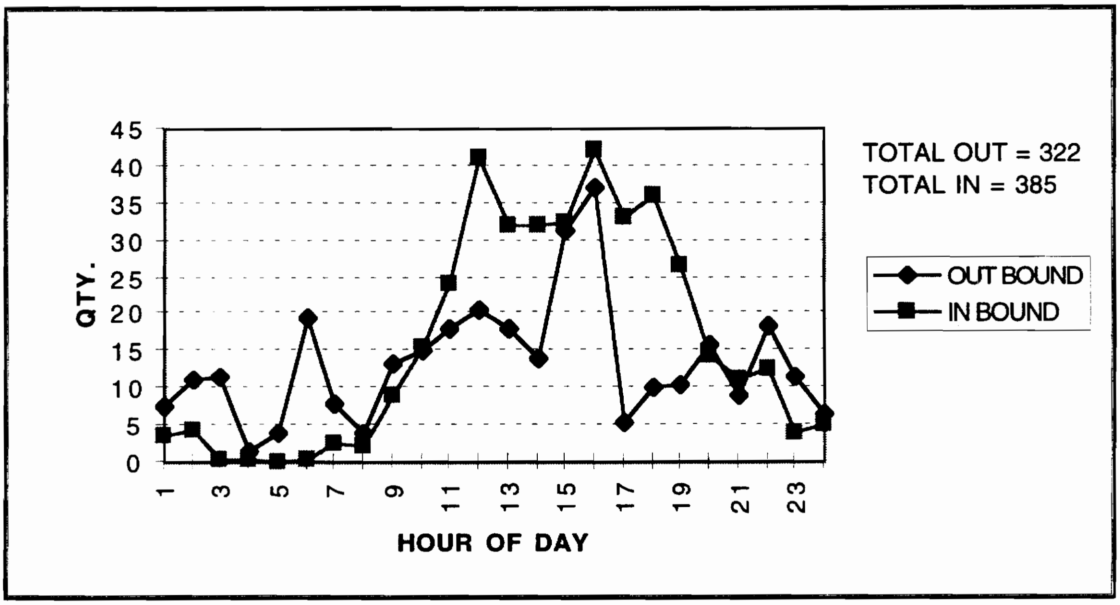

Figure 3-3 Easylink message distribution

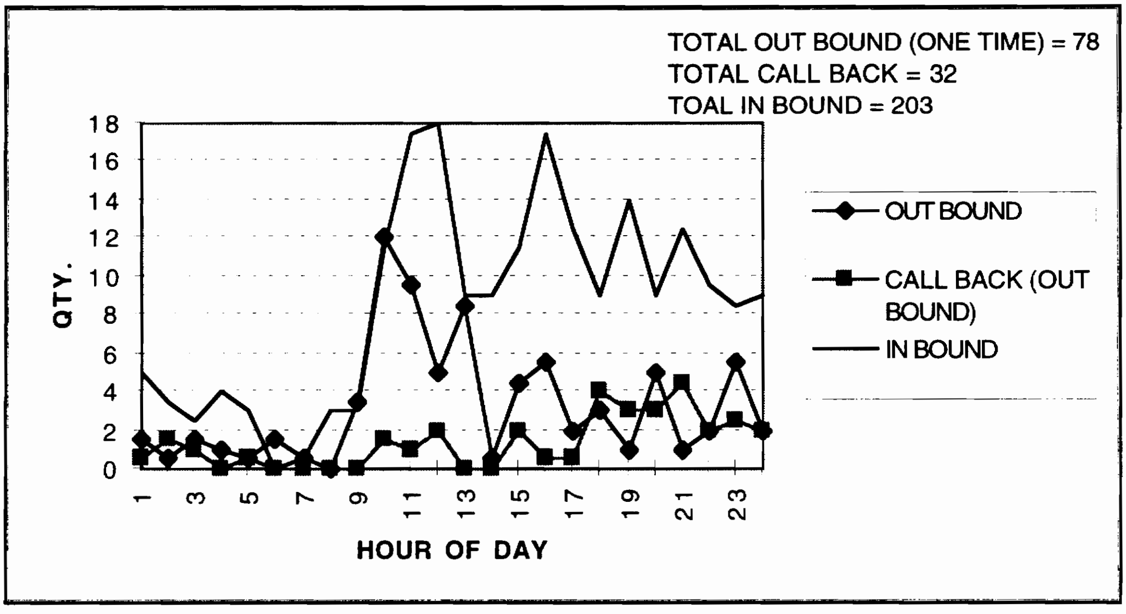

Figure 3-4 Telephone message distribution

3.4 Message transfers within AMCROSS

As shown in Figure 3-5, the AUTODIN messages almost always go to the Domestic Editor. The transfers happen uniformly across first, second, and third shifts. Easylink, with limited exception, passes to the International Editor as is apparent from Figure 3-6. The phone system, as shown in Figure 3-7, distributes the incoming messages to the AFRU Editor, International Editor, and the Domestic Editor. The AFRU Editor receives the most messages of the three editors with 25% of the total. Approximately 30% of the total go back out on AUTODIN without going to an editor. Looking at the AMCROSS network inbound message providers, AUTODIN, Easylink, and telephones from Figure 3-8, Figure 3-9, Figure 3-10 and Figure 3-11, one can observe that the AFRU Editor primarily uses AUTODIN, the Domestic Editor primarily uses Easylink, the International Editor primarily uses AUTODIN, and the Service Editor primarily uses Easylink. Telephones are used for transfers by all editors, but in relatively small numbers. These same figures indicate the shift supporting most of the messages transferred. The first and second shifts share the bulk of most transfers except for one. This isolated case comes from the Domestic editor who transfers most of the messages to the International Editor during the third shift period.

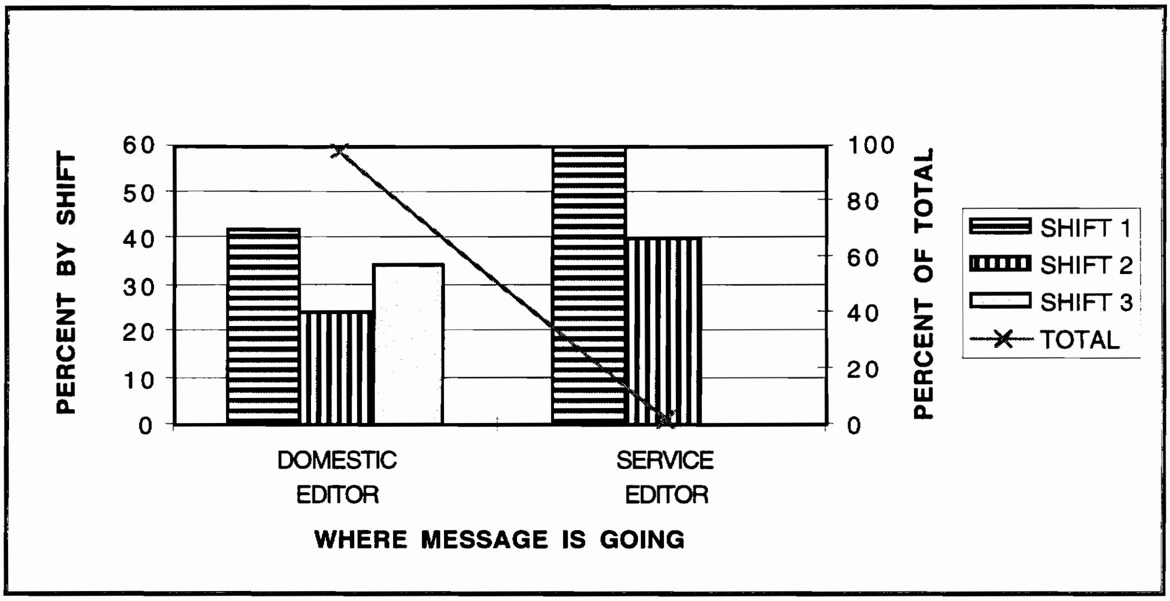

Figure 3-5 AUTODIN message transfer distribution

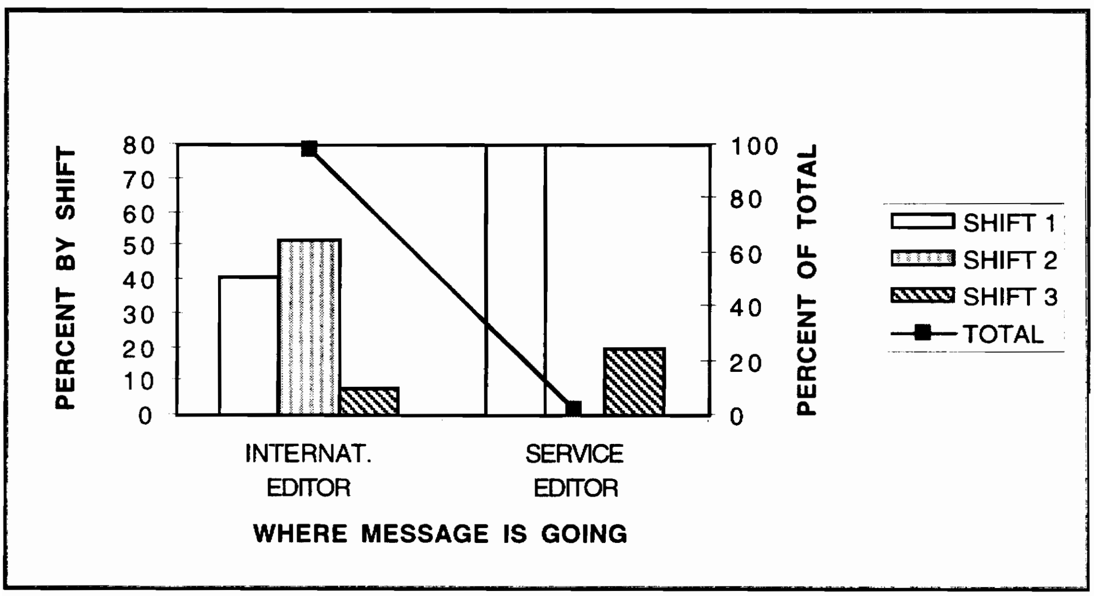

Figure 3-6 Inbound Easylink message transfer distribution

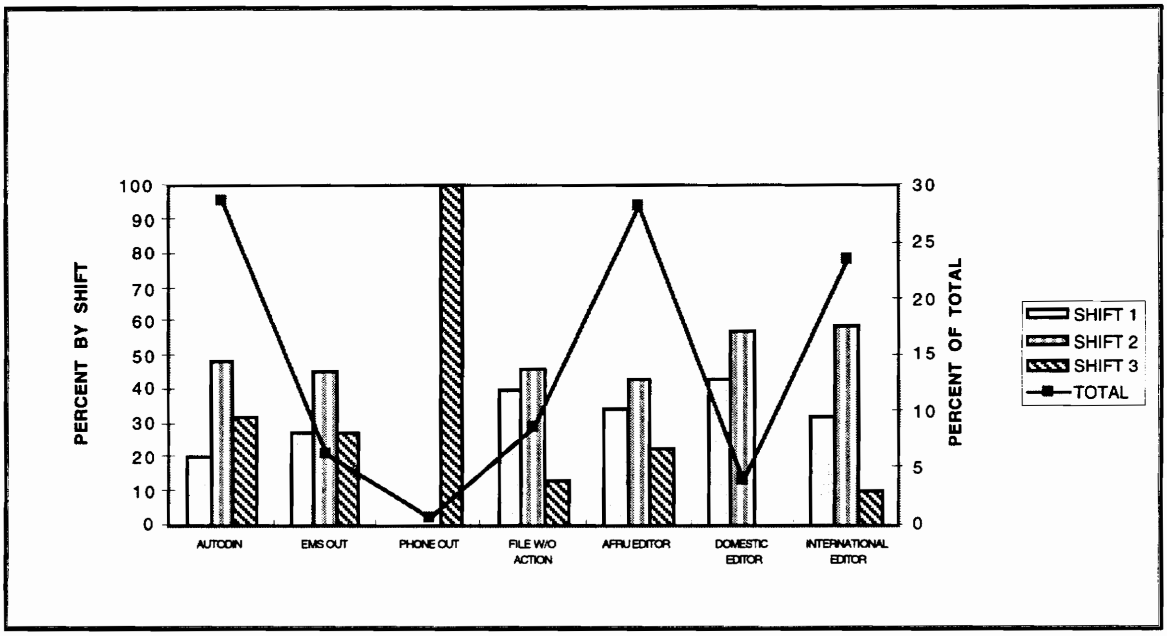

Figure 3-7 Inbound telephone message transfer distribution

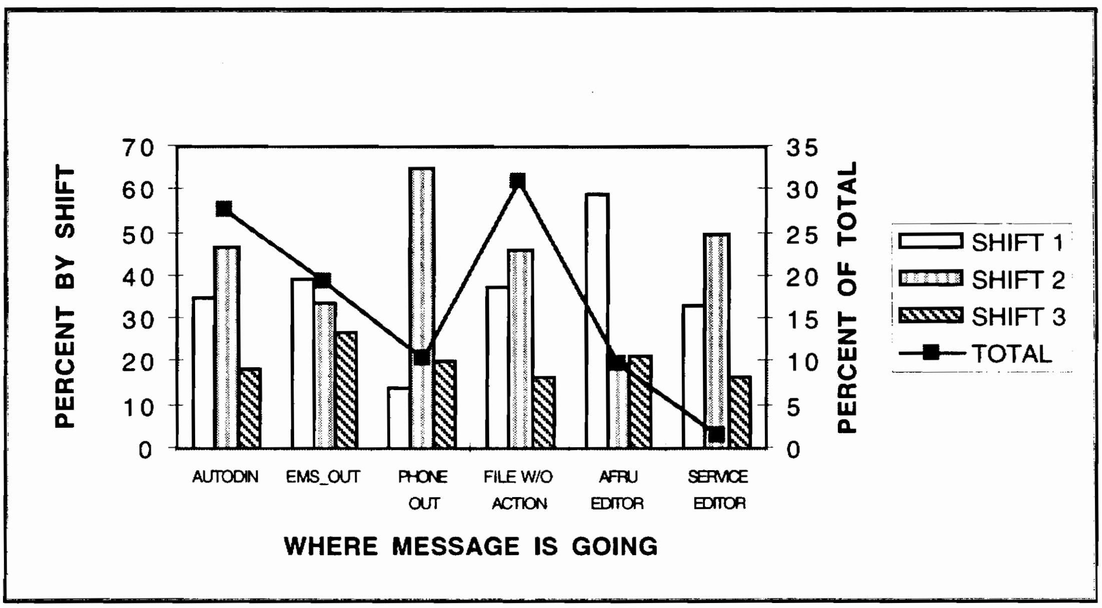

Figure 3-8 AFRU message transfer distribution

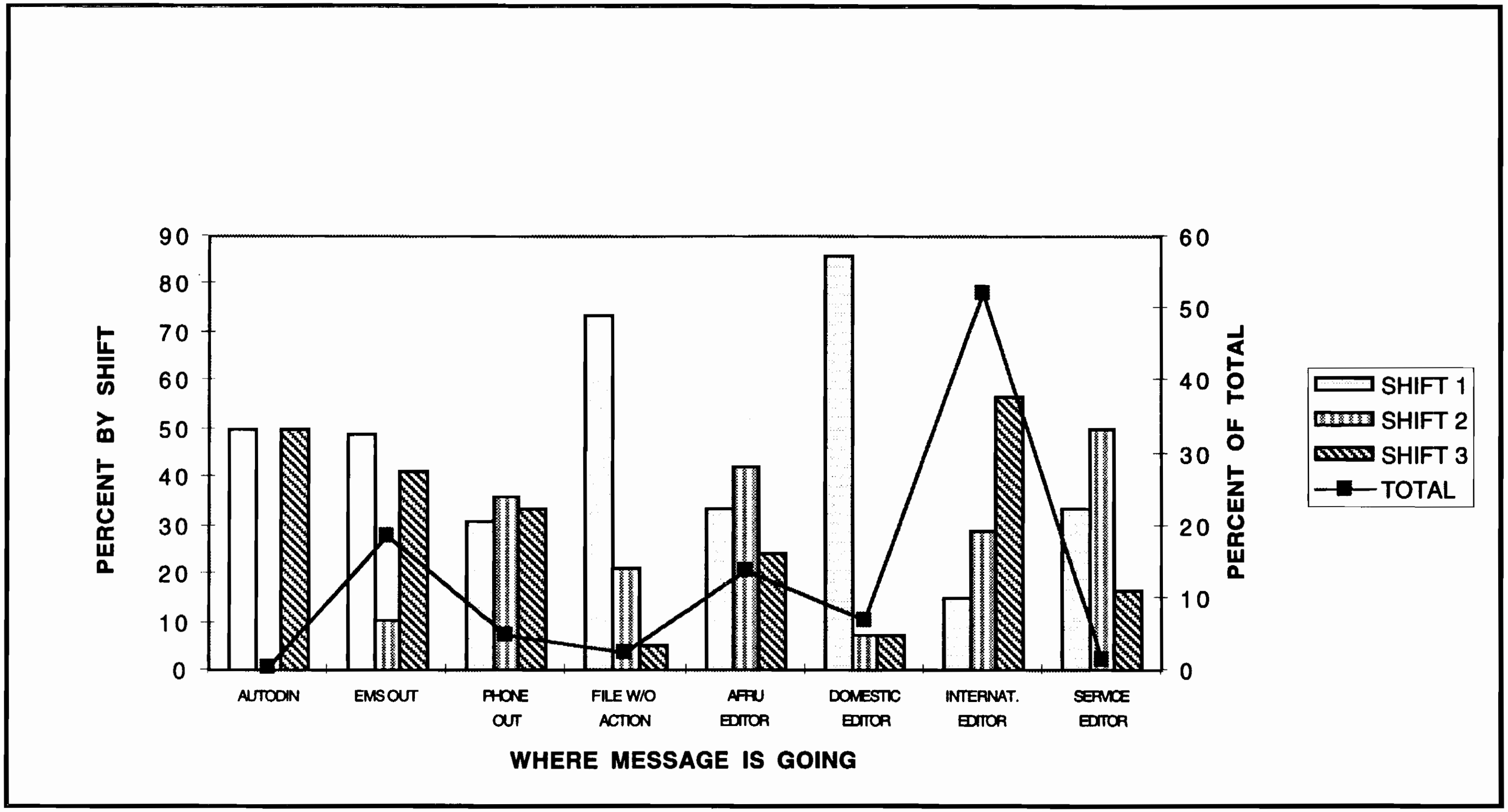

Figure 3-9 Domestic Editor message transfer distribution

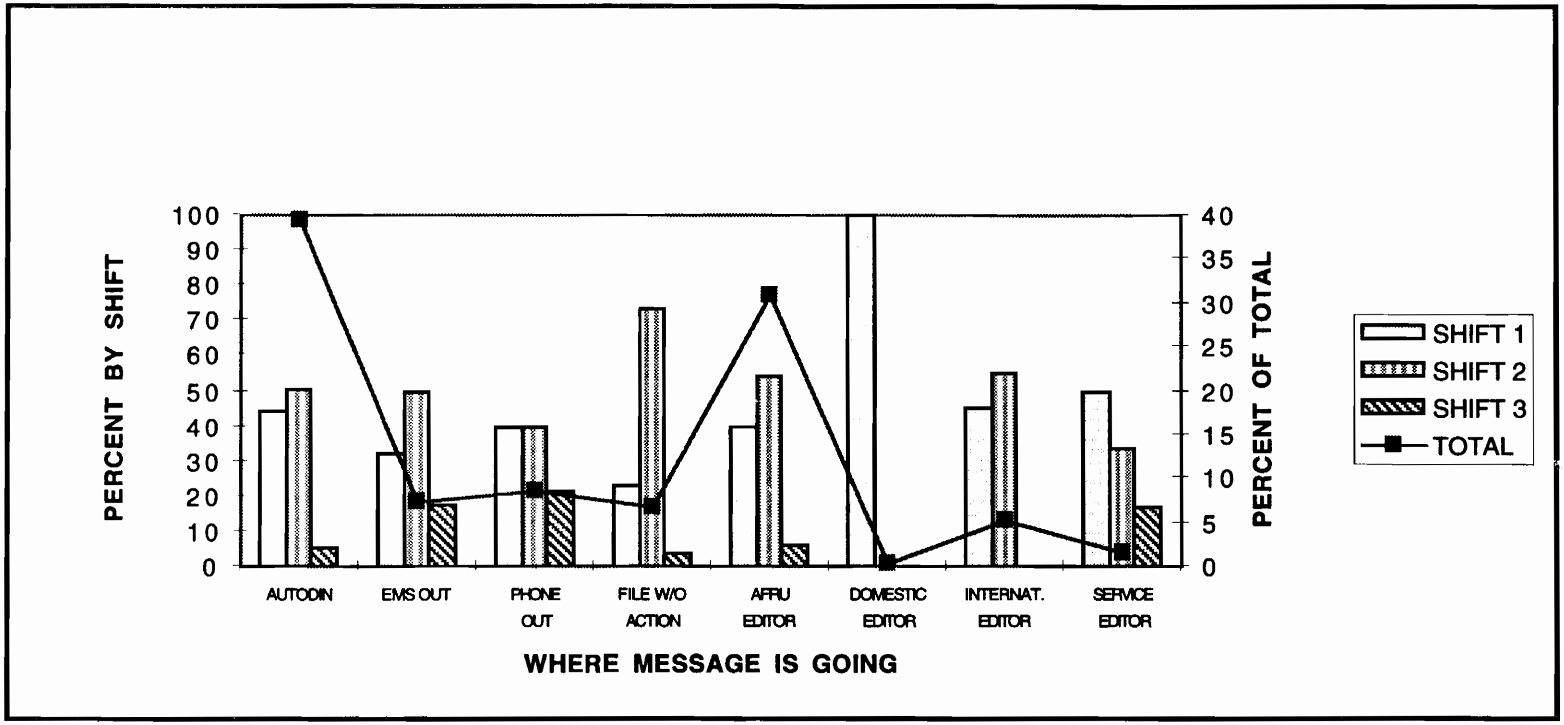

Figure 3-10 International Editor message traffic distribution

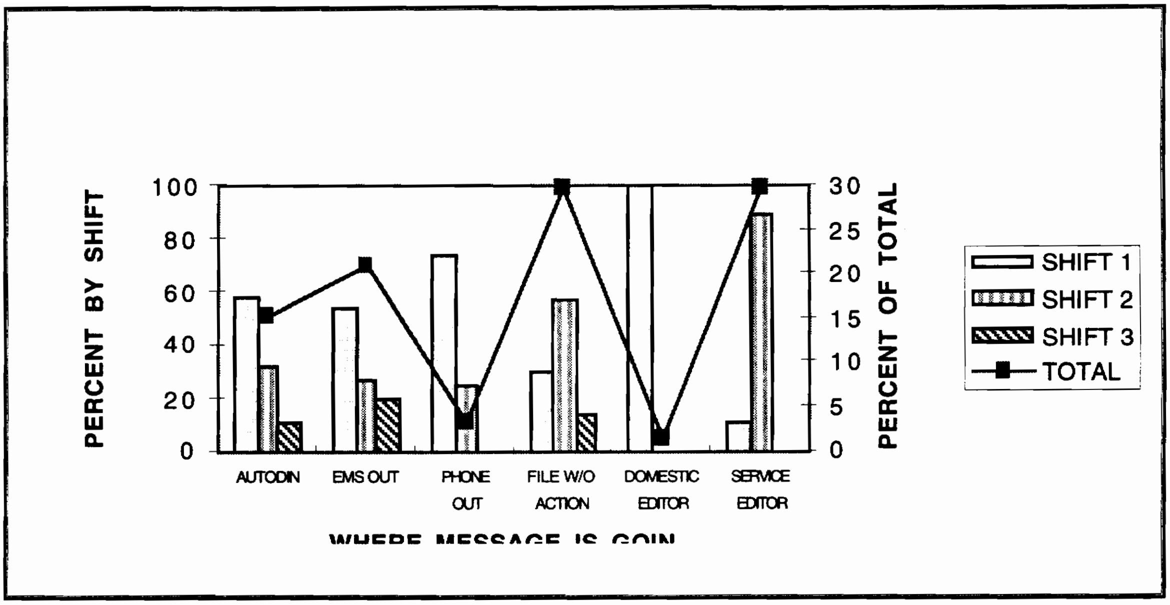

Figure 3-11 Service Editor message traffic distribution

3.5 Inbound telephone traffic queuing statistics with capacity margins

From the incoming-call data, it was determined that average peak traffic conditions are 18 calls in one hour. This equates to 0.3 calls in one minute. The average time for servicing an incoming call is 7 minutes. This equates to a service rate of 0.14 callers per minute. The results of the model run are graphed for each figure of merit for the multi-channel queuing analysis. Two series of data are plotted on each graph. One data series indicates the results of the peak hour traffic conditions, the second series is twice the load conditions of the first. Therefore, instead of having 18 calls per hour there would be 36. This increase is not unrealistic when one considers a possible failure of Easylink. In response to the loss of Easylink, telephone message volume would surely rise to compensate.

As shown in Figure 3-12, during peak hour conditions the caller has approximately 1 in 10 chance of getting immediate service. Doubling the volume translates to less than 1 in 100 chance of getting service the first time. The chance varies as a function of phone lines; however, diminishing returns occur after 3 lines in the peak hour situation and 5 lines for twice the peak hour situation. As shown in Figure 3-13, during peak hour conditions their are less than 2 people waiting for 3 or more phone lines. Doubling the volume still shows just 4 or less callers waiting for service. Figure 3-14 shows that during peak hour conditions there is almost no benefit to increasing the number of lines beyond 6. Doubling the volume shows minimal returns on performance after 5 available lines. As shown in Figure 3-15, during the peak hour with 4 lines operating, less than 1 minute of wait time is required for a caller. Doubling the volume dictates 7 lines be available for less than a 1 minute wait. Figure 3-16 reflects the exponential degradation in service a caller will incur as a function increased caller volume. For traffic volume that is twice that of peak hour (32 calls per hour), the caller will wait 33 times longer for service than they would have for peak hour conditions (1.5 minutes vs. 2.5 seconds) with 6 lines working. As shown in Figure 3-17, with 3 phone lines a 50% chance exists that an arriving call wait before service. The addition of 2 lines would drop the chance below 10%. Doubling the call volume shows that 7 lines will yield a 50% chance of an arriving caller having to wait. The 2 additional lines drop this chance of wait to 10%.

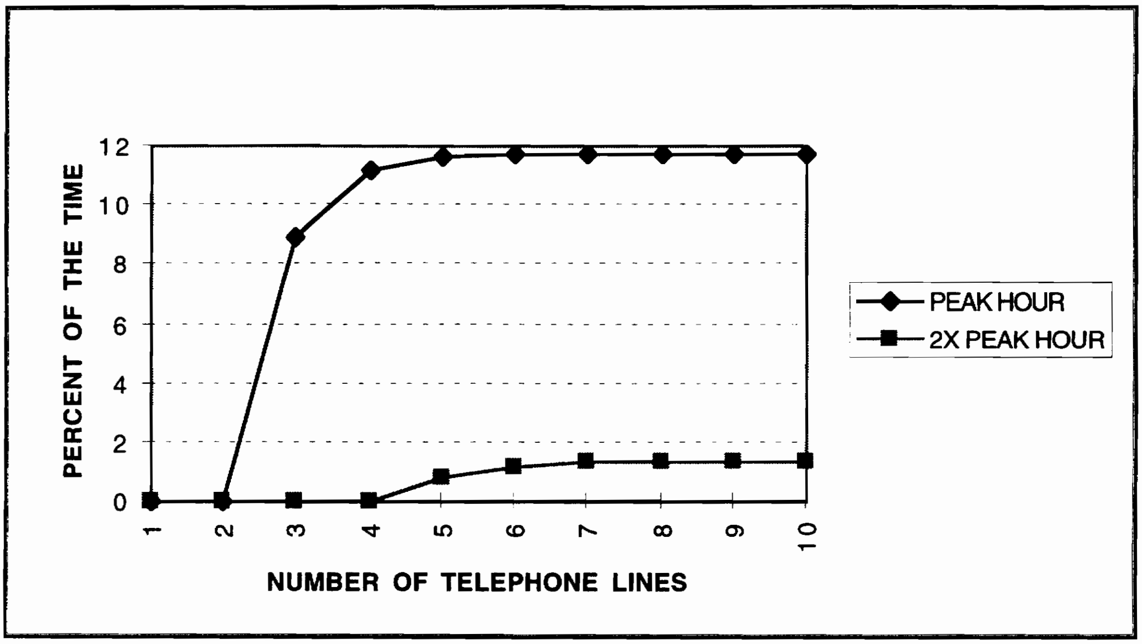

Figure 3-12 Probability of no callers in the system

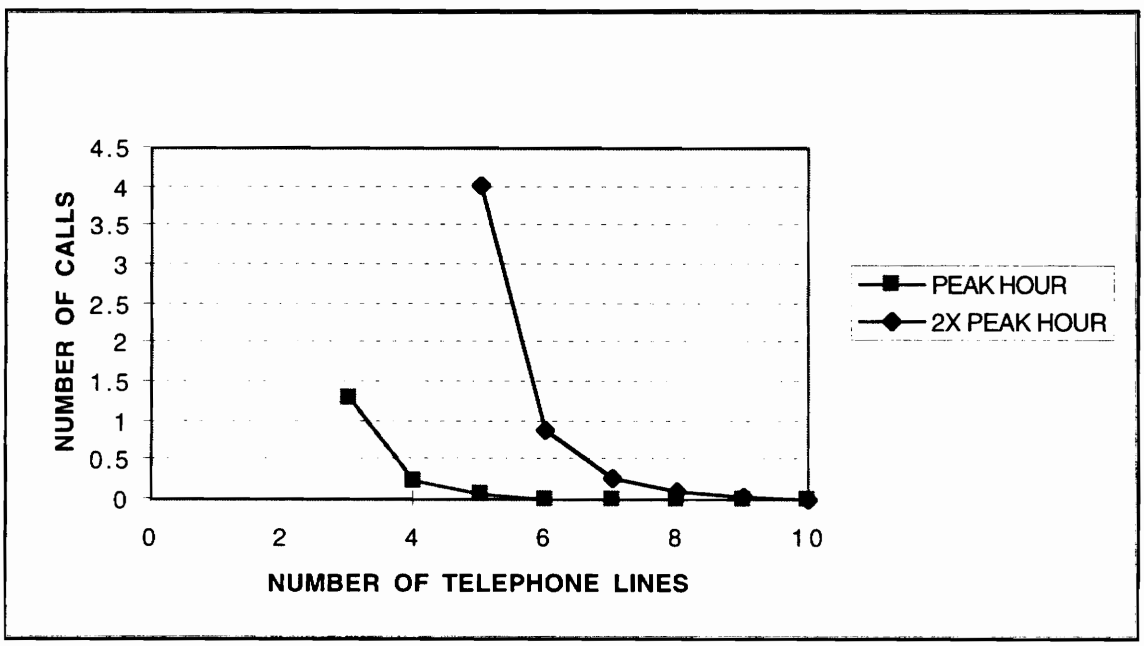

Figure 3-13 Average queue length

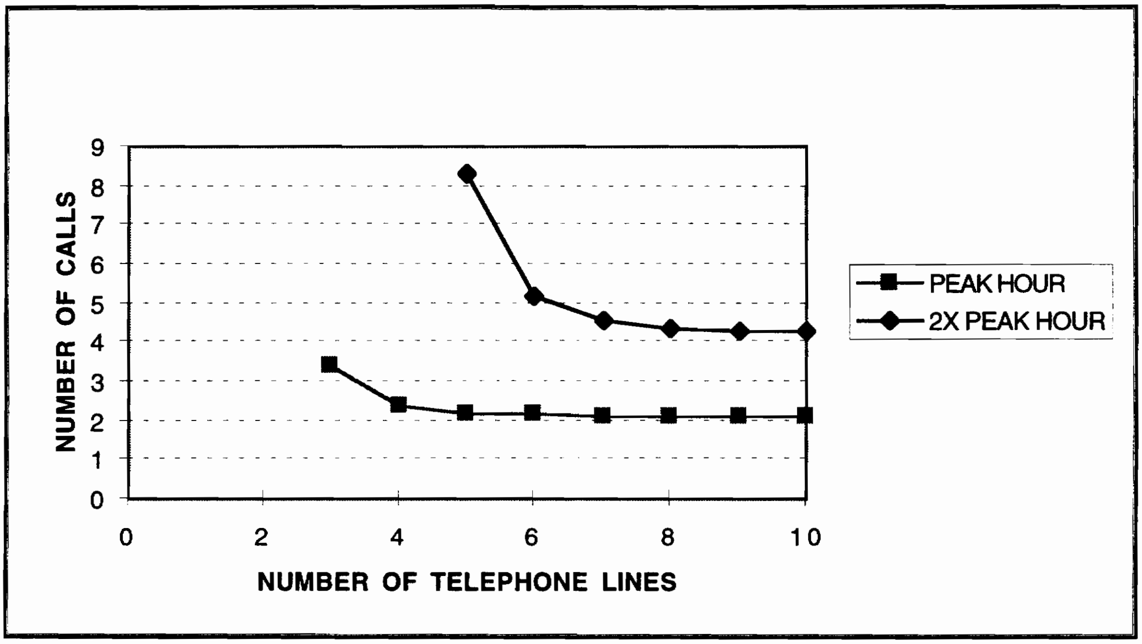

Figure 3-14 Mean number of calls in the system

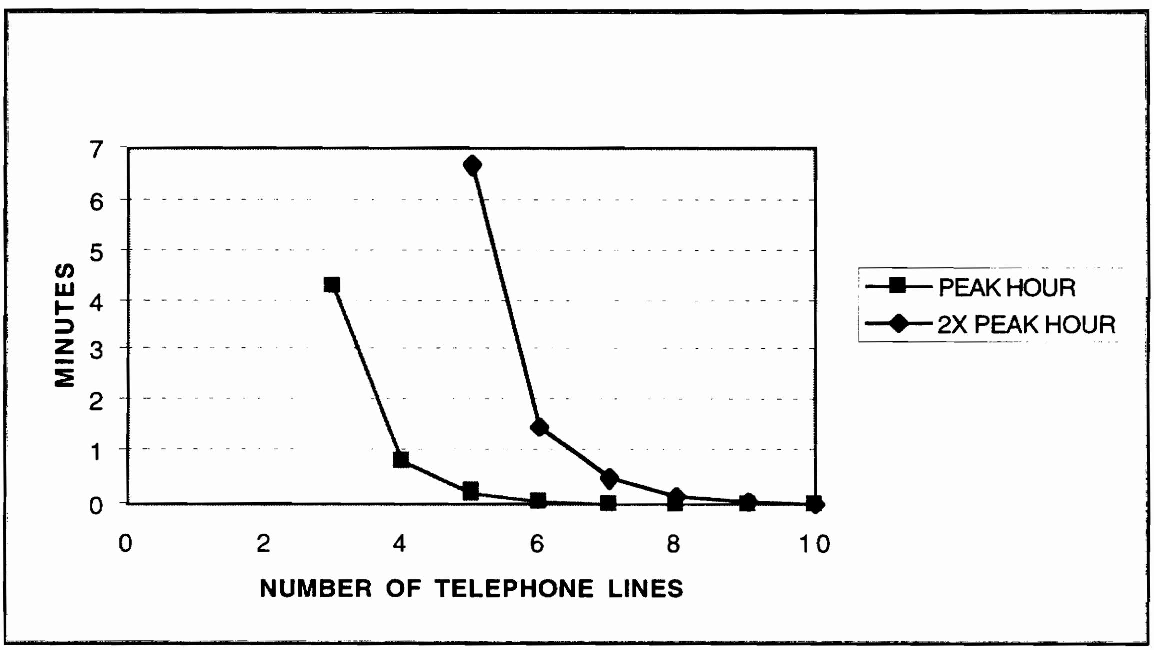

Figure 3-15 Mean time a caller must wait for service

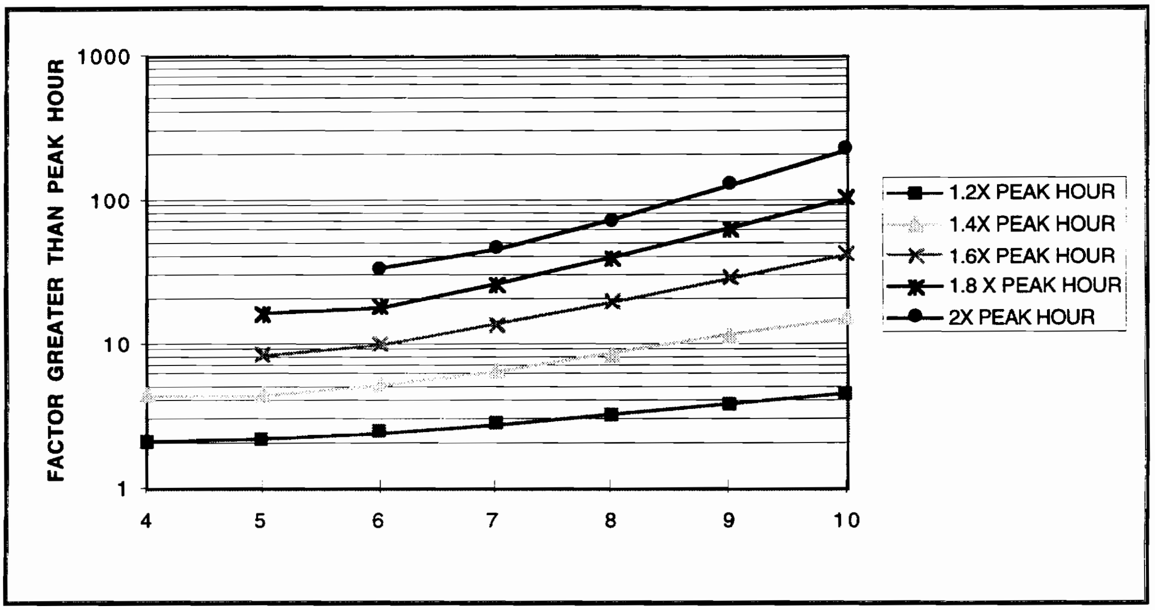

Figure 3-16 Traffic load impact on caller wait time

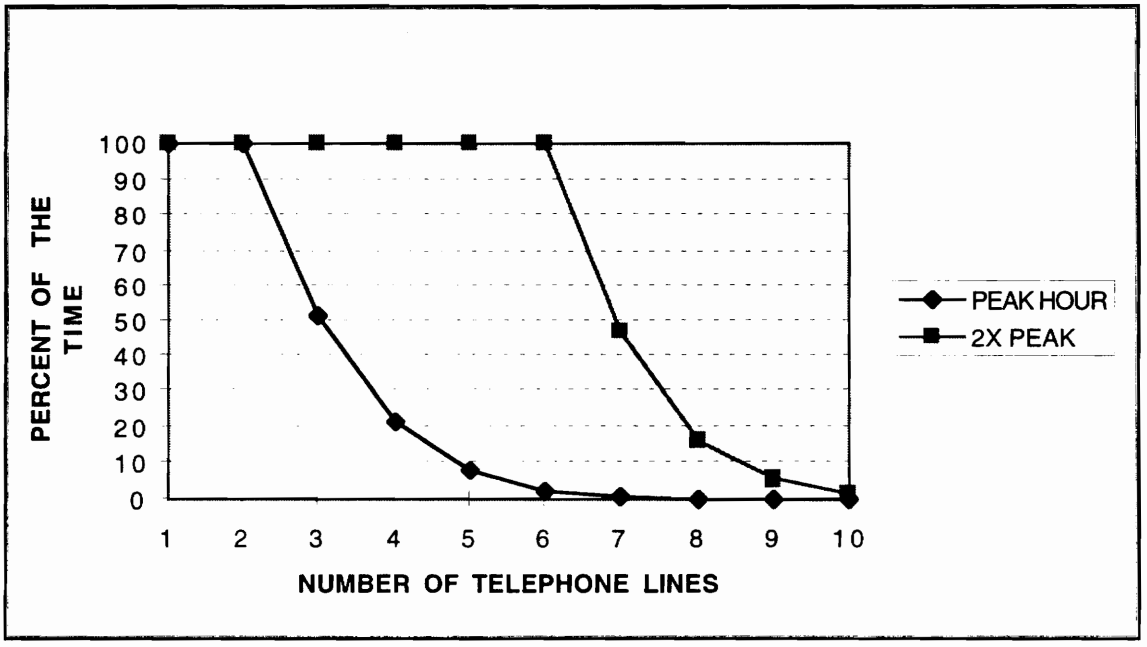

Figure 3-17 The probability a caller must wait

3.6 MSR Sensitivity and Cost Savings Projections

Figure 3-18 shows that as the Mean Service Rate (MSR) increases so does the required number of operators, i.e., the longer it takes an operator to receive the caller's information, the larger the staff must be. This is due to the imposed constraint of limiting the customers queue wait time to just one minute. Figure 3-18 indicates that under Peak-hour conditions (18 calls per hour), reducing the MSR form 7 minutes to 5 minutes, reduces the required number of operators by 1. Figure 3-18 also shows the potential impacts of the MSR slipping in performance. Increasing MSR from 7 minutes to 10 minutes will require 1 additional operator to hold the queue wait to just 1 minute.

Figure 3-19 shows the projected savings for improving the MSR by just 2 minutes (7 minutes to 5 minutes). An operator's salary of $7.50 per hour (40 hours/week) with an annual 3% increase was used for calculating the projected savings. The analysis showed a potential savings of $100,000 in 5 years for the modest performance improvement.

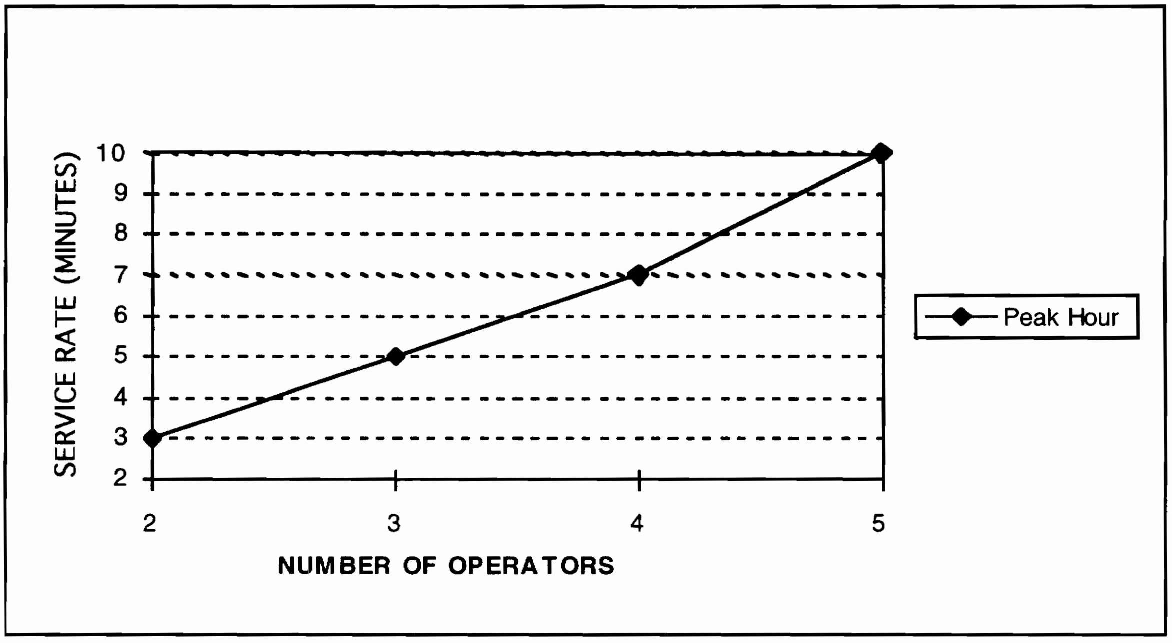

Figure 3-18 Staffing Profile (one minute queue wait)

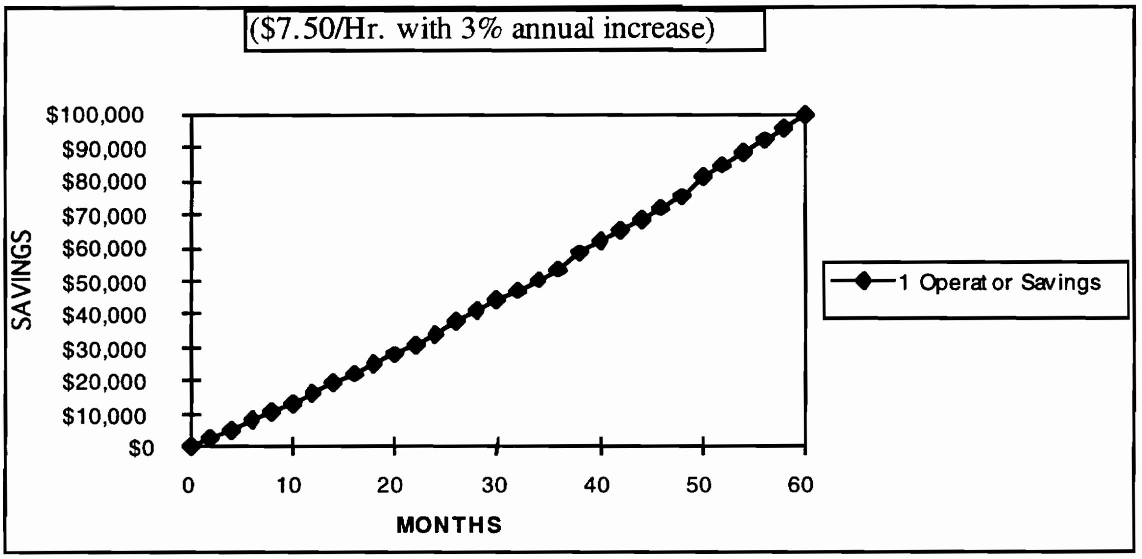

Figure 3-19 Projected Savings for Performance Improvement

4. Conclusion

The information presented in the previous sections provides a valid "snap shot" of message traffic activity handled by AMCROSS. However, because of the number and variety of results presented in the previous section, a summary of the performance analysis results is presented below.

Between AMCROSS and Military Locations Using AUTODIN

- Message exchange occurs around the clock.
- The predominate activity period for message flow is 0900 to 1900.
- The total number of messages from the two military locations is evenly divided.
- Total message quantity to Andrews is 40% higher than to Ft. Detrick.

Easylink vs. Telephone

- Easylink handles 40% more inbound messages than does the telephone.
- Easylink handles 75% more outbound messages than does the telephone.

Internal Transfers

- Messages received via Easylink are transferred to the International Editor 95% of time.
- Messages received via Telephone are transferred approximately equally to the International Editor, AFRU Editor, and directly to AUTODIN.
- 50% of all transfers completed by Domestic Editor are made to the International Editor with 50% of those done on 3rd shift.

Inbound Telephone Traffic Queuing Statistics

- Factors used in model
  - Arrival Rate is based on Poisson Distribution with a mean peak hour value of 18 calls/hour.
  - Service Rate is based on Exponential Distribution with a mean value of 7 minutes/call.

Table 4-1 Queuing Model Results Summary

Figure of Merit	Peak-Hour Conditions	2XPeak-Hour Conditions
Probability of no calls in the system (being handled + in queue)	<12%	<2%
Lines required for <1 caller in queue	4	6
Mean number of calls in system (being handled + in queue)	>2	>4
Lines required for a caller to wait <60 sec.	4	7
Lines required for the probability of a given caller to wait <5 % of time	6	10

Service Rate Sensitivity and Cost Savings Impacts

- The number of required telephone operators is closely coupled to the Mean Service Rate (MSR).
  - Allowing the MSR to grow 3 minutes from the current 7 minutes increases required operator staff by 1.
  - Shortening the MSR to 5 minutes from 7 minutes can reduce required operator staff by 1.

- The analysis showed that potentially $100,000 can be saved over a 5 year period by reducing number of telephone operators by 1.

The statistics gathered and the observations made are a starting point for understanding volume, timing, and direction of AMCROSS message flow. These statistics are measures of the AMCROSS system performance. Long-term survival and growth can be achieved by continuously measuring performance. This achievement is in line with the words of Peter Drucker, who once said "The purpose of a business is to survive". Even successful businesses like Toyota, who has $20 billion in cash, preach the survival mentality to its management, employees and suppliers. Survival is a real and immediate concern for AFES and intelligent decisions are paramount. Credible data is the foundation on which intelligent decisions are built. The importance of basing decisions on sound data is understood by Milliken & Co. where the sign above their entrance reads "In God we trust. All others must bring data".

The application of the systems engineering methodology was demonstrated throughout this project in both process and purpose. AMCROSS is at the Sustaining Support Phase of the system life cycle. As part of the Sustaining Support Phase, ongoing analysis of performance is crucial so that system effectiveness can be routinely evaluated.

Continuous measurable improvement is a fundamental tool used in today's successful businesses. Understanding the characteristics and patterns of the AMCROSS operation help to define an origin from which benchmarking and improvement can evolve. Defining helpful metrics for charting performance and progress can come from the data currently being captured by the AMCROSS message switch as was shown with this report. Unfortunately, with the existing AMCROSS operation, the reduction and synthesizing of the raw data into decision support information is virtually absent. Information like the Message Transfer Matrix created as part of this project can be automated with developed software to make chart updating virtually effortless. The graphics created in this report help to convey the information quickly and should be part of the end product on all future metrics.

The results of the multi-channel queuing model showed that current operations are not suffering from an inadequate number of phone lines. However, it was also shown that an increase in caller volume could impact the highly responsive customer service performance now given. Surveys conducted by the American Red Cross indicate overwhelming satisfaction by their customers as a whole. This fact of general satisfaction was used to constrain the caller wait time to 1 minute for the MSR analysis. The 1 minute caller wait limit is an established customer service goal used by the AMCROSS operations management. From the model runs it was clear that doubling the caller volume while holding the service rate constant yields non-linear results. This information should make the AMCROSS management aware of the system's sensitivity to caller volume. Sudden increases in caller volume could come for the loss of Easylink or unforeseen world events.

Staffing needs were derived from the results of the model runs as well. Depending on the acceptable wait time for a caller to be helped, the required number of lines to maintain a given performance level can be translated to required staff. Since AMCROSS has 10 phone lines available to support inbound and outbound traffic, flexibility can be maintained on how they choose to service the customer based on staffing and not communication limitations. However, room for cost savings was uncovered through the MSR sensitivity analysis.

4.1 A Word of Caution

Changes in procedures, key equipment, or items of logistic support, often induce changes in other areas. Any change that gets considered should be evaluated for impacts to other areas. Hardware, software and procedures are all susceptible due to their inter-relationships. A minimum amount of evaluation and planning are necessary for rational decision making. Feasibility should be considered before a change is made. Before change is made near term affects and mission costs should be evaluated. Any change to the organization should be monitored for unexpected results. The ability to backout changes should be available to minimize the risk of adverse system impacts. For example, if the telephone operator staff were reduced to save cost without proper control measures in place, the goal to reduce the current MSR might backfire. Important information that should be collected from the caller may be forgotten or missed because the operator was in a hurry. Monitoring the quality of work once a reduced staffing plan was in effect could insure the correct decision was made or that further operator training is not needed. Because the AMCROSS system is in the Operational phase of the system life cycle, the risk and costs of change are higher.

4.2 Future Studies

The data sample used to derive the documented observations and results were small due to the limitations of compute capacity. Larger sample sizes provide greater appreciation for possible variations in operations and should be pursued. The analysis conducted for this project should act as a spring-board to further endeavors of quantifying system effectiveness to support optimization. Other parameters that affect the system effectiveness are logical candidates for future study. These parameters include personnel factors; skill level, training, and equipment maintenance data - scheduled and unscheduled. In particular, the Whisper Writers and Whisper Screens should be evaluated for retirement. This messaging system is antiquated and is no longer manufactured. The costs of money, time, and customer satisfaction should be considered when entertaining this and other alternatives. A comprehensive approach to evaluating cost implications resulting from system modifications is through a LCC analysis.

Portions of a LCC analysis were addressed in this project (data collection, data reduction, model building, sensitivity analysis, potential cost saving projections). However, opportunities exists for a rigorous LCC analysis to be conducted within the AFES organization and it units. A comprehensive model that details costs incurred by EMERCOMM could be a project within it self. A comprehensive EMERCOMM LCC model could be used to identify and analyze life cycle cost drivers that include the system effectiveness measures identified above. An effective LCC analysis would identify areas where future enhancements would earn the greatest pay-off. An LCC model tailored to the EMERCOMM organization would be useful in cost benefit and cost effectiveness studies, long-range planning and budgeting, comparison of competing systems, decisions about replacement of aging equipment, and a better general control of their ongoing process. A good LCC model will include many input parameters. An abbreviated list of such parameters follows:

- Work breakdown structure
- Engineering manpower requirements
- Test program requirements
- Acquisition strategy
- Cost estimating relationships
- Software requirements
- Non-recurring costs
- Learning curve slopes
- Support equipment requirements
- Training requirements
- Length of system life cycle
- Spares requirements
- Management manpower estimate
- Planned utilization rate (i.e., operating hours per year)
- Failure rates
- Maintenance Concept

Another area of future work that flows directly from the results of this project is understanding why a particular transfer occurs once it enters the AMCROSS network. Several editors are involved with the verification and completion of address fields on each message. If the message process allows fewer transfers, throughput could rise and the staffing requirements could fall. Automation of message addressing should be pursed to the greatest extent to expedite a message through the system. The number of times a message is returned for improper address information could be tracked for automation justification.

5. References

American Red Cross worldwide emergency communications network. frequently asked questions and answers. (1990, May 20).

Blanchard, B., & Fabrycky, J. (1990). Systems engineering and analysis. Englewood Cliffs: Prentice Hall.

Davis, R. (EMERCOMM Manager), (1996). Telephone Interview. Falls Church, VA: American Red Cross

Everything you ever wanted to know about AMCROSS -- and more. (1990). AMCROSS Emergency Communications .

Fleischer, G. (1984). Engineering Economy. Belmont: PWS Publishers.

Held, G. (1994). Local area network performance. W. Sussex: John Wiley & Sons Ltd.

Hicks, J. (1993). Management information systems. St. Paul: West Publishing Co.

Olson, K. (Manager), (1996). Telephone Interview. Falls Church, VA: American Red Cross

Appendix A

```
' Macro5 Macro
' Macro built 11/19/95 by Mr. Douglas M. Wegner
'
'
Sub Macro5()
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    ActiveWindow.SmallScroll ToRight:=-1
    ActiveCell.Offset(1, -4).Range("A1:D1").Select
    Selection.Copy
    ActiveCell.Offset(-1, 4).Range("A1").Select
    ActiveSheet.Paste Link:=True
    ActiveWindow.SmallScroll Down:=4
    ActiveCell.Offset(17, -5).Range("A1:D1").Select
    Application.CutCopyMode = False
    Selection.Copy
    ActiveWindow.SmallScroll Down:=-4
    ActiveCell.Offset(-16, 5).Range("A1").Select
    ActiveSheet.Paste Link:=True
    ActiveWindow.SmallScroll Down:=7
    ActiveWindow.SmallScroll ToRight:=-1
    ActiveWindow.SmallScroll Down:=13
    ActiveCell.Offset(32, -5).Range("A1:D1").Select
    Application.CutCopyMode = False
    Selection.Copy
    ActiveWindow.ScrollRow = 6
    ActiveCell.Offset(-31, 5).Range("A1").Select
    ActiveSheet.Paste Link:=True
    ActiveWindow.SmallScroll Down:=36
    ActiveCell.Offset(47, -5).Range("A1:D1").Select
    Application.CutCopyMode = False
    Selection.Copy
    ActiveWindow.ScrollRow = 6
    ActiveCell.Offset(-46, 5).Range("A1").Select
    ActiveSheet.Paste Link:=True
    ActiveWindow.SmallScroll Down:=2
    ActiveWindow.ScrollRow = 27
    ActiveWindow.ScrollRow = 18
    ActiveWindow.ScrollRow = 8
    ActiveWindow.SmallScroll Down:=1
    ActiveWindow.ScrollRow = 15
    ActiveWindow.ScrollRow = 22
    ActiveWindow.ScrollRow = 25
```

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    ActiveWindow.ScrollRow = 27
    ActiveWindow.ScrollRow = 33
    ActiveWindow.ScrollRow = 40
    ActiveWindow.SmallScroll Down:=18
    ActiveCell.Offset(62, -5).Range("A1:D1").Select
    Application.CutCopyMode = False
    Selection.Copy
End Sub
```

Appendix B

Table Appendix B - 1 Message Transfer Matrix

FROM/TO	S1_AUTODIN	S2_AUTODIN	S3_AUTDIN	TOT_AUTDIN	S1_EMS_OUT	S2_EMS_OUT	S3_EMS_OUT	TOT_EMS_OUT
AUTODIN	0	0	0	0	0	0	0	0
EMS OUT	0	0	0	0	0	0	0	0
EMS IN	0	0	0	0	0	0	0	0
PHONE OUT	0	0	0	0	0	0	0	0
CALL BACK	0	0	0	0	0	0	0	0
FILE W/O ACTION	0	0	0	0	0	0	0	0
AFRU EDITOR	46	61	24	131	36	31	25	92
DOM. EDITOR	1	0	1	2	76	16	64	156
INTER. EDITOR	67	76	8	151	9	14	5	28
PHONE IN	10	24	16	50	3	5	3	11
SERVICE EDITOR	11	6	2	19	14	7	5	26
SUB TOTAL	135	167	51	353	138	73	102	313

FROM/TO	S1_EMS_IN	S2_EMS_IN	S3_EMS_IN	TOT_EMS_IN	S1_PH_OUT	S2_PH_OUT	S3_PH_OUT	TOT_PH_OUT
AUTODIN	0	0	0	0	0	0	0	0
EMS OUT	0	0	0	0	0	0	0	0
EMS IN	0	0	0	0	0	0	0	0
PHONE OUT	0	0	0	0	7	13	1	21
CALL BACK	0	0	0	0	0	1	0	1
FILE W/O ACTION	0	0	0	0	0	0	0	0
AFRU EDITOR	0	0	0	0	7	32	10	49
DOM. EDITOR	0	0	0	0	12	14	13	39
INTER. EDITOR	0	0	0	0	13	13	7	33
PHONE IN	0	0	0	0	0	0	1	1
SERVICE EDITOR	0	0	0	0	3	1	0	4
SUB TOTAL	0	0	0	0	42	74	32	148

FROM/TO	S1_CALL_BK	S2_CALL_BK	S3_CALL_BK	TOT_CALL_BK	S1_FWA	S2_FWA	S3_FWA	TOT_FWA
AUTODIN	0	0	0	0	0	0	0	0
EMS OUT	0	0	0	0	0	0	0	0
EMS IN	0	0	0	0	0	0	0	0
PHONE OUT	13	18	7	38	0	0	0	0
CALL BACK	4	0	1	5	0	0	0	0
FILE W/O ACTION	0	0	0	0	0	0	0	0
AFRU EDITOR	0	0	0	0	55	68	24	147
DOM. EDITOR	0	0	0	0	14	4	1	19
INTER. EDITOR	0	0	0	0	6	19	1	26
PHONE IN	0	0	0	0	6	7	2	15
SERVICE EDITOR	0	0	0	0	11	21	5	37
SUB TOTAL	17	18	8	43	92	119	33	244

Table Appendix B -1 Message Transfer Matrix Continued

FROM/TO	S1_AFRU_ED	S2_AFRU_ED	S3_AFRU_ED	TOT_ARFU_ED	S1_DOM_ED	S2_DOM_ED	S3_DOM_ED	TOT_DOM_ED
AUTODIN	0	0	0	0	128	73	105	306
EMS OUT	0	0	0	0	0	0	0	0
EMS IN	0	0	0	0	0	0	0	0
PHONE OUT	0	0	0	0	0	0	0	0
CALL BACK	0	0	0	0	0	0	0	0
FILE W/O ACTION	0	0	0	0	0	0	0	0
AFRU EDITOR	27	9	10	46	0	0	0	0
DOM. EDITOR	39	49	28	116	49	4	4	57
INTER. EDITOR	47	64	7	118	1	0	0	1
PHONE IN	17	21	11	49	3	4	0	7
SERVICE EDITOR	3	6	2		2	0	0	2
SUB TOTAL	133	149	58	329	183	81	109	373

FROM/TO	S1_INT_ED	S2_INT_ED	S3_INT_ED	TOT_INIT_ED	S1_PH_IN	S2_PH_IN	S3_PH_IN	TOT_PH_IN
AUTODIN	0	0	0	0	0	0	0	0
EMS OUT	0	0	0	0	0	0	0	0
EMS IN	129	163	24	316	0	0	0	0
PHONE OUT	0	0	0	0	0	0	0	0
CALL BACK	0	0	0	0	0	0	0	0
FILE W/O ACTION	0	0	0	0	0	0	0	0
AFRU EDITOR	0	0	0	0	0	0	0	0
DOM. EDITOR	65	126	248	439	0	0	0	0
INTER. EDITOR	9	11	0	20	0	0	0	0
PHONE IN	13	24	4	41	0	0	0	0
SERVICE EDITOR	0	0	0	0	0	0	0	0
SUB TOTAL	216	324	276	816	0	0	0	0

FROM/TO	S1_SERV_ED	S2_SERV_ED	S3_SERV_ED	TOT_SERV_ED	TOTAL
AUTODIN	3	2	0	5	311
EMS OUT	0	10	0	10	10
EMS IN	4	0	1	5	321
PHONE OUT	5	0	3	8	67
CALL BACK	7	0	0	7	13
FILE W/O ACTION	0	0	0	0	0
AFRU EDITOR	2	6	0	8	473
DOM. EDITOR	4	6	2	12	840
INTER. EDITOR	3	2	1	6	383
PHONE IN	0	0	0	0	174
SERVICE EDITOR	4	33	0	37	125
SUB TOTAL	32	59	7	98	2717