**AUTODIN Brief History**

L. M. Paoletti
Defense Communications Agency
Washington, D.C.
USA

This paper was originally published in: NATO Advanced Study Institute on Computer Communication Networks, University of Sussex, held in 1973. Proceedings were published by Noordhoff - Leyden in 1975.

ABSTRACT

This paper presents a brief history of the development of AUTODIN, a data communications network of the Department of Defense of the USA. It covers the general properties of the network, its design characteristics and some of the system statistics acquired from 1963 to the present. A glimpse of what the future holds for AUTODIN is also presented.

The presentation will address the traffic processing capability of each switching center of the network, the system response time and the various modes under which the subscriber terminals can operate through the network. The security aspects and the reliability features are also addressed. The growth of the network in the past decade, the variety of terminal equipment and other communications systems that interconnect with AUTODIN are presented. The major hardware and software components of the switching nodes together with the general characteristics of the transmission media and associated error control are discussed. Finally, a brief presentation is made on the manner in which the traffic flows through a switching center.

INTRODUCTION

In the mid-50's the Department of the Air Force of the USA had a manual data communications system for logistics card traffic, and an automatic teletype communications system for narrative traffic. The inherent limitations in speed and capacity and the susceptibility to human error of the manual data system, combined with the success of the automatic teletype communication system, motivated planning for the purpose of automating the data network. The proposed, automated data communication system, known as the "Combat Logistics Network" (COMLOGNET). would provide for computer controlled data switching centers and automatic data terminals on a nationwide basis. This network was initially planned to be strictly a data oriented system to replace the manual data relay centers then in existence. However, very early in the design phase it was proposed that the system concept be modified so that both narrative and data traffic could be processed in the network. Accordingly, the purpose of the system was broadened and the name changed to "Air Force Data Communications System" (AFDATACOM). The AFDATACOM consisted of five Automatic Electronic Switching Centers (AESC), each of which would provide for both store-and-forward message switching and circuit switching. The program for implementation of these five AESC's lasted from 1958 to 1963.

In 1960 the Defense Communications Agency (DCA) was established with the basic mission of planning, performing system engineering, and maintaining operational control of the Defense Communications System (DCS). The DCS is the communications system needed to meet all long-haul telecommunications requirements, both voice and data, of the Department of Defense (DoD).

Upon activation, test and cutover of the last of the five AFDATACOM centers in the Continental USA (CONUS), the network was made a part of the DCS and it was renamed the "Automatic Digital Network" (AUTODIN). Throughout the 60's AUTODIN underwent significant changes as a network - four AESC's were added in CONUS and eleven new centers, called the "Automatic Digital Message Switching Centers" (ADMSC), were developed and deployed overseas (Europe and Pacific regions). The major difference between an AESC and an ADMSC is that the overseas switches do not have the circuit switching capability. Furthermore, even though the two types of centers are configured with different hardware and operate under somewhat different software, as far as store-and-forward message switching is concerned, they can be considered to be functionally identical. In CONUS, the network is leased from and maintained by the Western Union Company (WU), but it is operated by DoD personnel; while overseas AUTODIN is owned, maintained and operated by the Government. Finally, from an historical point of view, each center today is called an "AUTODIN Switching Center" (ASC).

NETWORK PROPERTIES

Capacity

The basic function of AUTODIN is to accept, process, store and deliver digital message traffic to and from subscribers located around the world. The relaying of messages by the network is accomplished under the highest possible degree of reliability, speed of service, message security and integrity. The AUTODIN switches employ the store-and-forward concept of transmission in which each message is accumulated and stored in its entirety at an ASC before further transmission along the network is initiated. Accumulation of a complete message at an ASC provides the required message protection since each message is acknowledged and responsibility for it accepted by each node of the network that is involved in the message relay. The routing of messages in the network is accomplished on a deterministic basis. In general, at every node in the network, the destination of a message is assigned a predesignated primary and alternate route which can be modified manually from the supervisory console.

Each ASC has the capability of accepting traffic from, at most, 200 subscriber terminals which can vary in speed from 45 to 4800 bits per second. The average message length is 2,000 characters; the maximum message length is 40,000 characters. The average address multiplicity per message is 1.75. Each ASC can accommodate traffic rates up to the full capacity of all input lines, provided that the subscriber's terminals are distributed, as far as speed is concerned, in such a manner that the switch throughput does not exceed approximately 2 X 105 bits/sec. Message processing by an ASC consists basically in:

Header Validation - to ensure on both input and output that information such as precedence, security, routing indicators, start of message (SOM) and end of message (EOM) designators are properly contained in the message.

Journaling - to record pertinent information about a message so that the status of a message at an ASC can be traced as the message is transmitted through the network. This information is recorded on magnetic tape and retained for a period of 30 days.

Referencing - to record a complete copy of every message for rapid access during a period of 24 hours and for off-line access during a period of 96 hours immediately following receipt of message by an ASC.

Security Safeguards - to ensure that both on input and output and internally within the ASC the sensitivity of a message is not compromised.

Traffic Intercept - to provide for temporary storage of traffic destined for tributary or trunk circuits when the circuit is known to be out of service either through scheduled closing of the tributary or, equipment or circuit outages.

Retrieval - to provide for either automatic resumption of message processing after a system malfunction or retransmission of a message by the ASC through manual intervention of the operator.

Translation - to provide for converting between ACP-127 and JANAP-128 message formats and between ASCII and ITA-2 codes.

Responsiveness

Messages are processed and transmitted in AUTODIN on a first-in-first-out basis in accordance with precedence. Basically, four precedence are recognized in the network. These are:

|  |  |
| --- | --- |
| PrecedenceDesignation | PrecedencePro-sign |
| FLASH | Z  |
| IMMEDIATE | O  |
| PRIORITY | P  |
| ROUTINE | R |

On a worldwide basis, the speed of service required for traffic transmitted over AUTODIN is given below:

|  |  |
| --- | --- |
| Precedence  | Communication Handling Time |
| FLASH | 10 minutes  |
| IMMEDIATE | 30 minutes  |
| PRIORITY | 3 hours  |
| ROUTINE | 6 hours |

The communication handling times indicate the time elapsed from receipt of a message from the customer at originating tributary station to receipt of the message at the destination tributary station. The criteria is based upon average message length and upon the receiving tributary station being capable of accepting traffic. It is also based on traffic being distributed by precedence in the following manner:

|  |  |
| --- | --- |
| FLASH | 1% |
| IMMEDIATE | 19% |
| PRIORITY | 30% |
| ROUTINE | 50% |

To meet the above speed of service requirements, messages with FLASH precedence preempt the transmission of messages of lower precedence on trunks and receive station circuits.

Flexibility

AUTODIN is designed to meet the data and narrative communications needs of subscribers utilizing a large variety of terminal equipment, from teletypewriters to small computers. Furthermore, to preclude rapid obsolescence of the network due to ever changing communications requirements, the system was designed to optimize nodular techniques and software rather than hard-wire implementation.

The messages processed by AUTODIN are prepared in either of two formats: ACP-127 or JAMAP-128. The basic characteristics of these formats are presented respectively in Figures 1 and 2. The formats are selected based on subscribers’ communications needs and terminal equipment; and, in general, the JANAP-128 format is used for data communications while the ACP-127 format is used for narrative communications. For transmission purposes, messages in the JANAP-128 format are subdivided in blocks of 84 characters each (80 characters for information and 4 characters for framing), Five operational modes are permissible In AUTODIN for transfer of information between any two elements of the network. These modes provide various levels of sophistication for error detection and correction and message protection. These modes are:

Mode I - defined as duplex synchronous operation allowing for independent and simultaneous two-way communication with automatic error and channel controls. This is accomplished by means of control characters which are used to acknowledge receipt of valid blocks and messages or to return error information.

Mode II - defined as duplex asynchronous operation allowing for independent and simultaneous two-way communication normally associated with teletypewriter equipment. There are no automatic error or channel controls, and message accountability is maintained through channel sequence numbers and service message actions.

Mode III - defined as duplex synchronous operation allowing for only one-way communication with automatic error and channel controls. The return oath is used exclusively for error control and

channel coordination. The Mode III channel is reversible on a message basis. Control characters are used in the same manner as in Mode I.

Mode IV - defined as unidirectional asynchronous operation allowing for one way only (send only or receive only) communication with no error control and channel coordination. The Mode IV channel is non-reversible and is equivalent to one-half of a Mode II channel. Message accountability is maintained through channel sequence numbers and service message actions.

Mode V - defined as duplex asynchronous operation allowing for independent and simultaneous two-way communication normally associated with teletypewriter equipment. Control characters are used to acknowledge receipt or rejection of messages. Message accountability is maintained through the use of channel sequence numbers and service message actions.

There are two transmission modes in AUTODIN, synchronous and asynchronous. Synchronous transmission is used on all channels which employ the operational Modes I and III and which accommodate modulation rates of 75 X 2m, where m = 0, 1, 2, 3, 4, 5 or 6. Asynchronous transmission is used on all channels which employ the operational Modes II, IV and V and which accommodate modulation rates of 45, 75, 150 and 300 baud. The codes used for transmission of information are the American Standard Code for Information Interchange (ASCII), and the International Teletypewriter Alphabet #2, American Version (ITA-2). ASCII is a 7-level (7 information bits) code, but in AUTODIN a parity bit is added to form an 8-level code. The parity bit is odd for information characters and it is even for control characters. ASCII is always used on synchronous communication channels, and it may be used on asynchronous channels provided that a start bit and a 1 or 2 unit stop bit are added to every character. ITA-2 is a 5-level code and is used only on asynchronous communication channels. A start bit and a 1 to 2 unit stop bit are added when an ITA-2 character ts transmitted. No parity bit is utilized with ITA-2.

Speed, message format and code can all be converted by an ASC to permit the variety of subscriber equipments to transfer information to one another.

Security

In military communications the sensitivity of information is identified by a security classification which prescribes the safeguards needed to ensure that the information is not accessible, either intentionally or inadvertently, to unauthorized personnel. Strict measures, both in system design and ASC operation, are taken to ensure that the security safeguards are not compromised. A multiplicity of security checks are performed at an ASC. These include validating on both input and output that the security level of the channel is equal to or higher than that of the message being received/transmitted; attaching the security code on every block of a message which is segmented for internal storage and processing and validating this code for every block at output processing; preventing any single equipment malfunction from causing security checks to be accomplished incorrectly; generating supervisory alarms immediately upon suspicion of a security compromise; and establishing strict procedures for modifications of security safeguards from the supervisory console. Additionally, all channels requiring communications security are encrypted by inserting cryptographic equipment between any information source and sink. The security levels of messages processed in AUTODIN are:

|  |  |
| --- | --- |
| SecurityClassification | SecurityPro-sign |
| TOP SECRET | T  |
| SECRET | S  |
| CONFIDENTIAL | C  |
| UNCLASSIFIED EFTO | E  |
| UNCLASSIFIED | U |

Categories of traffic with special security are also transmitted through the network.

Reliability

The ASC's are designed to operate on a 24-hours/day, 7-days/ week, 52-weeks/year basis. No single failure affects the operational capability of a switching center. Graceful degradation is permissible; however, message security protection and accountability are maintained through all ASC operating states. Isolation of a malfunction, together with recovery and fallback from malfunctions, are automatic. The probability that an ASC loses a message is less than 10-8 ; while the probability that an ASC is the cause of an error in the relaying of a message is less than 10-7.

NETWORK CONFIGURATION

Topology

The initial configuration of AUTODIN is shown in Figure 3. It consisted in 1963 of five nodal switches, fully interconnected by 2400 bps transmission lines. As communications demands increased in CONUS and developed rapidly overseas the network evolved to the configuration shown in Figure 4. In this stage, the network retained its distributed nature and a large percentage of its full-interconnectivity. The transmission lines tying the nodes together remained at 2400 bps. The AUTODIN configuration of today is shown in Figure 5. The CONUS switches are interconnected by 4800 bps transmission lines; while 2400 bps lines are utilized overseas.

CONUS Nodes

The hardware used to implement a CONUS ASC is shown in block-form in Figure 6. It consists of a Technical Control Unit, a Message Switching Unit (MSU), a Circuit Switching Unit (CSU), a Centralized Control Unit, and a Power Unit.

The Technical Control Unit is used for terminating transmission lines, and for interconnecting transmission lines to the MSU and CSU. It includes the modulating and demodulating (modem) equipment, monitoring and measuring instruments, cryptographic devices, and patching facilities. The modems are used for converting signals carried over transmission lines to a form compatible with digital equipment; while the monitoring and measuring instruments are used for indicating transmission line continuity and signal quality. The cryptographic devices provide traffic security protection on the transmission lines; and the patching facilities provide a flexible means of interconnecting MSU/CSU equipment and transmission equipment in a variety of combinations.

The MSU is the heart of the center. It consists basically of a general-purpose computer tailored to perform the store-and-forward message switching function. The MSU is comprised of a front-end and a data processing complex known as the CDP (Communications Data Processor). The front-end consists of buffer elements which perform the basic functions of matching the transmission line speed and signal level to those of the MSU and of translating from bit-by-bit to character-by-character and vice versa. These elements differ in accordance with data transfer rates and transmission mode - synchronous or asynchronous. The accumulation and distribution unit (ADU) is also part of the front-end and it coordinates the transfer of data between the buffer elements and the data processing complex. This unit performs the channel coordination procedures (as described under Transmission), and it converts from ASCII or ITA-2 to Extended Field data, the data handling code of the Communication Data Processor. The CDP consists of a central processing unit, a number of high-speed core memory banks, and an I/O complement of disks, magnetic tapes, high-speed paper tape reader and operator's console printer. The CDP, utilizing stored programs, coordinates all message flow and^ sequencing for both local exchange within itself and other units of the ASC, and external exchange with other ASC's and subscriber terminals. For reliability purposes, the central processing unit and the operator console are duplicated.

The CSU performs direct switching among subscribers connected to the circuit switching units of the network. This unit functions as a space division, common control, multiple register-senders switching system. It provides 4-wire transmission via glass-sealed, dry-reed, relay cross points arranged in a non-blocking matrix. The subscriber’s terminals can operate at speeds from 75 to 4800 bps; however, to transfer information through the CSU, the end terminals must be compatible in speed, format, and code. Both local and tandem calls can be made through the CSU; in tandem calls, the unit will automatically search for alternate routes open to traffic. In-band signaling is used in the CSU. Supervisory signals are either dc levels or 8-bit characters conforming to the modulation rate of 75 X 2n where n Â‚ 0, 1, 2, 3, 4, 5, 6. The destination address is derived from the message preamble which is used to establish a call and which conforms to the header of a JANAP-128 message format. Both precedence and security checks are performed by the CSU. The Circuit Switch Unit interfaces with the Message Switch Unit on a full-duplex basis; accordingly, any CSU subscriber can obtain store-and-forward service, and any MSU

354 subscriber can transfer messages with any CSU subscriber.

The Central Control Unit consists of a console where centralized supervision of the major equipments of the switching center is provided by means of controls and status display. Indicators showing the operating condition of the major components of the ASC are located in this unit. Provisions are also made in this console for switching equipment units from stand-by to on-line conditions and for changing programs.

The Power Unit comprises 45 KVA motor-generator sets and regulating and control equipment to supply and distribute voltage-regulated, frequency-regulated and unregulated power in the switching center.

The software that makes the CONUS ASC's perform the store-and-forward message switching functions includes three major routines - the Control Program, the Traffic Handling Program, and the Equipment Handling Program, All programs are written in Assembly Language. The Traffic Handling Program and the Equipment Handling Program are modularly subdivided into functional tasks called units. Basically, a unit is a self-contained portion of coding; it is entered at the beginning and it follows through to the end in performing its assigned task and then exits to the next task via the Control Program. The Control Program, as its name implies, exercises control of the system. It also is divided into functional units; one-unit sequences all other program units. while the others control the issuance of instructions to peripheral devices and the handling of interrupts and abnormal or error conditions. The Traffic Handling Program performs all of the tasks associated with the acceptance of messages into the system, the input and output processing of messages, the storing onto and retrieval of messages from disks, and the delivery of messages to the proper outgoing channel. The Equipment Handling Program provides for the man-machine communication between the system console and the CDP, the handling and servicing of peripheral devices (except for disks), the servicing of ADU requests, and the printing-out of information vital to the operation of the system.

Overseas Nodes

The hardware used to implement an overseas ASC is shown in block-form in Figure 7. It consists of the Communications and Technical Control Subsystem, the Automatic Digital Message Switch (ADMS), and the Uninterrupted Power Supply (UPS).

The Communications and Technical Control Subsystem provides facilities for termination of the transmission lines, and for interconnecting transmission lines to the ADMS. As with the Technical Control Unit of the CONUS nodes, it also includes the modems, monitoring and measuring instruments, cryptographic devices, and patching facilities.

The ADMS performs the store-and-forward message switching function. It also consists of a front-end and a data processing complex. The front-end consists of buffer elements and a Line Traffic Coordination (LTC) unit. The LTC is composed of a Philco Co. 102 processor and 16 K words (32 bits/word) of high-speed core memory. The LTC accepts/transmits data from/to the buffer elements on a character basis and transmits/receives data to/from the data processing complex on a block (80 characters/block) basis. It performs also the channel coordination procedures. The data processing complex consists of a message processor (MP, the Philco 102), a number of high-speed core memory units, and an I/O complement of drums, magnetic tapes, high-speed printer, and card reader and punch. A supervisory console to monitor the overall operation and maintenance of the ASC, and a maintenance console to perform specific maintenance functions for the ADMS are also provided.

For reliability purposes, a switching arrangement is provided in the ADMS, whereby a stand-by unit of one type can assume the functions of any on-line unit of the same type (e.g., the stand-by 102 processor can be used for either the LTC or the message processor).

The UPS furnishes continuous regulated power to service the sensitive loads within the switching center. It consists of two dc power supplies, a 240-volt battery, five motor-generator sets, and power control and distribution equipment. The battery consists of 120 two-volt cells connected in series. The battery is connected to the common dc lines in parallel with the output of the dc power supply and is capable of providing power to the motor-generator sets for 15 minutes in the event of primary power source failure.

The software that makes the Overseas ASC's perform the store-and-forward message switching functions includes five major programs - the Executive Control Program, the Line Traffic Coordinator Program, the Message Processor Program, the Supervisory Functions Program, and the Restart and Off-Line Recovery Program. All programs are written in Assembly Language.

The Executive Control Program coordinates and sequences all on-line programs, I/O instructions and LTC/MP operations. It performs magnetic tapes scheduling and drum operations, and monitors overall system performance to assure that any malfunctioning equipment is removed from the system and replaced with operable equipment without impairing system operation.

The LTC Program performs channel coordination on the transmission lines; it allocates dynamically buffer storage in the amount up to 15 data blocks for each input and output line; and it coordinates the exchange of control information pertinent to the transfer of data between the LTC and the MP.

The MP Program performs the data handling functions of the ADMS: It prepares and sequences the I/O instructions to control the message flow; it performs all message processing functions; and it compiles data for statistics about message traffic.

The Supervisory Functions Program provides the means for the operator to issue commands to the system. Through this program reconfiguration of the system devices and supervisory commands such as remove a channel from service, cancel a message, alt-route traffic for a destination, patch a memory location, close history tape, and change routing table are executed.

The Restart and Off-Line Recovery Program provides the means for system initialization, program loading, and automatic recovery from system malfunction and fallback to message processing at the point where the malfunction occurred.

Traffic Flow

To acquaint the reader with a general understanding of how an ASC performs message switching, let us briefly trace a message through the system. Figure 8 illustrates this process. The Overseas ASC will be utilized in this description; the functions performed, however, apply equally well to the CONUS ASC even though they may be executed in a slightly different manner. A series of bits enter an ASC through the transmission lines; these are accepted by the Buffer Elements and are accumulated into characters. Each character is then transferred to the Line Traffic Coordinator where blocks (84 characters) of data are accumulated and each block is assigned a sequence number. Each block is then transferred to the Message Processor where the block framing characters and sequence number are checked and validated to ensure data blocks integrity. When the MP begins to accept blocks of data from an LTC, it selects an available section of drum where segments (each segment consists of up to 8 blocks) of a message can be stored, and it activates an entry in the drum linking table to control the linking of the segments of a message. Upon reception of the Header block, all of its elements are checked and validated by the MP, a serial number is assigned to the message for reference purposes during its processing in the ASC, the precedence pro-sign is checked to determine for each destination where, in the queue, this message should be placed, and the start-of-message-input entry is written on Journal Tape. Once a segment of a message has been written on drum, it is copied onto Reference Tape, and the MP notifies the LTC that the buffer areas for the particular segment can be made available for the reception of additional data. At this point responsibility for the transferred message segment rests with the MP. The transfer of message segments from LTC to MP continues on a periodic basis until a complete message has been received by the message processor. Upon reception of the end of message block, the MP prepares the end-of-message-input entry for the Journal Tape and notifies the LTC of successful acceptance of a message. If, during the transfer of blocks between the LTC and MP, an error or discrepancy is noted, the MP enters into a reject processing routine.

For every message that comes into an ASC, one or more transmission-out must be affected by the ASC, based on the number of destinations contained in the message. Every program cycle, each output line table entry is scanned to determine whether or not a message is being transmitted on that line. If no message transmission is in progress, a check is then made to see if there is a message in queue for the same line. If either a message is being transmitted or a message is available in queue, the MP checks if the LTC can accept data. If such is the case, a read drum list is built by the MP to retrieve data from the drum; and for every block transferred to the LTC, the framing characters, the block count and the security character are validated. For the Header block, routing line segregation is additionally performed, whereby only routing indicators that are pertinent to a destination are retained in the message. Once the header has been validated for transmission, format conversion is performed if necessary, preemption is effected if necessary, a start-of-message-output entry is prepared by MP for Journal Tape, and actual transfer of blocks of data begins between MP and LTC and it continues on a periodic basis until a complete message has been relayed. Basically, the data input process is reversed in that blocks are transferred from MP to LTC, characters are transmitted from LTC to Buffer Elements, and serial bits are placed on the transmission lines by the Buffer Elements. Once all this has been accomplished responsibility for the message passes from the center to the destination, and the drum segments are made available for storage of new messages.

Transmission

The transmission media utilized in AUTODIN include wire lines, LOS microwave, submarine cable, tropospheric scatter and satellite systems. The spectrum utilization on these media, on a channel basis, is basically 4 kHz or a VF channel. For the transfer of information at speeds of 1200, 2400, and 4800 bps, additional requirements with regard to frequency response, envelope delay distortion, idle channel noise, impulse noise, and phase jitter are placed on the VF channel. To achieve operational flexibility and maximum utilization of assigned bandwidth, circuits operating at speeds below 1200 bps are arranged in a frequency division multiplex scheme (FDM) on individual VT channels. The modems utilized to perform the A/D conversion include a low-speed asynchronous unit, which employs a frequency-shift keying (FSK) modulation technique, a low speed synchronous unit which also employs FSK, and a high-speed synchronous unit which employs phase-shift keying.

To achieve a BER of 1 X 10-8 or better on synchronous transmission lines, an error control procedure known as ARQ (Automatic Retransmission Request) is employed in AUTODIN. In synchronous operation, the information is segmented into blocks of 84 characters each, and the receiver must verify the accuracy of each block and must acknowledge reception of each error-free block. Character parity, longitudinal parity and character position are employed for block verification. If an error is detected in a block, the receiver sends to the transmitter an "error in block" acknowledgement, and the same block is automatically retransmitted. If necessary, the retransmission of a block is attempted three times, and, if unsuccessful, the ASC supervisor is notified to take remedial action. In asynchronous operation, error control is performed on a message basis. Messages are verified for accuracy at the receiver by the provision of character and control sequence validity checks and start and end of message checks. Messages which are correctly received are acknowledged by the receiver, while messages which are received incomplete or in error result in requests for retransmission.

Terminals

The basic types of subscriber equipment that presently connect to the network are teletypewriters, small-scale computers with either card or magnetic tape capability or both, and optical character readers. Large scale computers can also transfer information through AUTODIN as long as the network procedures are adhered to. Teletype Corporation models 28, 35 and 37 exemplify the type of teletypewriters used to transfer narrative messages. Lately, however, in order to eliminate the rather tedious and time-consuming conversion process between page-printed information and information recorded onto paper tape, OCR's are being introduced in the network.

The IBM 360/20/30, the UMIVAC 1004 and DCT 9000, the RCA Spectra 70/45, and Honeywell 200 are representative of computerized terminal facilities used to transfer data recorded on either cards. magnetic tapes, magnetic disks, and paper tape. Other message switching systems are also interconnected with AUTODIN. Some of these are the Automatic Message Processing System (AMPS), implemented with the Burroughs D825 computer, the Tactical Automatic Data System (TADS), implemented with the Burroughs 3500 computer, and Local Digital Message Exchanges employing computers such as UNIVAC 418, IBM 360/40/50, CDC 1700 and RCA Spectra 70/35.

NETWORK STATISTICS

Subscribers

The general categories of terminal equipments accessing AUTODIN are presented in Figure 9. The teletypewriters can operate at speeds from 45 to 300 baud and are utilized exclusively for narrative traffic. The ADP terminals consist of peripheral devices and controllers (which can be implemented with small computers such as the IBM 360/20) either as single units, a card terminal or a magnetic tape terminal, or in combination thereof, a compound terminal. The latter units can be utilized for both data and narrative traffic and are identified in Figure 9 as low speed, below 300 bps, medium speed, from 300 to 600 bps, and high speed, above 600 and up to 4800 bps.

Traffic Volume

The build-up of traffic in AUTODIN from its initial configuration to present is depicted in Figure 10. The ordinate presents the total number of originated messages processed in the network in one year.

Efficiency

Figure 10 shows also how the network has been performing throughout the years. The network efficiency is the average of the individual ASC's efficiencies, which are defined as the percentage of time each ASC is operative.

Speed of Service

The average amount of time that has taken to transmit a message of any precedence through AUTODIN is also given in Figure 10. This time includes manual processes, such as paper tape preparation and message duplication, required at the network origination and destination points.

THE FUTURE

The modes of communication presently satisfied by AUTODIN, we believe, will continue to exist and even expand in the foreseeable future. Improvement programs for the network are continuously being developed to ensure that "customer" service is maintained at a very high degree of efficiency. An area which needs to be improved is terminal facilities. In excess of 90% of the time used to transmit a message in AUTODIN is attributable to such manual operations as paper tape preparation, message logging, message duplication, conversion of destination names to routing codes, and conversion from the page-printed format to either ACP-127 or JANAP-128 formats. We in the defense communications community are constantly striving to find effective means to automate these processes and thus improve the writer-to-reader speed of service. Attractive and feasible solutions to reduce message preparation and handling times are available today in the form of such devices as OCR's, tape cassettes, and facsimile; however, we believe that problems associated with complexity, reliability and cost must be resolved before these equipments can find widespread application in defense communications.

While the 50's and 60's saw the achievement of rapid, reliable and efficient narrative and data communications through AUTODIN, we believe that the 70's and 80's portend the widespread need for other modes of communications for which our present systems were not designed. The types of information transactions that we foresee for these new modes of communications are:

Interactive - considered to mean the interoperation of a computer with the thought processes of a human through an I/O terminal or the chatter between two humans through I/O terminals. It may be thought of as a rapid series of interrelated questions and responses which converge to the resolution of a complex task. We expect these transactions to be characterized by a nominal length of 600 bits for a question, 6000 bits for a response; and a system response time in the order of seconds.

Query/Response - considered to be the exchange of one short question followed by a short conclusive answer with no attempt at sustaining continuity of thought within a human or logical continuity within a computer. The characteristics of these exchanges are expected to be nominally 600 bits for questions, 6000 bits for responses, and system response time in the order of seconds to minutes.

Data Base Update - considered to be the transmission of a short data message to a computer without expectation of a response. The transmission is expected to be typically 600 bits long with a delivery delay in the order of seconds to minutes.

Bulk 1 Transfer - considered to be the transmission of entire files, programs or processing results. The length of these transmissions is expected to be in the order of 104 to 106 bits with a delivery delay in the order of tens of seconds to tens of minutes.

Bulk 2 Transfer - considered to be the transfer of extremely lengthy information such as an entire data base or sensor data. The length of these transfers is expected to be greater than 106 bits with a delivery delay in the order of tens of minutes to hours.

To effectively satisfy the present and future communications needs of the DoD, the Defense Communications Agency is pursuing analyses of alternative networks ranging from modifications to AUTODIN, to an interactive ADP systems network, to an integrated digital DCS permitting global communications between humans in either voice or record, between men and machines, and between machines.

ACKNOWLEDGEMENTS

The preparation of this paper has been made possible through numerous discussions and valuable suggestions of many employees of the Defense Communications Agency. To my colleagues I am very much indebted.

BIBLIOGRAPHY

1. AFDATACOM System; RCA Instruction Book, Appendix III, Volume I; September 1963

2. Automatic Digital Message Switching Centers; Technical Manual, TM 11-5895-391-15; October 1968

3. DCS AUTODIN Interface and Control Criteria; DCA Circular 370-D175-1; October 1967

4. DCS Operating-Maintenance Electrical Performance Standards; DCA Circular 300-175-9; October 1969

5. System Description DCS-AUTODIN; DCA Circular 370-D95-1; July 1967