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SATORI: Situation Assessment through the Re-creation of Incidents

Mark D. Rodgers

Civil Aeromedical Institute
Federal Aviation Administration
Oklahoma City, Oklahoma 73125

Duane A. Duke

Office of Information Services
Federal Aviation Administration
Oklahoma City, Oklahoma 73125

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16. Abstract

A system has been developed that graphically re-creates the radar data recorded at En Route air traffic control (ATC) facilities. Each facility records data sent to the displays associated with the airspace under its control on a System Analysis Report (SAR) tape. SATORI (Situation Assessment Through Re-creation of Incidents) overlays the SAR data on the appropriate sector maps using map data from the Adaptation Control Environmental System (ACES) database. The analog switch display settings of the plan view display (PVD) are not recorded; however, subroutines have been written for SATORI that allow the display to be set up with the settings reported to have been used by a given controller. In addition, SATORI has the capability to display the high and low weather intensity that was displayed on a given PVD. All software routines written for SATORI use Open Systems Foundation (OSF) technology. Similar data to those available from En Route facilities are recorded at Terminal Radar Approach Control (TRACON) facilities and should allow for the development of a re-creation tool much like the one discussed in this report. Once SATORI is developed and evaluated, it will be possible to accomplish the goals of evaluating system designs, over-the-shoulder appraisals, training outcomes, procedures, airspace design, and measuring controller performance. Not only will the capabilities and features of SATORI provide those interested in air traffic with a valuable tool for assessing the dynamics of the air traffic situation, but additionally, and more importantly, the Agency will be in a better position to bring about effective change in future ATC systems.

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SATORI: SITUATION ASSESSMENT THROUGH RE-CREATION OF INCIDENTS

INTRODUCTION

A system has been developed that graphically re-creates the radar data recorded at En Route air traffic control (ATC) facilities. These data are sent to the controller scope, called the Plan View Display (PVD), and the Continuous Readout Update Display (CRD). The re-creation synchronizes the graphic display of these data with tapes containing the associated verbal interactions between pilots and the controller. This system is called Situation Assessment Through Re-creation of Incidents (SATORI). SATORI is a Japanese word that translates to English as "insight." In Zen Buddhism, it refers to a "state of enlightenment." It is hoped that, through the use of the SATORI system, it will be possible to gain a better understanding of the interaction between the various elements of displayed information, verbal interactions, and the control actions taken by air traffic control specialists (ATCSs).

Description of ATC System

This development uses data obtained from Air Route Traffic Control Centers (ARTCCs), also called En Route facilities. ATCSs at those facilities primarily handle aircraft traveling between the terminal facilities across the nation. Each facility records PVD and CRD data associated with the airspace under its control on a System Analysis Report (SAR) tape. The SAR tape contains all of the recorded dynamic display information about the National Airspace System (NAS), including weather, and the aircraft traversing it. Verbal interactions between pilots and controllers are recorded on a multi-channel tape unit at each facility.

ATCSs are required to maintain certain separation minima between aircraft under their control. Standards for separation minima are described in the Air Traffic Control (ATC) Handbook (7110.65G, and supplemental instructions). While there is considerable complexity in those standards, at flight levels between 29,000 and 45,000 feet, Air Traffic Control Specialists (ATCSs) at En Route facilities are required to maintain either 2,000 feet vertical separation or 5 miles horizontal separation between aircraft. At flight levels below 29,000 feet with aircraft under IFR conditions, ATCSs are required to maintain either 1,000 feet vertical separation or 5 miles horizontal separation. An operational error (OE) takes place when an ATCS allows less than the prescribed minimum separation distances between aircraft (or an aircraft and an obstruction).

Analysis of Operational Errors

Currently, the FAA Office of Air Traffic Systems Effectiveness requires an investigation into each OE. This investigation involves determining the circumstances in which the OE occurred and the causal factors associated with the error. Initially, a preliminary investigation report (FAA 7210-2) is filed in which possible causal factors are identified and a final report (FAA 7210-3) filed shortly thereafter. A project related to the development of SATORI and sponsored by the FAA Office of Air Traffic Systems Effectiveness involves studying the tasks of an En Route ATCS associated with the commission of an OE. One way to analyze OEs would be to identify which tasks were omitted or were performed incorrectly. This may facilitate identification of training needs or system deficiencies. In order for the tasks associated with the commission of an OE to be identified, it must become possible for one to review the dynamics of the situation in which the irregularity occurred.

Prior to the development of SATORI, it was not possible for the Quality Assurance (QA) team investigating errors to review how the control situation was seen by the ATCS as the OE occurred. That is, the dynamics (the interaction between control actions and displayed data) of the situation were unavailable for review, not only by the QA team investigating the irregularity, but also by the control-

ler who committed the error. This limited not only the extent to which a determination could be made of the tasks involved in an error, but also the effects of the dynamic situation on ATCS situation awareness.

In addition, the only means by which a graphical representation of an En Route OE could be achieved was to obtain a printout of the National Track Analysis Program (NTAP) or to have a simulation built at the ARTCC or FAA Technical Center using dynamic simulation (DYSIM) equipment. NTAP processes NAS data recorded on the SAR tape and provides a plot of aircraft tracks and altitude information as output using a line printer. NTAP is limited to the display of about four aircraft, however some of the data are lost when all four aircraft are displayed since it was designed not to overwrite information already printed. When only two aircraft are displayed, the information loss due to printing is minimal. The DYSIM simulation built at the FAA Technical Center or ARTCC is not as timely or accurate as NTAP. Each piece of data and its associated track must be hand entered to build a simulation using DYSIM equipment. The simulation would only be as accurate as the data used to create it, and since this is an extremely labor intensive process, typically not all of the data points are used.

Without the ability to review an error with the involved controller, the dynamics between the situation and control actions taken, as well as the task elements involved in the OE, remain relatively obscure. The purpose of SATORI is to display the ATC situation dynamics so that a more definitive determination of the factors involved in OEs becomes possible. SATORI utilizes a multi-media graphics workstation, which has the capability of developing a library of OEs and an OE performance and taskload database. A diagram of the SATORI data processing flow is provided in Figure 1.

SATORI DEVELOPMENT

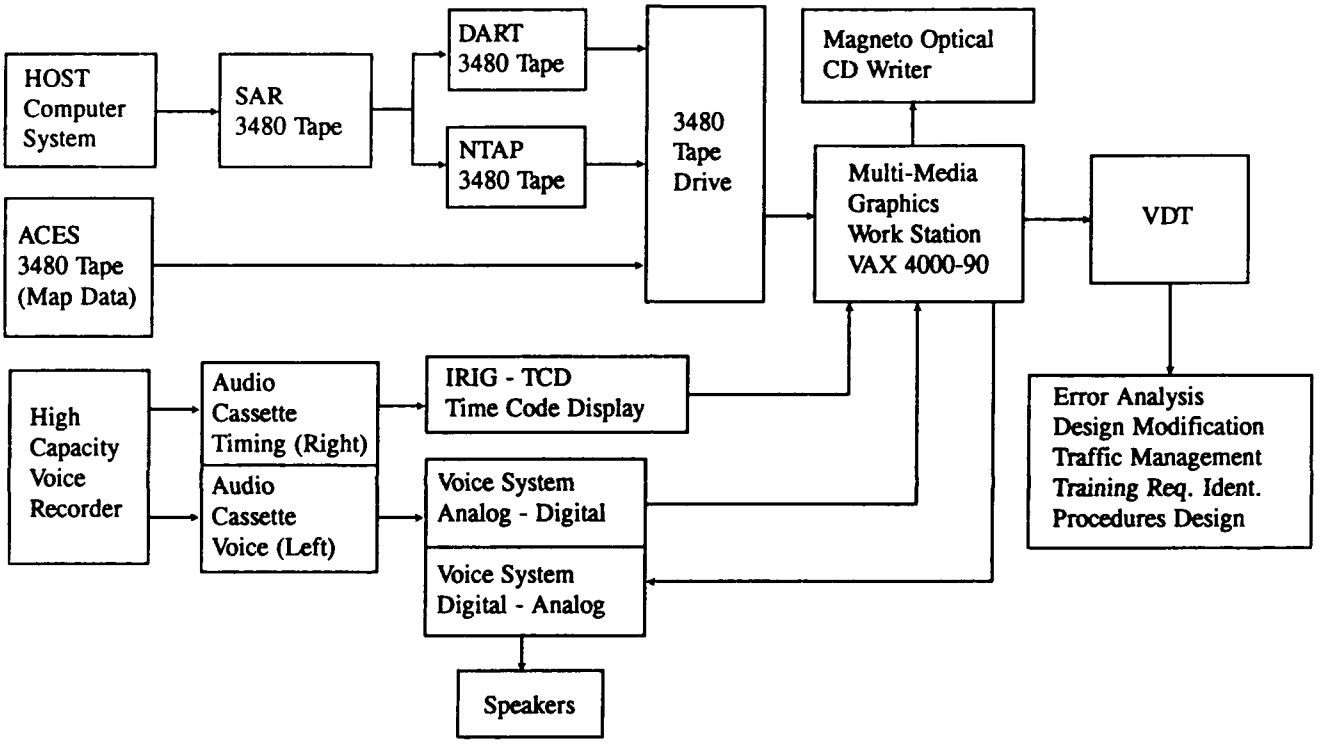
The following is a discussion of the SATORI development process. First, current system capabilities are described along with those under development. A brief note is included for issues yet to be resolved concerning capabilities under development. A detailed discussion of the National Airspace System Program (NASP) data files required for the development is provided when relevant. Also included in this section is a discussion of the required hardware developments and graphics software requirements for SATORI. The second section discusses the potential applications of SATORI. A concluding section discusses the future developments and potential directions of the SATORI project.

Graphical Re-creation of Airspace

For the SATORI development, the SAR tape is edited using the Data Analysis and Reduction Tool System (DART) and NTAP to obtain only those files required to provide the information displayed on the PVD and CRD. Several data files are required to obtain the necessary information for re-creating the information presented on the PVD. Aircraft position information is recorded in three separate files, one for each of the three symbols that could potentially be presented on the PVD for any given aircraft. These three symbols are the aircraft position symbol, beacon target, and primary target.

The tracks of the aircraft position symbols as they move through the facility airspace are recorded on the SAR tape for aircraft under positive control and are available using DART; the file is called TRACK. Position symbols are updated every 6 seconds and represent predicted aircraft positions based on the current aircraft track. This file also specifies the information contained in the data block and the direction of its leader line. DART does not allow for the extraction of aircraft primary radar or beacon targets, which are also recorded on the SAR tape. These data files are extracted using NTAP. Primary targets represent the position of aircraft based on radar data. Primary targets are required for the display of aircraft not under positive control (i.e., uncorrelated targets) in the sector being re-created. Primary targets are updated on the PVD every 10, 11, or 12 seconds depending on the aircraft location relative to the radar site and represent actual aircraft location to the degree of accuracy associated with the

Figure 1. SATORI Data Process Flow Chart



system. However, since the data associated with primary targets include only a symbol type and location without any identifier, representing them with SATORI may be inaccurate because it is not possible to tell how long a primary target symbol should be displayed (i.e.,. 10, 11, or 12 seconds). Several solutions to this problem are currently being considered, however further work is required.

Beacon targets represent aircraft locations generated by transponder-equipped aircraft and are used by controllers to provide separation between aircraft. Beacon targets for all transmitting transponder-equipped aircraft are displayed with SATORI. Currently, the SATORI system allows for review of all controlled aircraft, within any sector of airspace for any given period of time that was recorded on a SAR tape.

SATORI software overlays the NAS SAR data on the appropriate sector map using map data from the Adaptation Control Environmental System (ACES) database. This database is used to generate the various map configurations displayed on the PVD. The ACES map files contain map data for each sector within a given facility for all ARTCC facilities. These maps contain airway, navaid, and airport information, and other types of data used in the graphical representation of the airspace of the NAS. The file of particular interest in this database is the GMLMAP file. This file contains the logical map records for the center of interest.

Software has been developed that allows for any sector map to be edited from the ACES database for any ARTCC. This software allows for the selection of four maps that can be displayed together or separately, as follows: (1) sector boundary; (2) airways; (3) low sector boundaries below a high altitude sector or the high sector boundaries above a low altitude sector; and (4) any other available map data such as military operations areas (MOAs) and restricted areas.

Audio Data Synchronization

SATORI provides for the synchronization of the audio and video portions of the replay. The audio and video displays have the capability to start at any time, pause, stop, and reset to the earliest recorded time. Synchronization routines have been written that keep the audio and video displays synchronized to within 1 sec. (the audio time signals are only accurate to the second).

Audio data are officially recorded on two channels, with all of the voice communications between pilots and the controller for a given sector on the left channel and the Inter-Range Instrument Group (IRIG) timing signals on the right channel. These signals or reference pulses are amplitude-modulated time codes involving a 600 Hz. carrier signal (FAA modified IRIG-E). The signals are read by a Time Code Display (TCD) unit. Datum model 9700 TCD is equipped with RS-232 binary output. The Datum 9700 output provides the data to synchronize the voice channel to the video presentation. SATORI can also incorporate interphone communications into the re-creation.

The voice channel is first digitized, synchronized through timing routines to the video presentation, and then converted back to an analog signal for replay. The analog-to-digital, digital-to-analog data acquisition system is made by Gradient Technology. The voice data acquisition system can be used on either VMS or UNIX platforms.

PVD Emulation Subroutines

The analog switch display settings of the PVD are not recorded; however, subroutines have been written for SATORI that allow the display to be set up with the settings reported to have been used by a given controller. These include the vector velocity line, leader line, history, display center, range, and brightness. The vector velocity line can be set for one through five minutes, and the leader line length has five settings. The center of the display can be set anywhere in the sector map area selected from the

ACES database. Range is selectable from 6 to 400 miles; however, data are edited from the SAR according to the PVD device number and, therefore, might not be available for display at all ranges. Brightness is adjustable only as a function of the workstation's monitor controls. SATORI also allows for the display of the J-rings a controller selected for display.

Digital settings on the PVD, such as altitude filter selections, display of weather, alpha-numeric keypad (ANK) entries, use of quick action keys (QAK), and any changes made to the digital settings are recorded on the SAR tape. Using DART to obtain the LOG file from the SAR tape, it is possible to identify specifically what those settings and changes were and when they occurred. The SATORI system allows for display of the LOG file data, which are the digitally recorded Host Computer System (HCS)/ATCS interactions. Most of these data are displayed on the CRD display located next to the PVD display. The CRD displays all data entered using the alpha-numeric keypad and quick action keys (QAK). Both the radar and data positions can make QAK and ANK entries, which are displayed on separate CRDs. SATORI displays the CRD data from both positions simultaneously on separate CRD displays. HCS response to requests for route readouts, and arrival/departure lists is not currently part of this development.

In addition to the above, SATORI has the capability to display the high and low weather intensity that was displayed on a given PVD. This should be particularly helpful in reviewing situations requiring pilot deviations from typical routes when navigating around weather. Both heavy and light weather symbols are available for review with data obtained using NTAP. Conflict alerts for a given sector will be available for display with data obtained using DART. Electronic versions of flight progress strips (FPSs) can be created. If the original FPSs are unavailable, it will be possible to view the original FPSs before any strip markings occurred.

Hardware and Software Systems

All software routines written for SATORI use Open Systems Foundation (OSF) technology. The OSF standard recommends the use of an operating system with Posix compliance, ANSI C programming language, the X-Windows graphics system, an OSF/Motif graphical user interface, and network TCP/IP compliance. This permits the system the widest range of portability to the largest number of platforms. The platform for this development is a VAXstation 4000-90, conversion to the DEC Alpha workstation is in progress. The 4000-90 workstation has 40MB of RAM and a 1.35 gigabyte hard drive. A rewritable magneto-optical CD drive is available for storage of data, as is the 3480 tape drive used to read SAR, DART, and ACES tapes sent from field facilities.

SATORI APPLICATIONS

Previous to the development of SATORI, it was not possible to replay graphically the movement of aircraft targets and their associated data blocks across a given sector of En Route airspace synchronized to the associated voice data. This capability has the potential of improving the safety of the NAS. A discussion follows of the potential benefits from using SATORI.

Incident Reviews

Quality Assurance (QA) teams will have a tool for reviewing the situational dynamics that occurred during an incident under review. Currently, QA review of an OE involves looking at the NTAP printout, a process that is limited to the display of two to five aircraft targets and associated limited data blocks presented on paper. SATORI will provide the capability for the simultaneous display of all aircraft targets and data blocks for a given sector of airspace in a video format in sync with the associated voice track. NTAP would remain the legal tool used for assessment of the loss of separation; however, this system would facilitate investigation in determining the situational dynamics that took place prior to and during an error. It would also provide an opportunity to demonstrate "good" techniques of control and outstanding flight assists.

DYSIM Review

It will be possible to use SATORI to review performance on DYSIM problems without the use of training time on a PVD. At present there is no capability to replay a given controller's or trainee's performance on a DYSIM problem. DYSIM data are recorded on the SAR tape and would involve the same process for data reduction as that for actual ATC situation re-creation. It is hoped that through the review DYSIM performance and OEs and the determination of the tasks that were omitted or were done incorrectly it will be possible to identify those tasks that should be addressed in remedial training.

ATCS Performance Measures

SATORI has the capability to provide a basis for developing objective measures of controller performance rather than over-the-shoulder assessments derived from simulated scenarios. A number of measures have been developed by researchers at CAMI and the FAA Technical Center for use in evaluating ATCS performance. These measures and the system being developed for their calculation using NAS data are described in detail in a report by Rodgers and Manning (1993).

If the performance of several controllers is recorded for a DYSIM problem, it should be possible to compare an individual's performance with group performance on the same problem. It would be possible to review over-the-shoulder assessment techniques for accuracy. This would utilize the objective measures of performance currently under development as mentioned above. These measures would provide a standard for training ATC instructors or evaluators in over-the-shoulder rating techniques and a means to objectively evaluate their performance.

OE Research Tool

SATORI will provide a research tool for investigating the tasks and controller actions involved in the commission of En Route OEs. Previous to the development of SATORI, there was no means by which the dynamics of the control situation could be understood because they were unavailable for review. With the use of SATORI, the job tasks taxonomy (Rodgers and Drechsler, 1993), the reference guide to tasks associated with the causal factor categories of the current operational error reporting system (Rodgers, 1993), taskload and performance measures (Rodgers and Manning, 1993), and the assistance of the controller involved in the error, it should be possible to identify which actions were omitted or which were done incorrectly to precipitate the error.

Design Appraisal

The FAA has a requirement to evaluate its current systems against proposed future ATC systems designs. Without a means to objectively assess the current ATC system ATCS taskload and its effect on ATCS performance, it is not possible to make a meaningful evaluation of the potential impacts of any design changes proposed to be made. With the likely increase in automation of future ATC systems, it becomes imperative that the Agency have the capability to make comparisons between proposed system designs and the current system. Without such a tool the design process will be speculative and not cost effective.

Traffic Management

SATORI will allow for the review of the impact of airspace design on the flow of traffic through a facility's airspace. Currently, SATORI is simply an animation tool that re-creates the traffic flow through a sectors airspace. The development of a simulation routine to evaluate redefined airspace characteristics is currently under development. This software would allow for the modification of airspace, airways, navigation aids, etc., to review their effect on traffic flow. Calculation of measures of sector characteristics is also under development.

FUTURE DEVELOPMENTS

An automatic OE detection system was implemented in domestic ARTCCs in 1984. Under this system, an alarm is triggered whenever minimum separation standards are violated by radar-tracked aircraft. Although this system allowed for violations of separation standards to be more closely monitored, it did little to assist in determining why or how such

violations occurred. It is planned that SATORI will provide a means for determining the particular system component that failed. The identification of tasks that consistently cause problems for controllers would be candidates deserving consideration for automation or the development of automated aids. Instead of attempting to automate all tasks, it would be better to automate only those that have the potential to give controllers problems. Research has demonstrated that humans are not well suited for passive monitoring of system performance. Performance typically improves when they are actively involved in the control of the situation. The optimal level of automation in air traffic control is yet to be determined, and the potential for over-automation should not be discounted (Endsley, 1992). The effect of automation on ATCS situational awareness deserves greater attention.

Additionally, a development is underway to attempt to utilize Continuous Data Recording (CDR) data from the TRACON environment to provide a SATORI tool for those facilities. Similar data to those available from En Route facilities are recorded at TRACON facilities and should allow for the development of a re-creation tool much like the one discussed in this report.

The development of software to allow for the assessment of performance and taskloading is currently underway. Most of the required algorithms for the various measures have been derived and are currently being converted to source code. This development will be discussed in detail in a report in preparation (Rodgers and Manning, 1993).

Once SATORI is developed and evaluated, it will be possible to accomplish the goals of evaluating system designs, over-the-shoulder appraisals, training outcomes, and measuring controller performance. Not only will the capabilities and features of SATORI provide those interested in air traffic with a valuable tool for assessing the dynamics of the air traffic situation, but additionally, and more importantly, the Agency will be in a better position to bring about effective change in future ATC systems.

REFERENCES

Endsley, M. R., (1992). *Situation Awareness: A fundamental factor underlying the successful implementation of AI in the air traffic control system.* NASA/FAA Workshop on Artificial Intelligence and Human Factors in Air Traffic Control and Aviation Maintenance. Daytona Beach, FL., June.

Federal Aviation Administration. (1991). *Air Traffic Control (FAA Order 7110.65G).* Washington, DC: U.S. Department of Transportation.

Rodgers, M. D. & Manning, C. A. (1993). *Performance and taskload measurement of En Route air traffic control specialist* (in preparation).Washington, DC: Federal Aviation Administration, Office of Aviation Medicine.

Rodgers, M. D. (1993). *Relationship between En Route air traffic control specialist job tasks and causal factor categories of the current operational error reporting system: A Reference Guide* (in preparation). Washington, DC: Federal Aviation Administration, Office of Aviation Medicine.

Rodgers, M. D. & Drechsler, G. K., (1993). *Conversion of the CTA Incorporated job tasks database into a formal sentence outline.* DOT/FAA/AM 93/1. Washington, DC: Federal Aviation Administration, Office of Aviation Medicine.

APPENDIX A. SATORI GLOSSARY

ACES (Adaptation Control Environmental System) - A database used to generate the various map configurations displayed on the PVD.

AIRWAY - A control area or portion thereof established in the form of a corridor, the centerline of which is defined by radio navigational aids.

ALGORITHM - A set of instructions that solve a mathematical problem.

ALTITUDE FILTER KEYS - Eight display filter keys, which cause a target symbol to be displayed for all Mode C aircraft within the selected area.

ANSI C - A version of the C programming language that was standardized by an American National Standards Institute (ANSI) committee to eliminate variations that could cause problems in transporting a program from one type of computer system or environment to another.

ARTCC (Air Route Traffic Control Center) - A facility established to provide air traffic control service to aircraft operating on IFR flight plans within controlled airspace and principally during the en route phase of flight.

ATC (Air Traffic Control) - A service operated by appropriate authority to promote the safe, orderly and expeditious flow of air traffic.

ATCS (Air Traffic Control Specialist) - A person authorized by the FAA to provide air traffic control service.

BEACON TARGET - A computer-generated indication shown on a radar display resulting from a radar beacon reply.

CAMI (Civil Aeromedical Institute) - The aeromedical research, education, certification, and occupational health wing of FAA's Office of Aviation Medicine located at the Mike Monroney Aeronautical Center in Oklahoma City, Oklahoma.

CDR (Continuous Data Recording) - A service within NAS that provides a means of data transfer from memory to magnetic tape in which recordings are initiated by specific requests placed within the ATC subprograms. This program is available at TRACON facilities to collect and analyze air traffic statistics and maintenance statistics, and to produce detailed ATC operational information for use in proceedings and investigations.

CRD (Continuous Readout Update Display) - A cathode ray tube (CRT) measuring approximately five inches wide by eight inches high used by air traffic controllers. The functions of the CRD are to communicate computer-updated data to the sector; to output error, rejection, and acceptance messages; and to display data in response to controller request.

DART (Data Analysis and Reduction Tool) - A tool that reduces SAR tapes, generates reports, analyzes data reduced, and compares data with the data previously reduced. DART contains a general print program with a number of output operations available that are exercised by a programmer coded table. This table controls the use of the operations and the conversion of the compressed data on the tape to the normal printed format.

DATA BLOCKS - Letters and numerals used to show identification, altitude, beacon code, and other information concerning a target on a radar display.

DYSIM (Dynamic Simulation) - A piece of equipment developed by the FAA Technical Center in which a simulation of an En Route operational error can be built by hand entry of each piece of data and its associated track.

FAA (Federal Aviation Administration) - A component of the Department of Transportation responsible for air navigation and air traffic control; certification, regulation and compliance of aircraft and people working in the aviation field; aviation security; and aviation-related research and development programs.

FAA TECHNICAL CENTER - An aviation laboratory located in Atlantic City, New Jersey, where test and evaluation activities are conducted in support of FAA research and development programs.

FLIGHT PROGRESS STRIPS - used to post current data on air traffic and clearances required for control and other air traffic control services.

GIGABYTE - One billion bytes, or units of information consisting of a single character.

GMLMAP - ACES file that contains the logical map records of data required to build sector maps.

HOST COMPUTER SYSTEM - A computer system that utilizes IBM computer equipment at all ARTCCs in the continental United States for flight data posting.

IFR (Instrument Flight Rules) - Rules governing the procedures for conducting instrument flight.

IRIG (Inter-Range Instrument Group) - Timing signals recorded on an adjacent channel to audio data as reference pulses consisting of amplitude-modulated time codes. The FAA-modified IRIG-E uses a 600 Hz. carrier signal.

LEADER LINE - An element of a data block that connects the alphanumeric data to the associated position symbol.

LOG FILE - A listing of all input and output messages recorded on the SAR tapes that provide an evaluation of tests performed against the NAS program during development and provide an historical record of events occurring during an operational period.

MAGNETO-OPTICAL CD - An erasable or semi-erasable storage disc of very high capacity, in which a laser beam is used to heat the recording surface to a point at which tiny regions on the surface can be magnetically aligned to store bits of data.

MOA (Military Operations Area) - An airspace assignment of defined vertical and lateral dimensions established outside positive control areas to separate/segregate certain military activities from IFR traffic and to identify for VFR traffic where these activities are conducted.

MOTIF - A graphical user interface that was designed to work identically on a wide variety of platforms. MOTIF is the recommended graphical user interface for OSF.

NAS (National Airspace System) - The common network of U.S. airspace; air navigation facilities, equipment and services, airports of landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information, and manpower and material. Included are system components shared jointly with the military.

NASP (National Airspace System Program) - Software that processes and allows for the review of NAS data.

NAVAID (Navigational Aid) - Any visual or electronic device airborne or on the surface that provides point-to-point guidance information or position data to aircraft in flight.

NTAP (National Track Analysis Program) - A program that provides a reduction to the system analysis recording tape, which allows for a more detailed software program analysis of the NAS En Route automation program for track and radar target data.

OE (Operational Error) - A situation in which an air traffic controller allows less than applicable minimum separation criteria between aircraft or between aircraft and an obstruction.

OpenVMS - The new name for the VMS software that runs on Digital's VAX processors. VMS is a general-purpose multiuser operating system that supports VAX series computers in both development and production environments.

OSF (Open Systems Foundation) - A system that implements common specifications to allow properly developed software to run and interact with other applications with the widest possible range of portability to the largest number of platforms.

POSIX (Portable Operating System Interface) - A VMS-supported environment that includes support for the standards and draft standards for the system application programming interface, shell and utilities, and real-time programming. POSIX is the operating system recommended for use with OSF.

PVD (Plan View Display) - A cathode ray tube that accepts digitized video from the display channel. Alphanumeric and radar data are selected, formatted, and transmitted for display on the plan view display.

QA (Quality Assurance) - A service that provides evaluation, advice, coordination and recommendation of changes to assure that quality service is provided by the facility.

RAM (Random Access Memory) - Semiconductor-based memory that can be read and written by the microprocessor or other hardware devices.

RANGE - The distance, measured in nautical miles, from the center of the PVD to the edge of the radar display. The controller may select any of 14 settings, from 6 to 400 nautical miles, without affecting other controller positions.

SAR (System Analysis Recording) - A service within NAS that provides a means of data transfer from memory to magnetic tape in which recordings are initiated by specific requests placed within the ATC subprograms. This program is available at En Route facilities to collect and analyze air traffic statistics and maintenance statistics, and to produce detailed ATC operational information for use in proceedings and investigations.

SATORI (Situation Assessment Through Re-creation of Incidents) -A system that allows for the re-creation of any sector of En Route airspace for any period of time.

SECTOR MAP - Displays of airways, maps, and single symbols, as locally adapted. Mapping information is displayed by selecting display filter keys.

SECTOR BOUNDARY - Displays of sector and center boundaries. Sector boundary information is displayed by selecting display filter keys.

SOURCE CODE - Human-readable program statements written in a high-level or assembly language.

TCD (Time Code Display) - A digital display of the IRIG FAA modified E time code.

TCP/IP (Transport Control Protocol/Interface Program) - A software protocol developed by the Department of Defense for communications between computers.

TRACK FILE - A function of DART that provides a method of reducing the track data base of a NAS operational system run and correlating it with the flight plan data base by outputting a time-ordered listing of track data base information sorted by aircraft.

TRACON (Terminal Radar Approach Control) - A terminal ATC facility that uses radar and nonradar capabilities to provide approach control services to aircraft arriving, departing, or transiting airspace controlled by the facility.

VECTOR VELOCITY LINE - The velocity vector line is in proportion to the aircraft speed to the nearest 15 knots. The controller may vary the length of the vector line for all data blocks by a switch setting. Displays of 0, 1, 2, 4, or 8 minutes of flying time are shown for all data blocks.

X-WINDOWS - A graphics system in which programs with graphical interfaces running on different hosts can be controlled from a single station. X-Windows is the graphics system recommended for use with OSF.

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