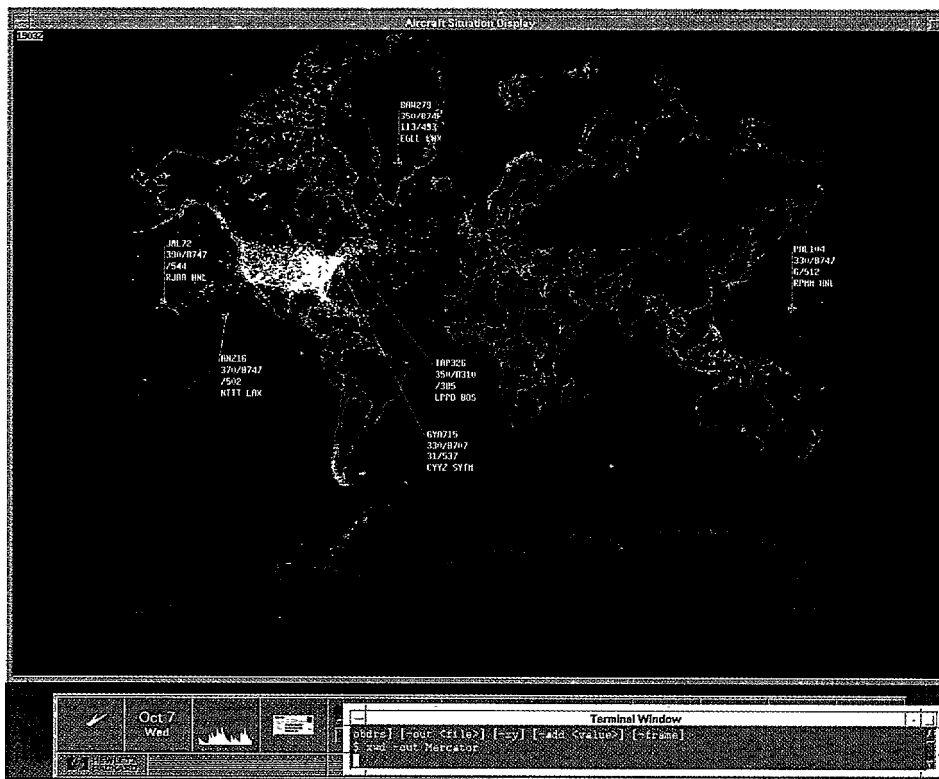# CASE HISTORY

Distributed, Real-time System Controls U.S Air Traffic Flow

In this world view, the Volpe Center ETMS provides data on flights that originated in the United States

Using an application developed by the Volpe National Transportation Systems Center, air traffic controllers regulate the flow of aircraft into and out of airports throughout the continental United States, balancing efficiency and safety.

As a dense fog lifts, an air traffic controller at the New York Air Route Traffic Control Center looks out at 42 aircraft waiting to take off for destinations from Portland, Maine, to Portland, Oregon, as well as to many international locations.

Consulting a color-coded map on the screen of a workstation, he learns that severe thunderstorms threaten Chicago while the fog in Boston is lifting. After requesting additional data, he discovers

that flights out of Chicago are being delayed and those coming out of Boston are almost two hours behind schedule. Integrating this data witk similar information on air traffic around the country, he can work with other air traffic controllers to pace the departures of the flights leaving the major New York airports and minimize delays at their destinations.

Before this system was installed, air traffic controllers used computers to monitor local flight conditions but lacked ready access to information on traffic beyond the range of their radar. Advances in computing and communications technology have expanded their horizons.

A technology case from OSF

THE ENHANCED TRAFFIC MANAGEMENT SYSTEM

Today, via networked computer workstations, air traffic controllers easily access data on traffic and flying conditions over, into, and out of the U.S. air space using the Enhanced Traffic Management System (ETMS). Developed by the Volpe National Transportation

and terrestrial links nationwide. Using the ETMS, controllers are expected to save billions of dollars over the next decade. Those savings will benefit commercial airlines, passengers, and the U.S. government, which employs the air traffic controllers.

Every day, 30,000 commercial and military flights carrying 1.5 million
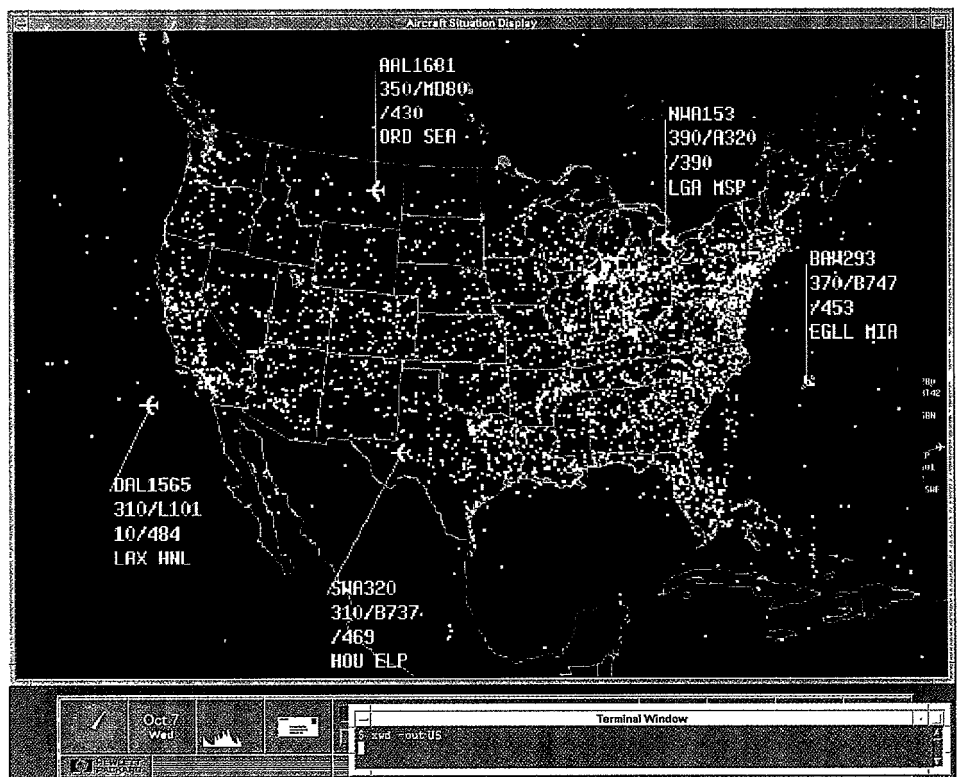
This ETMS screen like all the images shown in this case study. presents data through the OSF/Motif graphical user interface The white dots mark the position of all the flights being monitored

Systems Center for the U.S. Federal Aviation Administration (FAA), the ETMS compiles real-time flight and weather data and presents it in an easy-to-understand format, alerting controllers of areas where congestion is likely to occur. This real-time data is updated at least every five minutes over satellite

people are safely led through U.S. airspace. During peak travel times, as many as 4000 aircraft may be airborne simultaneously, creating a logistical challenge for the air traffic controllers who must choreograph their takeoffs and landings. Considering the cost of operating large aircraft — as much as $12,000

per hour — a one-hour delay of 100 aircraft, not atypical at a major airport such as Chicago's O'Hare, could cost more than one million dollars. The goal of the ETMS is to minimize such delays and significantly cut air transportation costs.

Since the ETMS was first deployed, in 1987, air travelers have experienced fewer and shorter delays over airports. The system was installed initially at Los Angeles International Airport to handle traffic flow while a runway was repaired. The FAA's objective was to compensate for the temporary loss of one runway and allow for more efficient use of those still in operation. The system exceeded expectations and actually increased capacity, because it allowed controllers to evaluate the situation in advance.

Viewing the Aircraft Situation Display, air traffic controllers can sort information selectively, checking the incoming flights to a particular airport. For more detailed data, they also can zoom in on selected areas and see boundaries, routes, and navigational aids. In addition, the system allows controllers to focus on a particular flight, calling up information on its origin and destination, aircraft type, altitude, flight number, estimated time of arrival, and speed.

To help controllers foresee — and possibly prevent — problems, the system predicts the flow of air traffic up to eight hours in advance. ETMS also suggests possible solutions for resolving congestion problems and avoiding delays, allowing controllers to consider several options. And it provides

weather information — data on precipitation, recent lightning strikes, and the velocity and location of the jet stream.

DISTRIBUTED COMPUTING PROVIDES EFFICIENCY RELIABILITY

The ETMS employs distributed computing technology, which allocates processing tasks to different computers on a network, and makes significant dollar savings possible. It allows processing that would have been done on expensive mainframe computers to be distributed over much less costly workstations. Additionally, the distributed architecture permits redundancy, so that a processing failure by any one of the workstations in the network causes no interruption of the information flow. Automatic detection and replacement of failed processors is built into the ETMS, to ensure a highly reliable system.

The ETMS was begun as a research program in the mid 1980s to test the concept of viewing live data representing all nationwide flights. The ETMS application has grown to approximately three-quarters of a million lines of Pascal code and operates on hundreds of networked workstations nationally. The research program and resulting operational system have been extremely successful. The FAA continues to add functional requirements for expanding the ETMS.

TRANSITION TO AN OPEN SYSTEMS ENVIRONMENT

The Volpe Center is preparing a major transition of the ETMS from the proprietary application language and platform software to an open, standards-based software

The Open Software Foundation is a not-for-profit research and development organization whose goal is to provide a software solution that enables computers from multiple vendors to work together in an open systems computing environment. OSF uses an innovative open process for selecting and implementing technology.
Headquartered in Cambridge, Massachusetts, OSF has 350 members. To learn more about OSF, call OSF Direct at (617) 621-7300.

MORE ON OSF TECHNOLOGIES
The OSF/1 operating system is adaptable to mainframes, super-computers, and PCs, permitting all those computers to work well with other OSF technologies. OSF/1 is compatible with the most widely used systems and supports all relevant industry standards. A wide variety of features, such as fully kernel-supported symmetric multi-processing, enhanced security, and dynamic system configuration, complete the picture.

OSF/Motif provides a consistent interface between users and machines in a heterogeneous computing environment. The OSF/Motif graphical user interface can be ported to platforms from different vendors, so that users need learn only one set of commands to operate any computer in the network. In addition, OSF/Motif is standards-compliant and enhanced for internationalization.

The OSF Distributed Computing Environment (DCE) allows diverse systems to work together cooperatively — to interoperate. In this way, it lets users retrieve information easily — regardless of where it is stored in a network — and distribute it to wherever it is needed. This integrated software environment makes a network of systems from a variety of vendors appear as a consistent, unified system. By masking the technical complexities of the network, the DCE gives users transparent access to diverse network resources — such as files, printers, and computer power. DCE thus gives users access to information and applications anywhere in the network while protecting data from unauthorized access.

The OSF Distributed Management Environment (DME) software provides a unified approach for managing systems, networks, and user applications in heterogeneous computing environments. Its purpose is to make system and network management more efficient and cost effective. OSF is currently integrating several technologies to form a DME framework that supports the management of systems resources as well as the development of applications for distributed systems management.

Open Software Foundation/North America
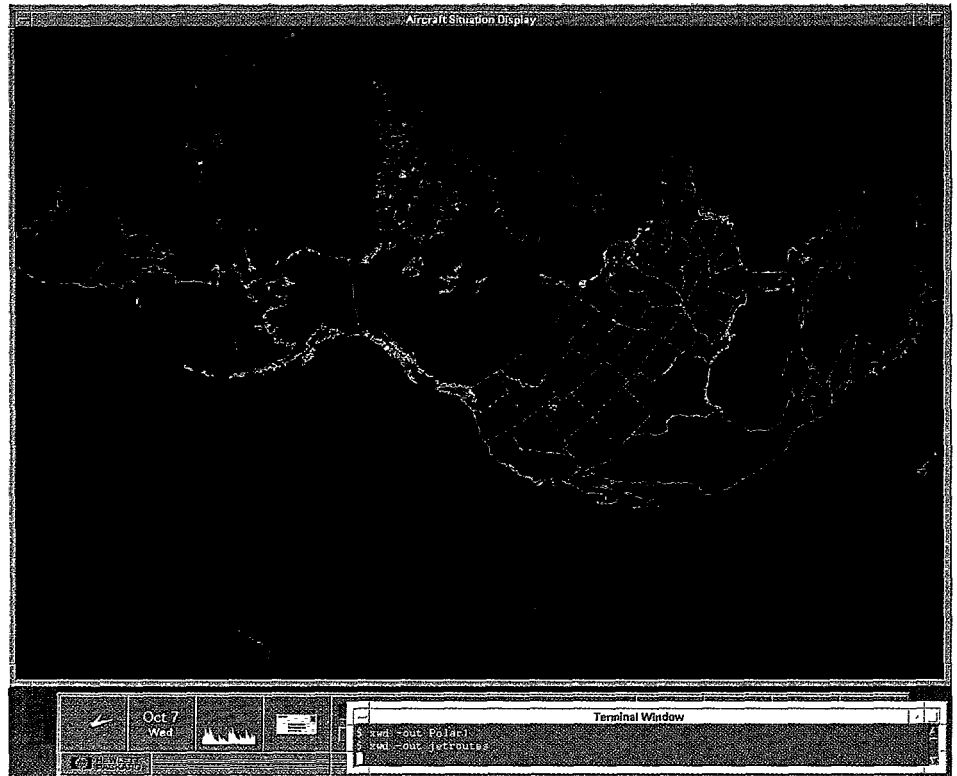11 Cambridge Center
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OSF

In this ETMS screen image, the U.S. jet routes are highlighted in red

MORE OS THE VOLPE CENTER
AND THE OPEN SOFTWARE
FOUNDATION

The Volpe National Transportation
Systems Center, in Cambridge,
Massachusetts, is a research and
development facility of the U.S.
Department of Transportation.

The Volpe Center has been an active
member of OSF since 1991, serving
on the OSF End User Steering
Committee, an international group
of major computer users who work
together to influence and expedite
the delivery of open systems. In
addition, the Center participates in
several OSF Special Interest Groups,
including the DCE and OSF/l SIGs,
as well as the Standards Coordin-
ating Committee.

"The Volpe Center membership in
OSF allows us to track OSF tech-
nologies, which will provide a solid
foundation for our architecture.
We try to be as involved as we can
because we need to shape and
monitor the direction of open sys-
tems technologies," Chew explains.
'We need to be in a position where
we are able to take full advantage
of the marketplace. Our active role,
through SIGs and member meet-
ings as well as the End User
Steering Committee, also allows us
to interact with other end users
experiencing problems similar to
ours." To learn more about the
Volpe Center's development of
ETMS using open systems tech-
nologies, contact Robert Chew at
(617) 494-3637.

architecture. This transition will conform to the U.S. government procurement guidelines, which specify open system technology standards. This will lower system life-cycle costs through procurement of advanced technology products conforming to standards on a very competitive basis. It also will provide for interoperability among heterogeneous vendor products, portability of applications over different platforms, scalability of applications over a wide range of hardware configurations, faster application development and reusable code, and a more consistent user interface.

"This is where the OSF technologies come in," says Robert Chew, on-site consultant at the Volpe Center. "By transitioning to vendor products based on OSF offerings, we can take advantage of open systems for our ETMS application platform, and conform to the government standards."

Richard Wright, the Volpe Center's Chief, Automation Applications Division and one of the principal ETMS designers, points out that ETMS must take advantage of technology that will allow it to be used by commercial and defense systems as well as international organizations.

Currently the Center is testing and evaluating OSF technologies through different vendor products in its portability lab. Paul Alciere, the designer of the Aircraft Situation Display (ASD) graphics, is redesigning ASD using the OSF/Motif™ graphical user interface and object-oriented concepts, conforming to the OSF Application

Environment Specification, early vendor versions of OSF/1TM, and other operating systems. The entire ETMS application will be redesigned selectively and converted from the Pascal language to C++ and C.

In the future, the ETMS will run on the OSF/l operating system. This will "give us a large performance boost," says Wright. "OSF/l will allow our R&D environment to move ahead in an evolutionary way, using the system far more efficiently. The Mach kernel provides threads technology, which allows us to take better advantage of multiprocessing. UNIX@ is rather complicated and doesn't provide the real-time capability we need. OSF/1 is the next logical step for our real-time performance requirements."

Wright adds that the ETMS also will take advantage of the OSF Distributed Computing Environment (DCE) "for our database activities, interoperability, communication, security, file transfer capability-everything it has to offer. We also need the Distributed Management Environment (DME) to control our heterogeneous networked systems as we transition into the new, open environment. We are doing analysis and planning on how we can best transition to these OSF technologies."

Wright emphasizes that this transition must be carried out smoothly in an evolutionary way, so as not to disrupt FAA operations. Finally he adds, "the consequences of not transitioning to a new, open system is gradual degradation, and eventually, an insupportable proprietary platform for the critical ETMS operation."