P R O C E E D I N G S

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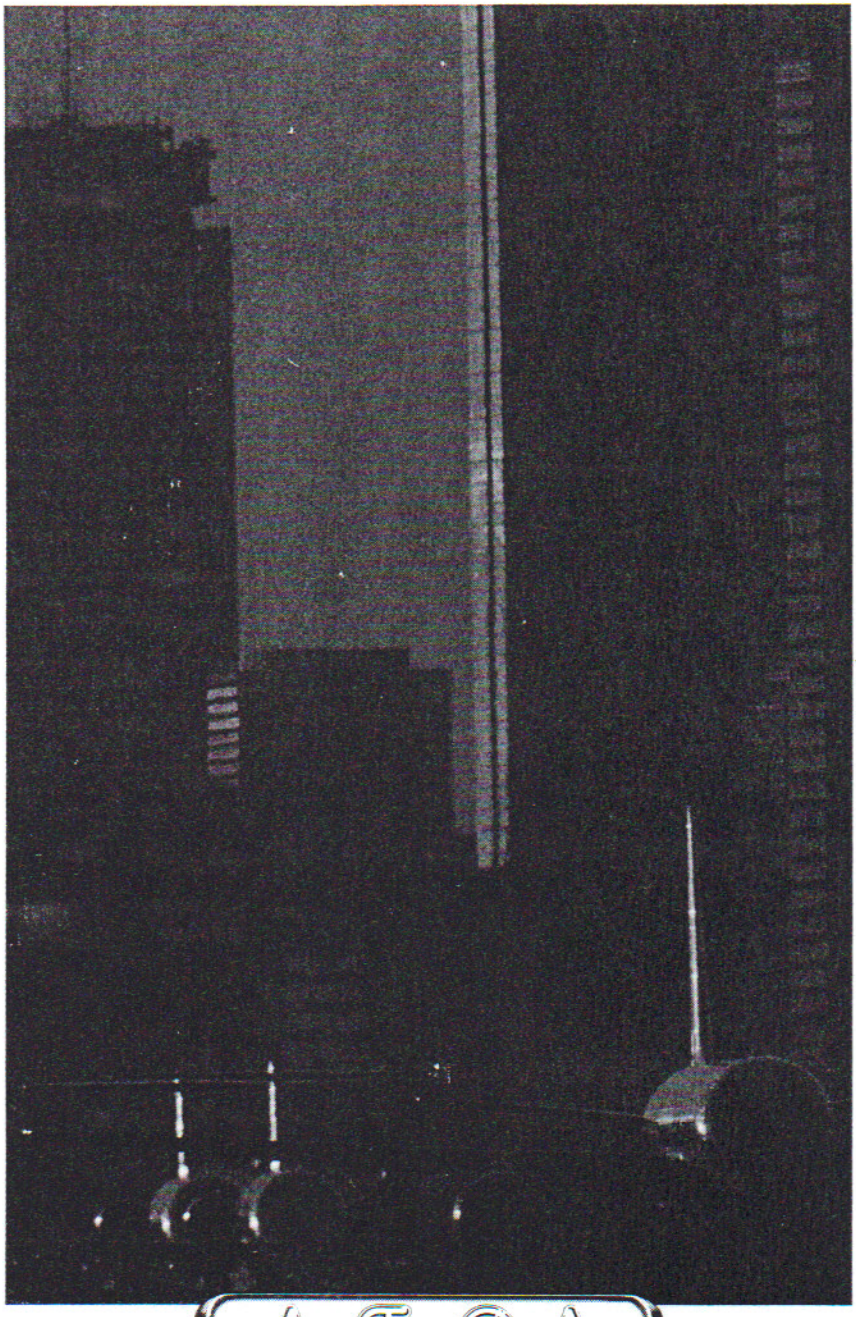

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THE POTENTIAL USE OF OVER-THE-HORIZON (OTH) SENSORS FOR OCEANIC AIR TRAFFIC CONTROL

Walter Sobkiw *
E-Systems, Inc., ECI Division
P.O. Box 12248
St. Petersburg, FL 33733

ABSTRACT

The Federal Aviation Administration (FAA) is in the process of improving Oceanic Air Traffic Control. This improvement will include the transfer of position information from Inertial Navigation Equipment and/or Global Positioning System (GPS) as part of the Automatic Dependent Surveillance (ADS) program. The USAF is currently establishing a new generation of Over-The-Horizon Backscatter (OTH-B) sensors. These Bi-static sensors will be integrated with the current Air Defense Network and the Advanced Interface Control Unit (AICU) program will be the vehicle to support this integration. E-Systems has been investigating this integration since 1988 and has recently established a lab to assess program risk and develop a workable approach for integrating the new OTH sensors into the existing air defense network. This lab includes the latest Reduced Instruction Set Computers (RISC) and rapid prototyping Man-Machine Interface (MMI) software. The OTH sensors are capable of providing oceanic coverage and are being considered for applications in Air Defense and Drug interdiction.

Potentially, these sensors could be used to augment the position data for oceanic air traffic control. The approach for integrating these new sensors into the air defense network could be applied to oceanic air traffic control with the result of improving ADS performance and providing better position information for non-ADS equipped aircraft.

This paper summarizes the capabilities of the OTH sensors, describes the lab established to support the integration of OTH into the existing air defense network, and provides an approach for integrating these sensors into ADS and the oceanic air traffic control system.

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OTH BACKGROUND

The FAA and the Air Force currently share Radar assets in the Continental U.S. The Joint Surveillance program was successful in the past, and as the current long range Radars are replaced, these new assets will continue to be shared between the FAA and the Air Force. The Air Force is in the process of implementing a new generation of sensors that will be capable of providing coverage for over 1 million square miles per sensor. These OTH-B sensors will be integrated shortly into the air defense network via the AICU program. The Navy is also planning to implement Relocatable OTH Radar (ROTHR) sensors and current plans call for the Air Force and Navy to share these sensor assets. The Air Force and Navy sensors will primarily be directed towards Oceanic Air Space (1), (2).

Figure 1 shows the approach for integrating the OTH sensors into the current Air Force command facilities. The OTH sensors receive the equivalent of target position information. Unlike most sensors, they perform significant processing on the target information that includes correlating the resulting tracks with flight plan information from the Air Movement Information System (AMIS).

Unknown track data are forwarded to one of several command centers that will contain an AICU workstation. This workstation will be manned, and it will support the forwarding of this track data to an existing co-located system. Track information from Navy ROTHR assets enter the system from one of several Navy command centers. The Air Force using the AICU will then have coverage from both ROTHR and OTH sites.

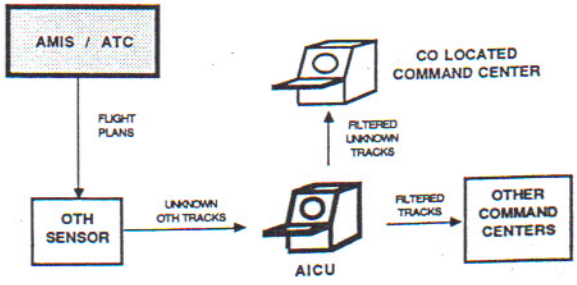

FIGURE 1. Advanced Interface Control Unit and OTH Sensor

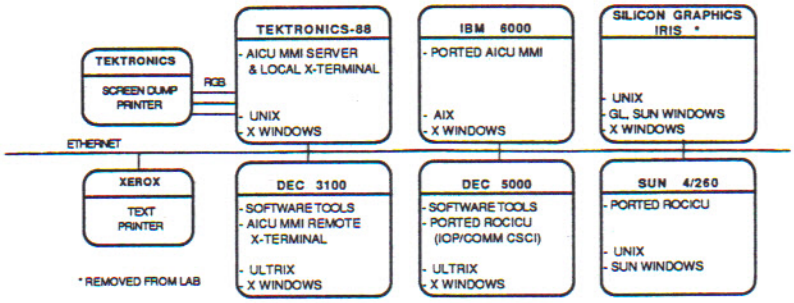

FIGURE 2. AICU Lab Configuration**

THE AICU LAB

The AICU is a follow-on program to an existing prototype program, the ROCC/SOCC/OTH-B CMAFB Interface Control Unit (ROCICU). The OTH sensors were interfaced to the command centers, and a limited message processing capability was provided as part of the ROCICU. Track processing, track display, and an efficient MMI were not provided. During operational evaluation of the AICU system, it became clear that a workstation with both track and message processing capabilities should be provided to effectively integrate the OTH sensors into the network. As part of pursuing the AICU program, a lab was established to verify this assumption and assess program risk.

Figure 2 identifies the lab established to support the AICU pursuit effort. This lab was preceded by traditional system analysis where an architectural concept was developed. From this analysis the lab was populated with current state-of-the-art RISC based workstations from several vendors. These workstations were provided to support separate activities in the lab and to support analysis for final vendor selection.

The SUN 4/260 was used to rehost the existing ROCICU software. This software was hosted previously on a SUN 3/150 and SUN 3/60. The prototype ROCICU had severe performance limitations; however, the software included functionality that could be used on the newer AICU solution. The Air Force is cognizant of this issue and made the ROCICU software Government Furnished Equipment (GFE). This GFE software can be used in a vendor's AICU total solution. After 3 weeks the ROCICU MMI and communications software was rehosted. A baseline was then available for operational evaluation of the ROCICU MMI. In addition, further analysis was performed on the existing ROCICU software, which included determining what pieces could be reused on the AICU program.

Simultaneously, E-Systems designed a new AICU MMI and implemented this MMI by using rapid prototyping software from Prior Data Sciences. The AICU MMI was hosted on the Tektronics XD/88. The goal was also to rehost the new AICU MMI on the Dec 5000 and IBM 6000. Partial rehost occurred on each machine. To show that rehosting of this software was possible, another MMI was rehosted on each machine, in less than a week.

TECHNOLOGY TRANSFER TO SUPPORT AICU

To support this entire effort, E-Systems transferred key elements from the following programs and customers:

Initial Tactical Warning & Assessment (ITW & A)
- In-house Air Force Program

ROCICU Prototype
- Outside Air Force Program

FAA Advanced Automation System (AAS)
- Outside FAA Program

The sources for various pieces of the current AICU concepts were from E-Systems in-house work, a current Prototype program with the Air Force and the FAA's Advanced Automation Program. The vehicles for identifying key items to transfer were varied. In the case of ITW & A, the transfer vehicles were people and in-house documentation. In the case of ROCICU, the transfer vehicles were documentation and customer visits. In the case of FAA AAS, the transfer vehicle was people.

The technology transfer process is shown in figure 3. The common console and transition concepts were the key elements to stabilizing the AICU and making it a viable program for the Air Force. The workstation technologies that are used on AAS were extremely helpful in surfacing issues related to the AICU MMI. For example, should a 20 x 20 inch display be provided as part of the AICU solution?

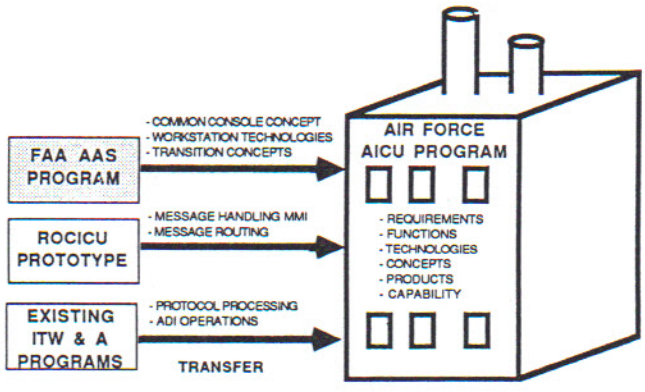

FIGURE 3. Technology Transfer to AICU

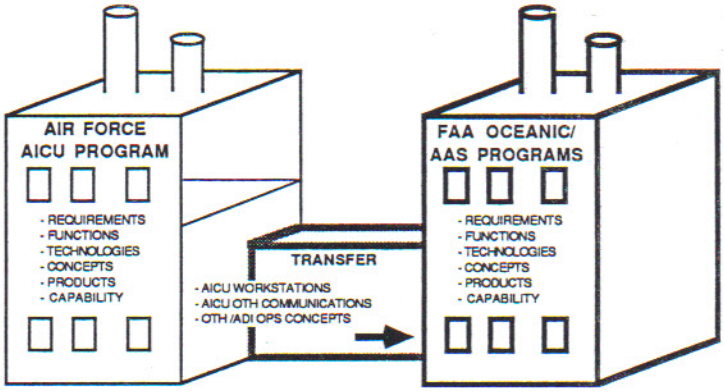

FIGURE 4. Technology Transfer to FAA

TECHNOLOGY TRANSFER TO SUPPORT FAA OCEANIC AIR TRAFFIC CONTROL

If technology transfer supported the development of the AICU program, could technology transfer support the FAA in providing better Oceanic Air Traffic Control services? The Air Force will fund the development of a workstation capable of receiving and displaying track data from an OTH sensor. The entire cost to the Air Force for six sites is currently estimated by E-Systems to be less than $10 million dollars.† This includes all the hardware and software to interface with OTH, interface with other commands, and display the situation data on a workstation. Reference figure 4 to see what can be transferred from the Air Force to the FAA.

OCEANIC AIR TRAFFIC CONTROL

It should be noted that OTH alone probably cannot replace existing systems nor can it provide for the kind of effective oceanic surveillance required by the FAA.

There are a number of reasons for this. The primary reason is that the OTH is an extremely flexible sensor and its coverage can be modified. Moreover, the primary mission of the OTH sensors will be to support Air Defense activity. Therefore, the FAA cannot control the quality of coverage that it would expect from the sensor as other command centers put in higher priority requests.

The second reason is related to the technology of the sensor, which is based on high frequency transmission (5 MHz - 28 MHz). These frequencies are susceptible to solar disturbances where sun spot activity can make the sensor "ineffective".

The OTH sensors, however could augment the Oceanic Air Traffic Control (ATC) Systems. The OTH sites could interface with an ACF responsible for oceanic ATC and transmit known correlated track data to a workstation developed as part of the ATC solution. In addition, the "workstation" could be easily upgraded to interface to the ODAPS series 1 computers and OTH track data could be provided to reinforce existing or future processing (ADS) and improve Oceanic ATC. A potential approach for integrating OTH sensors into the Civil ATC system is shown in figure 5. There are two issues associated with integrating OTH into the civil ATC system:

The first is related to how the OTH sensor effectively can pass only the commercial aircraft to the ACF and ensure that classified data does not emerge from the interface.

The second is related to how effective will the oceanic air traffic control be if these sensors are integrated into the FAA ATC system.

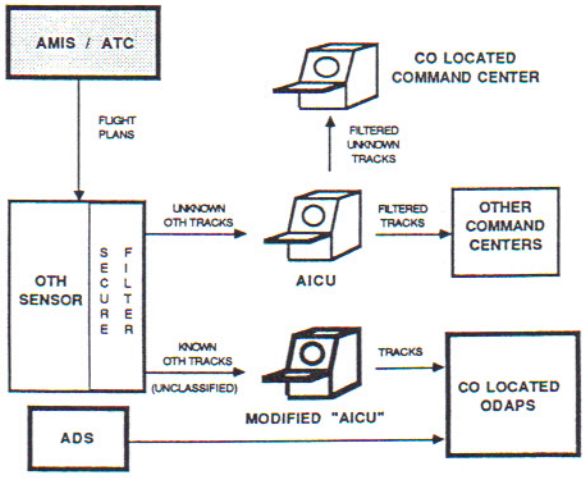

FIGURE 5. OTH Reinforced Oceanic ATC

OBSERVATIONS / CONCLUSIONS

What was illustrated by the AICU lab experience was how far hardware and software technology progressed in recent years. For approximately $20,000, a RISC based workstation can be purchased with 16 Mbytes of memory, 620 Mbytes of disk, a 19" color monitor, and a RISC processor that runs from 15-22 MIPS.

This cost is probably not far from the cost of a typewriter in the 1950's once adjusted for inflation. However, using UNIX, X-Windows, and a prototyping package, a quick and dirty MMI can be implemented in less than one month that rivals the current PVD MMI. Given the power and cost of some of todays technology, it might be more prudent to just try out new ideas, such as integrating OTH into the ATC system, than analyzing whether it would be possible or practical from an operational, cost, or technological point of view.

More importantly, these powerful new technologies are not fully appreciated until someone tries to automate a piece of a process. Making these technologies available to people who have to perform the jobs may result in new and innovative ways of performing the same job, applying the new technology. The cost of providing a "modified AICU" to the FAA may be insignificant once the people involved in oceanic ATC examine if it fits in with ADS and other current oceanic automation processing.

NOTES

** The following trademarks pertain to figure 2:

Ada is a registered trademark of U.S. Government Joint Ada Program Office.

IBM 6000 is a product of IBM Corporation.

Tektronics -88 is a product of the Tektronics Corporation.

Silicon Graphics Iris is a product of the Silicon Graphics Corporation.

DEC 3100 and 5000 are products of the Digital Equipment Corporation.

Sun 4/260 is a product of Sun Microsystems, Inc.

Xerox is a product of the Xerox Corporation.

UNIX is a product of the AT&T Corporation.

† Estimated in the Air Defense Connectivity Study 1989 Lawrence Livermore National Laboratory for Headquarters Tactical Air Command.

REFERENCES

(1) "Navy Installs ROTHR System in Alaska to Protect Battle Groups in Pacific," Aviation Week, pp. 69 - 75, 27 November 1989.

(2) "Virginia ROTHR System Covers Caribbean Drug Smuggling Routes," Aviation Week, pp. 76 - 80, 27 November 1989.

(3) "NOTIP in Retrospect." Journal of ATC, pp. 25 - 27, April - June 1990.

(4) "Offshore Flight Data Processing System Overview," Journal of ATC, pp. 28 - 30, April - June 1990.

(5) "The Use of Satellites in the Provision of Air Traffic Services," Journal of ATC, pp. 31 - 35, April - June 1990.