EXPANSION

OF

KIMPO AIR TRAFFIC CONTROL SYSTEM

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1. FOREWORD

This paper will acquaint the reader with the capabilities of the automated ATC System located at the Kimpo International Airport and proposes a logical, cost effective, system expansion plan to enhance this system so that it can accommodate future operational requirements. The plan presents system expansion taking into account the projected growth in air traffic at the Kimpo International Airport and provides for control of traffic at the new Seoul International Airport.

2. AIR TRAFFIC CONTROL DEVELOPMENT

With the projected growth in air traffic at both Kimpo, and planned Seoul International airports, considerable thought must be given to the ability of the air traffic control system to maintain the present safety standards. Needs of the air traffic controller must be considered since the controller has the ultimate responsibility for ensuring the safe and orderly flow of traffic in the terminal control area.

In initiating the Kimpo Airport Improvement Project, which will be operational in 1980, the Ministry of Transport of the Republic of Korea has taken a significant step towards meeting the needs outlined above. This project involved a major upgrade in aircraft facilities, passenger handling facilities, airfield improvements, and installation of a modern automated air traffic control system.

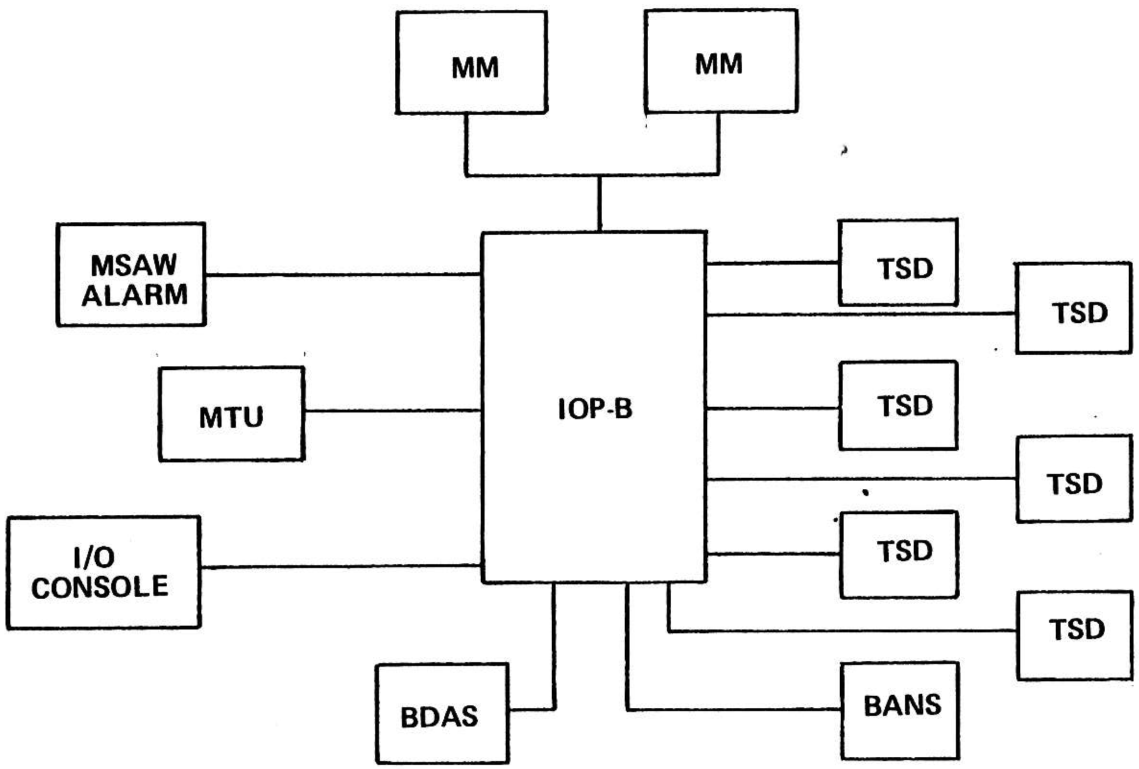
This new automated air traffic control system (Figure 1) is similar to the system used initially by the United States Federal Aviation Administration at all major airports throughout the United States. Principle functions performed by the new Kimpo Automated Systems are:

- o Tracking of all transponder equipped aircraft.
- o Alerting controllers to low flying Mode C equipped aircraft.
- o Providing identification and calculated ground speed on all transponder equipped aircraft. For Mode C aircraft, altitude information is also provided.
- o Automatic initiation of tracking for all aircraft which have filed flight plans.

Initially this system will accommodate the present traffic within the Kimpo terminal control area. Howerver, projected growth in Kimpo traffic plus creation of a new airport creates a need for planned expansion of ATC facilities. The following paragraphs outline a plan for adding various functions and capabilities to the Kimpo Automated ATC System which can facilitate safe and orderly traffic flow as the number of operations increases.

3. PLANNED EXPANSION

The evolution of air traffic clearly indicates that growth will continue and subsequently increase the demands placed on the present Kimpo Air Traffic Control system. Using, as a baseline, the new Kimpo Automated Air Traffic



LEGEND:

IOP-B	INPUT OUTPUT PROCESSOR
MM	MEMORY MODULE
MSAW	MINIMUM SAFE ALTITUDE WARNING
MTU	MAGNETIC TAPE UNIT
I/O	INPUT/OUTPUT
BDAS	BEACON DATA ACQUISITION SYSTEM
BANS	BRITE ALPHANUMERIC SYSTEM
TSD	TIME SHARE DISPLAY

Figure 1. Kimpo International Airport Data Processing and Display System

Control system. Principle functions which would be added under this Kimpo enhancement Project are:

1. Conflict Alert
2. Primary Radar Tracking
3. Automatic Failure Detection, Reconfiguration and Recovery
4. Data Extraction and Reduction
5. Support Functions
6. Remote Sensor/Display

The above functions are described more fully in paragraph 4. The expanded Kimpo system block diagram, which will provide functions 1 through 5 above, is shown in Figure 2. The expanded system block diagram to facilitate control of traffic at the new planned Seoul International Airport, step 6 above, is shown in Figure 3. Data sheets describes the characteristics of the new hardware items not in the present Kimpo system, are provided in the Appendix.

4. ADDITIONAL SYSTEM FUNCTIONS

4.1 Conflict Alert

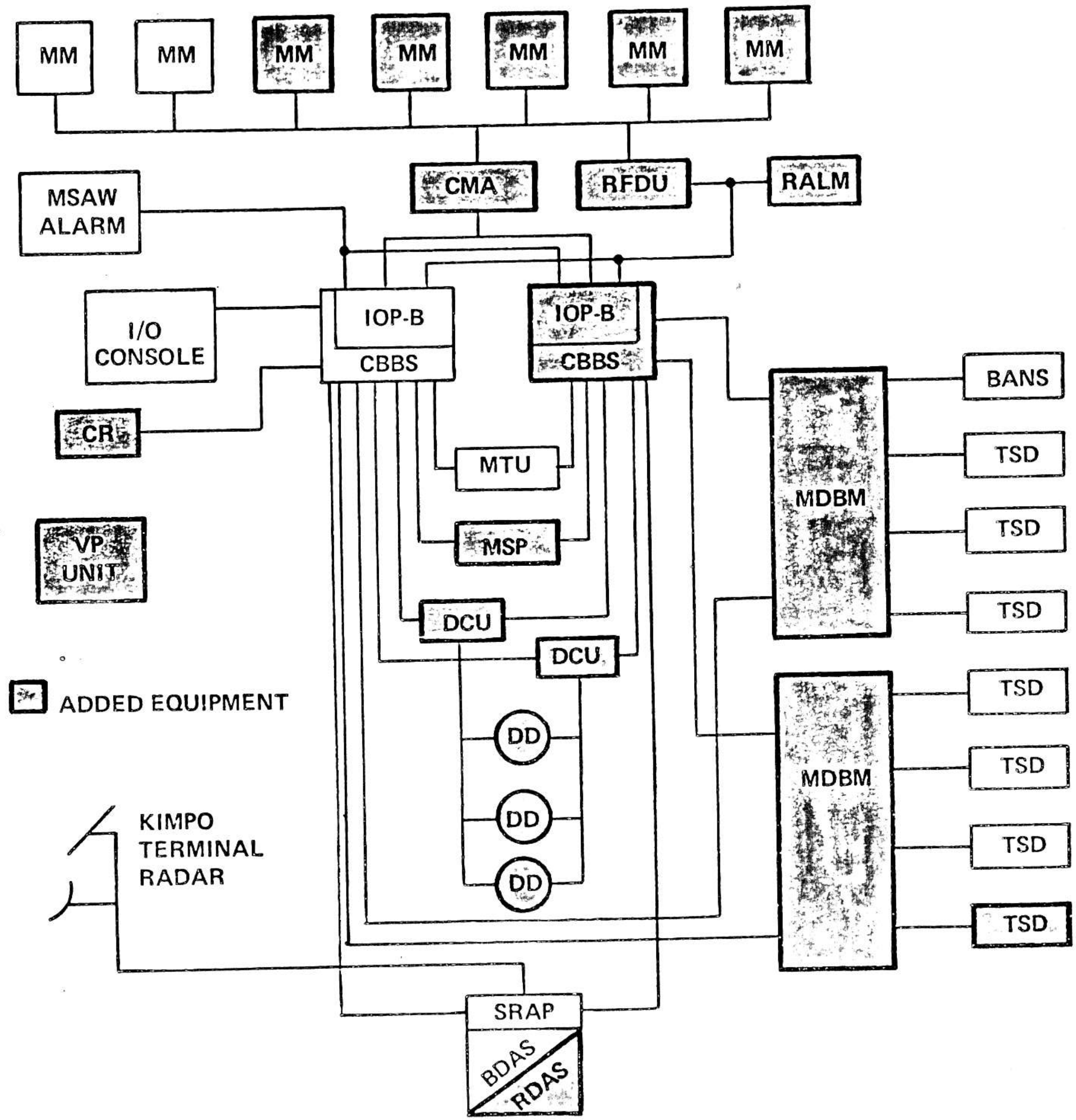
This feature alerts controllers when altitude reporting aircraft are on coverging courses which may lead to a violation of radar separation standards. Using position and Mode C altitude data, the Conflict Alert Software calculates the projected flight paths of controlled aircraft. If a potential conflict is detected, the system provides both a visual and audible alarm to alert the air traffic controller of this possible hazard. The alert allows the controller time to analyze the situation and issue any instructions necessary to ensure the safety of the involved aircraft. Conflict Alert is an automated function which can assist the air traffic controller in performing his job. Experienced controllers will normally recognize potential conflicts before they fully develop and issue necessary advisories accordingly. As such the automated Conflict Alert function is intended as a backup tool for controllers!

4.2 Primary Radar Tracking

Primary radar tracking permits the alphanumeric display of all aircraft flying within the terminal control area. This feature enables the sector air traffic controller to see symbolic positional information and associated alphanumeric data, if desired, on non-transponder equipped aircraft. Radar tracking also helps to ensure track continuity if secondary surveillance radar contact is lost such as may occur during aircraft maneuvers. Therefore, primary radar tracking will minimize COASTING of targets which occurs in the present Kimpo system if secondary surveillance radar contact is lost. Furthermore, implementation of primary radar tracking increases the accuracy of target position, by correlating the secondary radar returns with the primary radar return.

4.3 Data Extraction and Reduction

This feature provides the means of recording operational system data and for reduction and subsequent analysis. The Data Extraction and Reduction capability is being installed at all United States Federal Aviation Administration



LEGEND

CMA	CENTRAL MEMORY ACCESS
RFDU	RECONFIGURATION FAULT DETECTION UNIT
RALM	RECOVERY ALARM
MDBM	MULTIPLEXED DISPLAY BUFFER MEMORY
MSP	MEDIUM SPEED PRINTER
CR	CARD READER
RDAS	RADAR DATA ACQUISITION SYSTEM
SRAP	SENSOR RECEIVER AND PROCESSOR
DCU	DISK CONTROL UNIT
DD	DISK DRIVE
CBBS	CHANNEL BACK TO BACK SWITCH
VP	VARIFYING PUNCH

Figure 2. Single Radar Beacon Tracking Level ARTS IIIA System

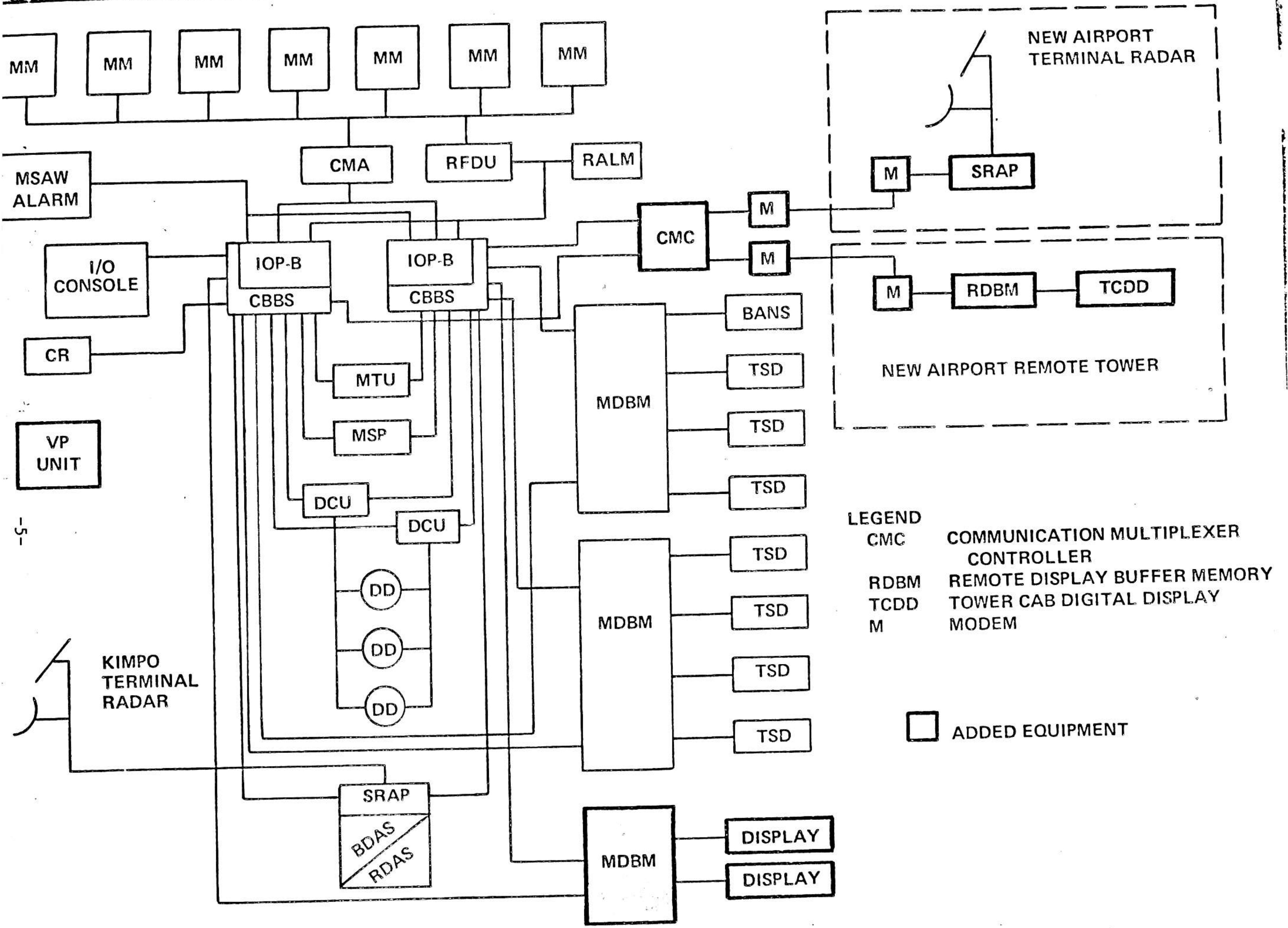


Figure 3. Dual Radar Beacon Tracking Level ARTS IIIA System

ARTS III facilities. The advantage of this capability are many as it provides a means of:

- o Supplementing voice recording when analyzing flight incidents.
- o Keeping records of day-to-day traffic status.
- o Testing results of changing various system parameters.
- o Aiding in the evaluation program changes as the pertain to system performance.

The·data recording is a logical enhancement in an automated air control environment. During air traffic control operations, a great deal of information is exchanged between the controller and the pilot. This direct exchange in turn is supplemented by data inputs, such as target reports, tabular flight plan information, keyboard entries and other kinds of automated information generated by the computer in reference to aircraft. The data extraction program is integrated into the operational program and continuously records the system data with a time reference as it occurs. This recorded data can subsequently be reduced to printed form using "filters" to entract selected information.

4.4 Automatic Failure Detection, Reconfiguration and Recovery

Failures in the data processing system are detected by hardware and software monitoring of power, parity errors, memory lockout violations, processor time-out, and illogical conditions. When a failure is detected, an interrupt is generated which stops the operational program and initiates the recovery sequence. During the recovery sequence failed modules are identified and automatically partitioned from the operational system. The failed modules can than be repaired using diagnostic routines without interfacing with the operational system.

The automatic recovery sequence is based on fail-safe/fail-soft philosophy. In a fail-safe recovery mode redundant hardware modules are automatically switched-in to replace the failed modules, thus total system capability may be maintained. In a fail-soft recovery mode system performance is degraded in a predetermined manner corresponding to the magnitude of the failure by loading the highest level operational program that can operate with the remaining system modules.

During normal operation, the system periodically records critical operating data, which if a failure occurs, will allow a return to normal operation in a minimum time. In the event of a failure, the recovery logic automatically determines the operable computer resources, configures system program accordingly, retrieves the critical operating data, and in an orderly manning restores operation of the system. The failure recovery interval, excluding primary power interruptions, is typically ten seconds or less.

The fail-safe/fail-soft feature has been implemented in a number of air traffic control facilities throughout the United States and is of proven design. Implementation of this feature will minimize system operational interruptions. Considering that the present, Kimpo, system does not contain this capability, minutes or even hours of lost system operation may be encountered while emergency maintenance on the system is being performed. As air traffic is expected to increase, safety must be considered. Prolonged system outages would represent a potential safety hazzard.

4.5 Support Functions

Support functions will be provided with the expanded system that are not currently available in the existing system. These support functions will permit controller training, software maintenance and hardware maintenance to be performed concurrent with normal system operation. In some cases these functions are available as on-call programs which can operate under control of the operational program executive. Off-line programs will require partitioning of the system to eliminate conflict with the operational program.

4.5.1 Controller Training

Continued increase in traffic will necessitate a proportionate increase in controllers. To reduce the time required to train new controllers, the system provides a training simulation capability. This function allows the designation of two or more display console positions as training positions while remaining display positions are being used to control live traffic. Using the function realistic traffic environments, can be presented on a time-controlled basis to the controller trainee.

4.5.2 Software Maintenance

Experience has shown that as controllers used the Automated ATC system they can define improvements which would be of operational benefit. To implement these controller suggested improvements may require operational program modification. The present Kimpo Automated system does not have the capability which permits a convenient method for modifying the operational program. Addition of support software capability would provide your programmer personnel with the tool that would permit reassembly of the operational program. This reassembly can be performed concurrent with normal system operations.

4.5.3 Hardware Maintenance

The enhanced system capability of having automatic and manual system reconfiguration via the Reconfiguration and Fault Detection Unit permits emergency and preventive module maintenance to be performed during normal operation traffic periods. However, as a general practice module preventive maintenance and background processing tasks such as operational program assembly or controller training should be performed during minimal traffic periods.

4.6 Remote Sensor/Display

The Remote Sensor/Display feature is a cost effective method whereby Air Traffic Control functions for terminals located in close proximity are combined. Data Processing and Area Control can then be performed by a centralized facility. It is recommended that a centralized data processing and control facility be established at Kimpo International Airport, hereinafter referred to as Kimpo Facility. A system block diagram of this expanded Kimpo system is shown in Figure 3. Two displays dedicated as arrival and departure control will be added to the Kimpo Facility for controlling air traffic at the new Seoul International Airport. A remote all digital display located in the new airport tower cab will be used for final approach control. This remote display will present a full version of the air traffic control activity within range of the new sensor system also located at the new airport. The data entry capability of the remote tower cab display is identical to that of the present time-shared displays located at the Kimpo Facility. The remote tower cab display will communicate with the Kimpo Facility over dedicated (full duplex) telephone lines. Narrow-band sensor data (primary and secondary radar information) from the new Seoul International Airport radar would be transmitted to the centralized data processing system located at the Kimpo Facility via dedicated (half duplexed) telephone lines (sensor data could be transmitted via microwave however this method is more expensive). The centralized data processing system performs aircraft tracking, formats all display outputs, including those for the remote tower cab display and acts on all appropriate messages for each display position.

This technique of providing centralized air traffic control for terminals located in a close proximity will soon be in operational use within the United States. It has been recognized as a cost effective approach which eliminates the need for dedicated terminal automation systems located at each airport.

5.0 SUMMARY

Technological advancements have made the expanded use of automation a financially viable solution to accommodate increased traffic. This scenario of system expansion is not by any means the only method of implementing an automation plan, but does provide a conceptual approach based on technology and trends currently available in automated air traffic control. However, the time required to implement a Kimpo modernization project as described in this scenario would be between 2 and 3 years. Therefore it is imperative that the KCAB develop their plans and establish their budget which will consider this 2 to 3 year implementation period.

Sperry Univac's intent is to provide the necessary tools which will make the KCAB self sufficient in both the hardware and software maintenance areas. From an economical standpoint, as the proficiency of your personnel increases, it is logical step for the KCAB to assume total responsibility for both software and hardware maintenance.

The Remote Sensor/Display technique is a proven cost effective method for controlling aircraft operations at terminals in a close proximity. We recommend that the KCAB adopt this technique for controlling air traffic at the new Seoul International Airport.

The controller training function has proven to be a valuable tool for the United States Federal Aviation Adminstration in the training of new controllers and maintaining the proficiency of experienced controllers. Utilizing this technique the KCAB can effectively train the required number of controllers which will be necessary to accommodate the expected increase in air traffic.

APPENDIX

Copies of S.U. HW data sheets