An integrated system for airline planning and management information

by
MORTON EHRLICH
Eastern Airlines, Inc., U.S.A.

INTRODUCTION

Eastern Air Lines is the third largest commercial airline in the world, superseded in passenger volumes only by Aeroflot and United Air Lines. During the year of 1976, Eastern carried twenty-nine million passengers on more than half a million flights. That is equivalent to eighty thousand passengers a day on one thousand five hundred flights operating between one hundred cities throughout North America and the Caribbean.

And not only is Eastern's operation large, it is also very complex. For instance, today at the Atlanta, Georgia airport Eastern's 250 operations will arrive with sixteen thousand passengers. Eight thousand of these will connect between the more than one thousand, three hundred origination and destination markets Eastern serves using the Atlanta airport as a connecting hub. These and eight thousand other Atlanta originating and connecting passengers from other airlines will then depart Atlanta on two hundred fifty scheduled departures. Eastern's Atlanta operation is the largest single carrier airport operation in the free world and as such I think you can appreciate the complexity of scheduling five hundred flight movements to provide daily service between the thirteen hundred markets served through this single facility.

I mention these statistics to illustrate not only the size of Eastern's operation but equally important – as evidenced by the Atlanta operation – is the complexity and interdependence of an air transportation system.

And, within this environment an air transport system needs to serve the requirements of the public by providing only those services demanded at the proper times and with appropriately sized aircraft and the services needed to operate with a high degree of punctuality.

We believe that Eastern has been somewaht succesful in providing customer demanded services. Our load factors and growth rates have recently been among the highest of all United States trunk carriers.

And, the punctuality demanded by our customers is evidenced by the completion of more than 99% of scheduled plane miles and the fact that more than 80% of our flights arrive within fifteen minutes of schedule.

These parameters do not permit more than a minimal occurence of marketing or operational slack – and certainly preclude any appreciable design or planning error.

So, the criteria by which we need to evaluate our Planning effectiveness is – to say the least – strict. There is little room for error.

I don't wish to make it sound as if Eastern is somehow unique – that is not the case. Most airlines in the world operate in a similar environment.

Where Eastern may be somewhat unique, has been in our committment to develop advanced systems that permit our management to function with the most accurate, timely and relevant information in making decisions that impact the future of the airline.

In today's discussion, I'll:

First: Outline the perspective that we at Eastern have utilized in developing management information systems that guide our decisions in planning the path the airline will travel.

Second: I'll describe some of these systems that today perform an integral function in the planning process. I think you'll find these to be among the more comprehensive and useful systems in operation in any transportation network. and

Finally: I'll review some of the current research and systems development projects now being pursued at Eastern.

SYSTEMS PERSPECTIVE

An airline can be viewed as a vast information system in that it depends on multiple levels and directions of information flows. This view is conceptually important in establishing an ideal set of information systems that foster an environment where decisions are made in context of the current state of the entire transportation network.

Functions of Systems in the Management Process

The systems involved in this structure are initially concerned with data collection and communication; both that which is endogenous to the airline and also that which defines the environment in which we operate.

After the raw data is gathered and summarized, it needs to be systematically reported and compared to objectives as part of a control mechanism.

As we proceed beyond that step to an analysis of the underlying causes of the observed results, we find more complex reporting systems that bring together data from various sources to fully clarify problems and opportunities. This is the intitial systematic process within the Planning function.

Proceeding yet further we have simple models that evaluate proposals for correcting problems and exploiting opportunities.

And finally, there exist complex models using operations research techniques that actually develop optimal solutions.

This progression outlines several distinct classes of systems. Initially providing for the capture and communication of information are data systems. Beyond that the process, whereby data is converted into varying degrees of useful management information, constitutes the higher level applications I classify as Management Information Systems.

Credit for assistance in the preparation of this report is given to Mr. D.C. Birdsall, Manager-Planning Systems, and Mr. O.F. Auten, Sr. Systems Analyst-planning, at Eastern Airlines.

Four Levels of Management Information Systems

These higher level applications can be categorized as follows:

LEVEL ONE: Basic reporting and communications systems usually focusing on a single source of data.

LEVEL TWO: Complex reporting systems bringing together various sources of data and focusing it on decision variables.

LEVEL THREE: Simple models that evaluate proposed plans, and

LEVEL FOUR: Complex models that actually develop solutions.

A "System of Sytems"

This conglomeration of successively complex management tools provide what we see as "A System of Systems" each dependent and largely integrated with those at the lower and higher levels. We began working towards the development of this "System of Systems" in the late 1960s.

Principles and Prerequisites

It was apparent at that time, as it is now, that if we were to implement systems proficient in advanced modeling and operations research techniques, there were a number of prerequisite systems and capabilities that would have to be developed.

Guidelines for our work were thus set:

– A good data system had to proceed any level of proficiency in Management Information Systems – be they as simple as LEVEL ONE or as complex as LEVEL FOUR Planning Systems. And to the extent that we could visualize eventual development of the LEVEL FOUR systems, it was necessary to devote more attention to the definition of complete data base systems. We knew then that the more advanced systems required more detailed information to function.

– We also knew that as we progressed through the evolution of each level of systems we had to maintain a purity of design. Each level could be developed only after complete definition of the prior level, as each depended to a large extent on the output of the lower level systems. This will be obvious to you in our discussion of Eastern's Planning Systems.

– And most importantly systems need to be decision oriented. And even oriented towards specific decisions. The information to be included and presented or analyzed has to have its origin in the mind of the decision maker. Only from an in-depth study of his needs within a decision process, can a system to fulfill those needs be defined. In this study one must identify, evaluate and modify traditional information flows to convert these flows into Management Information Systems that precipitate intelligent decisions.

– And the "System of Systems" must be permitted to evolve within the environment of their users. Very few of today's decision makers, for valid reasons, are prepared to casually accept systems that profoundly impact the traditional means by which they make and implement decisions. Therefore, most often, even if the systems planner could envision the ultimate manager/systems synthesis that would promote optimal decisions, he needs to implement this solution on a phased basis. Invariably, during the phased implementation, many improvements and refinements to the original system design will become apparent. A complex series of systems, like other live organisms need to germinate, build a solid root system and can then yield a product that is productive and symbiotic within its environment. Certainly systems that assist management in arriving at decisions need to have benefit of the symbiotic relationship.

These then, are some of what I think can perhaps be called a priori principles that need to serve as a guide in the development of any complex series of Management Information Systems.

DATA SYSTEMS

Data systems are a necessary prerequisite to a Management Information System. These are concerned with the capture and communication of raw data and the subsequent creation of a series of data bases.

The data capture and communication processes have undergone significant technological change in the decade of the seventies. Prior to this period this process was predominantly structured around the completion of paper forms and the physical transportation of these forms to a central site at which the information could be encoded via the keypunch process into machine readable form. This slow, cumbersome process was rather error prone due to the separation of the encoder from the physical operation of the airline and the necessary reliance on hand-written material for input to the data system.

Technological innovations in cable, microwave and satellite data transmission capabilities, complimented by the development of solid state electronics and high density storage media have fostered the migration of the data encoding process from the central site to operational locations, regardless of their geographical dispersion.

Now data can be entered directly into CRTs, equipped not only with a keyboard and display screen, but also with editing and feedback features that improve the accuracy of the data at its source. This technology was critical to many of the data capture systems surveyed. It also figured prominently in their economic productivity.

The operational, financial and marketing oriented data systems discussed here are but a sample of Eastern's total data systems but are those most critical to the Planning function.

Operational – SYSTEM INFORM

Technology made possible the design and implementation of an integrated series of on-line airline operations oriented data collection and communications subsystems. They provide for airport operating personnel to input and audit 178 elements of data defining the operation of each flight concurrent with the progress of the day's operation. This data is instantaneously transmitted from each airport to Eastern's Charlotte, North Carolina computer facility making this information available for query to all operating locations and also to central dispatch for real-time operational decisions.

It is then transmitted to Eastern's Miami, Florida commercial computer facility at 2:00 a.m. each day for the prior day's operation. As the data for approximately one thousand five hundred flights is received in Miami it is organized and structured into the data base we know as SYSTEM INFORM. It is this daily accumulation of raw operating information that provides the bulk of data available for higher level reporting and Management Information Systems.

Examples of the elements of data maintained for each flight are:

– Flight routings, equipment and departure and arrival times.

– Fuel loadings and consumption.

– Delay information.

– Passenger enplanements, deplanements and onboard counts and cargo movements as above.

SYSTEM INFORM has served as a critical data base system since 1971.

Financial-Expense & Revenue Accounting

Eastern's accounting systems have likewise been de-

signed to collect and maintain expense and revenues at a low level of detail.

Expenditures are classified by location, department, general and specific expense account and aircraft type where applicable. The Accounting Ledger System (ALS) uses remote keyboard-CRT terminals for the input, coding, verification and payment of expense items.

Coupled with the expense system is the Earned Revenue System. It, like INFORM and ALS, uses terminals and minicomputers for data entry and auditing. The small computer aggregates the data for communication with the IBM 370 systems, which in addition to providing billing and receivables accounting, generates a fares data base containing sector price information.

Marketing – Traffic Information

One other system that I shall mention, only in passing at this point, provides a data base containing all connecting passenger flows between Eastern's on-line flights.

These data bases consitute the bulk of Eastern's historical data available as input to the airline planning process.

Scheduling – On-line Schedule Development System

Serving the planning process, in an iterative schedule development environment is an on-line minicomputer data entry system. This system audits proposed schedules, provides instant statistical summaries of operations and also communicates with Eastern's IBM/370 systems thereby supporting all schedule reporting, analysis and communication functions.

The system simultaneously supports two or more schedule development efforts in the future and current planning cycles in addition to schedules presently operating. It is so thoroughly integrated with the entire planning "Systems of Systems" that a single individual inputs schedule decisions and then provides machine instructions that automatically generate all necessary downline processing – including:

- the printing of reports
- printing of public timetabels
- creating schedule tapes as input to travel guides
- updating the reservations system, and
- updating operational systems

and so on through the entire communication process. Our ability to concentrate the responsibility for all schedule information needs under the control of a single person has been instrumental in substantially reducing Eastern's response time cycle in implementing schedule related planning decisions. The online system resides in the Schedules Department. There are three work stations each consisting of a keyboard and one or several CRT units. A printer, card reader, and magnetic tape and disk drive accessories are configured with the central processor and comprise the on-line hardware. As changes are made to the schedule, the operator keys them into the system. Airports, operating times, stations and other elements of data are audited to assure accuracy. The system rejects invalid data. Valid data is added into statistical summaries and the schedule flight operations are stored in the flight data base. This system has advanced technical features that make it easy to use and promote a high level of operator productivity. The reports generated by the system are discussed later as they fall under the category of LEVEL ONE Management Information Systems.

Competitive Information

In addition to internal data, Eastern Airlines operates in an environment that provides an extensive amount of competitive data. The bulk of this data is gathered by the Civil Aeronautics Board and made available to the certificated carriers in machine readable form.

Information obtained from this source includes:

– A quarterly 10% sample of domestic passenger movements providing their itineraries and carrier.

– Monthly flight segment data similar to that Eastern gathers in our SYSTEM INFORM, and

– Quarterly financial data providing revenue and expense details for each carrier, operating entity and aircraft type.

Eastern also purchases a data base detailing all competitive schedules in North America from the publishers of the North American Official Airline Guide.

The above coupled with Eastern's internal information provides a comprehensive network of data bases.

But data does not constitute a management information system.

MANAGEMENT INFORMATION SYSTEMS

Data has to be transformed into management information through initial processes of filtration, selection, organization and reporting. More complex processes involving comparisons, analysis, modeling techniques and the use of advanced mathematical forecasting tools are then used to generate very specific inputs to Planning's decision processes.

The four levels of Management Information Systems used at Eastern Airlines were defined earlier. In the balance of this discussion I will describe a number of those systems beginning with LEVEL ONE and progressing through to LEVEL FOUR systems. Most of these have been in use at Eastern for a number of years. Those currently under development reflect the natural evolutionary extension of the systems now serving the planning function.

A. LEVEL ONE – Management Information Systems

LEVEL ONE management information systems primarily fulfill basic reporting requirements. Within the Airline Planning function these are part of a control process that identifies areas where some Planning action may be required.

Eastern has a number of such systems. For the most part they reflect a single data source and show operating results that are often compared to either a plan or prior period, but do not attempt to analyze or explain the results.

Traffic Results

A series of these systems keep management well informed on traffic results both on a company-wide basis and for each market and flight within the airline. Timeliness is a necessary ingredient because changes to flight schedules involve lead times of two to six months from decision to implemention.

Eastern's traffic performance is measured using several systems, each with different degrees of timeliness and amounts of detail.

Daily System Performance – PIR Report

Aggregate totals of passengers, passenger miles and load factor, as well as aircraft departues, miles and seat miles are summed from the INFORM data base for the prior day's operations. These summaries are compared to expected results and reports are available to management at the start of each day.

These reports keep management apprised of strengths or weakness in aggregate system traffic and capacity levels and highlight deviations from expected results that need to be investigated in more detail.

Weekly Traffic and Load Factor Reports

Percentage traffic growth in each of more than 200 of Eastern's largest markets is measured weekly by a sys-

tem that compares passenger volumes (using the INFORM database) versus the same data for the equivalent week in the prior years. Results in these markets are further summarized to six general market categories and compared to the prior year. These weekly comparisons alert management to trends in individual markets as well as in groups of business and vacation markets.

Load factors are similarly reported for nonstop markets and summarized for the six groups. Load factors on new services are highlighted. This system also produces a report detailing passenger volumes and load factors for each flight which is instrumental in researching problem markets.

Weekly statistics are summarized to show the month's performance and are reported in the context of the prior month's information.

Monthly System and Station Performance

Traffic data contained in the INFORM data base is summarized each month and transferred to a time-share environment. In the context of reporting, the current data is compared to forecasted amounts and reports specifying variances by marketing region and station are used for responsibility measurement. Division and station managers are held accountable to achieving forecasts for their stations.

A second report created within the timeshare environment compares Eastern's traffic growth and load factors to that of the other U.S. domestic trunk airlines. This report puts Eastern's traffic results in context of performance within the total industry.

Market Schedule Development – MSD System

A third series of monthly reports involve a more complex process where a number of elements of data from several sources are systematically combined to form a higher level data base unique to the needs of the Planning function. This compendium of data includes both Eastern and competitive information.

The prime value of this system is that is has broad flexibility in creating reports. When specific problems are identified this system provides analytic time series summaries of various traffic and capacity related statistics that are germane to the problem. The system also provides monthly traffic reports for directional and origin-destination markets and generates summaries for a rather diverse number of economic and geographic marketing economics.

This entire series of traffic oriented reporting systems is designed to assure that senior management at the corporate level and managers at all levels within the Airline Planning function are continually apprised of the airline's marketing position. Insofar as these systems are performance oriented, they predominantly report historical data.

Schedule Development System – SDS

Planning has another LEVEL ONE series of systems that is forward looking. This is the Schedules Development System which is an integrated processing network. It consists of an on-line minicomputer that provides data entry and some reporting functions and is linked with an IBM 370 which provides the bulk of applications and communications functions. This integrated network of systems is key to the iterative process that is necessary for optimizing schedules.

The aspects of the on-line system that facilitate the creation of the data base were discussed earlier. The on-line system also performs LEVEL ONE reporting functions.

It reports summaries of scheduled aircraft operating statistics, such as flight hours, available seat miles and aircraft utilization. This information is by aircraft type and for various periods within the schedule under development. The on-line system also stores statistical profiles of the corporate approved schedule operating plan and compares the current status of a schedule with those objectives.

There are several other reporting capabilities each of which provides aircraft schedulers with details of the planned operation that need to be monitored.

The on-line system provides magnetic tape input to Eastern's IBM 370. It is within that environment that the more extensive LEVEL ONE reporting and communication systems reside.

The 370 report generating programs provide the following:

– A flight listing showing the operating details of all schedule flights

– A nonstop segment report giving a chronological listing of all services in each market,

– A station activity report, and

– An aircraft flow listing

Each of these reports has been designed to fulfill the information requirements of managers within all marketing and operational departments of the airline.

The IBM 370 resident applications also construct passenger time-tables and create magnetic tapes which provide schedule input to airline guides, Eastern's reservations systems and other industry vendors and governmental agencies.

In terms of the breadth of its applications, the SDS series of sub-systems figures most prominently in the schedule development process. And most importantly, the integrated structure of the system assures that schedule decisions can be transformed into any of those outputs, even as involved as a complete timetable, by 9:00 a.m. of the following morning.

B. LEVEL TWO – Management Information Systems

The LEVEL TWO systems involve more complex reports involving the analytical treatment of the observed information. These systems need to provide decision makers with a knowledge, not only of what happened, but with an understanding of why these results occurred. Or with regard to future operations, there is a need to provide enough information so as to suggest a likely range of results.

Schedules Information System – SIS

The first of two systems surveyed here is the Schedules Information System. It produces flight, segment and station reports similar in structure to the LEVEL ONE SDS reports, but with complete historical passenger and cargo traffic information.

These reports show not only the volumes of passengers carried on each flight, but also the origination and final on-line destination point for each passenger. In addition, day of week traffic, the passengers total mileage on all Eastern segments, and connecting complex passenger counts detailing the exchanges between all flights are shown in these reports.

The SIS reports are the basic tool used by planners in designing future Eastern schedules. This system has recently been supplemented by another that provides similar reports, but with competitive schedules and traffic volumes.

Competitive Schedule Analysis

The Competitive Schedule Analysis system uses several data bases. Prior and future Eastern schedules, competitors' schedules, and passenger and cargo traffic are included in these reports.

The purpose of the report is to have Eastern manage-

ment view the future placement of our flight schedules in context of competitors' schedules and traffic volumes. Schedules in a market for three successive periods are shown by departure time for all carriers. A competitor's prior period schedules are extrapolated into the future and can be modified to reflect assumed changes. Traffic volumes and projected load factors for each flight and market are included in the report. This process provides estimates of capacity changes and resultant load factors and market shares.

This system exists in a time-sharing environment, resident in Eastern's own IBM 370 computer. As such, it too communicates with other systems and will reflect Eastern's most up-to-date scheduling decisions.

It is also structured to provide a timely analysis of competitive schedules as rapidly as they are published in the airline guides. This capability is instrumental in focusing Eastern's sales and advertising efforts toward those markets where the competitive environment will be most challenging.

The two systems are very basic analytical ingredients in Eastern's schedule development efforts. In essence they represent the storehouse of knowledge from which most of our flights are planned.

C. LEVEL THREE – Management Information Systems

LEVEL THREE management information systems go one step beyond the reporting systems in that they provide not so much a report of past or future activity – but more significantly – a model of it.

The concept of the model is important as it implies that the system understands and emulates the process being observed.

Profit and Loss by Flight

One of Eastern's most useful tools is a financial model of the schedule. This system uses all the internal data sources referenced, and many not referenced. From these it constructs the revenues, expenses and profit associated with each flight in the airline. It is imperative that P & L by Flight be an accurate representation of the financial consequences associated with each service as decisions to add or delete flights are influenced, if not dictated, by their profitability. To assure a high degree of accuracy, costs are brought into the system at a low level of detail at which they can be associated with flight activity. This logic applies also to revenues which are calculated using actual passengers on each flight and their itineraries and observed prices in the various markets.

Costs are summarized to identify; first, direct costs for each flight, second, those costs that are highly correlated with a service, and lastly, system overhead costs that vary with the aggregate size of the airline but not directly with specific flights.

The availability of these levels of expense identification are important to estimating the marginal financial impact of adding or deleting services.

The P & L by Flight system produces flight level, market and aircraft type oriented reports. In terms of market and schedule planning, P & L by Flight provides a financial model that assures that the profits or losses from each scheduled flight are known to management. Correction or reaffirmation of scheduling decisions thereby becomes an ongoing process.

Operations Forecasting – FMS

The Frequency Management System is Eastern's long-range macro operations forecasting tool. It exists in the time-sharing environment as the basic reports, comparisons and analyses it generates are part of a highly iterative process. The forecasts cover a period up to three years in the future. They provide operating management with projections upon which te make plans for their divisions.

The forecast is primarily an extrapolation of prior period operations. Aircraft acquisition and retirement programs and the resultant change in growth rates and changes in scheduling priorities are input to the system and future operations are parametrically altered to reflect these changes.

FMS produces high level statistical summaries upon which divisional operating and financial forecasts are made. The forecast cycle is repeated three times each year with the current portion of the final forecast being the next year's Operating Plan.

Traffic Forecasting Systems

The statistical output from FMS provides a capacity level for which traffic is forecasted. The traffic forecast system is linked to FMS in the time share environment. It, like FMS, is primarily a mathematical extrapolation of historical data that can be tempered for expected exogenous factors by control parameters. This system provides the airline with a traffic forecast from which future revenues are projected.

The macro level forecast is complimented by a station boardings forecast for the next twelve months. Station boardings are generated by a system that contains historical data that is projected forward and dynamically adjusted for variations in service levels by marginal load factor assumptions.

Together the latter two systems are the basic tools of management in projecting corporate revenues and providing a basis for performance measurement.

D. LEVEL FOUR – Management Information Systems

LEVEL FOUR management information systems have a high degree of complexity due to both the vast quantity of detail with which they operate and the use of advanced mathematical and operations research concepts. Much of the necessary computer technology and academic theory required for these systems is relatively new, and therefore, not many LEVEL FOUR applications are currently in use.

Flight Crew Scheduling – TPACS

An exception is the flight crew scheduling models that are widely used throughout the industry. These are deterministic models that utilize linear programming techniques to assing flight crews to trips so as to minimize the costs of flying the schedule. These models contain numerous parameters that constrain the scheduling of flight crews, but by evaluating a large number of potential solutions, the one that is most optimal is identified. Crew scheduling systems are one of the most prolific applications of LEVEL FOUR systems in the airline industry.

Flight Forecasting System

Just over a year ago we initiated at Eastern the development of a system that would provide passenger forecasts for each of about 180,000 discrete flight operations within a schedule period. Specific forecasts for each operation were necessary to estimate the number of seats on each flight to be made available for advance purchase discount fare programs.

The system was completed in April, 1976 and has been in use since then. Through it, full fare passenger demand is forecasted for each flight departure. Then using a statistical profile of that flight's history we are able to estimate the various probabilities of all demand levels. Knowing the fare discount, the system determines the optimal number of seats to be saved for expected full fare passengers in order to maximize total revenue. The

remaining seats are made available to be sold at a discount.

The output from this system is fed into Eastern's reservations system and seat availability for the discount programs is automatically controlled by the reservations computer.

The statistical and mathematical processes involved in forecasting traffic and probabilities of demand are rather complex but this system is now generating flight forecasts, that when summed, are within two percent of Eastern's official aggregate traffic forecast.

The use of this capability has improved the revenue yield by more than two million dollars in 1976. The primary inputs to Flight forecasting are LEVEL ONE and LEVEL TWO SDS and SIS outputs.

This represents the most sophisticated forecasting system currently being used in Eastern as it operates at the lowest possible level of detail and maximizes revenue tradeoffs using higher level mathematics.

Airline Schedule Planning Evaluation Model – ASPEM

The Airline Schedule Planning and Evaluation Model (ASPEM) developed by MacDonnell Douglas Aircraft Corporation, evaluates airline schedules in attempting to estimate the traffic that each flight would carry. ASPEM receives as input all airline schedules in the markets to be evaluated and from these constructs a catalogue of all nonstop, direct and connecting services that would be available to each Origination-Destination market. The model then uses various parameters to assess the quality and time of day value of these services. The quality index is used to allocate the available traffic to the flights in the market.

The model has not yet been used extensively by airlines to arrive at schedule decisions, but Eastern is currently engaged in implementing a version of ASPEM that will be tested to determine its value to us as a schedule planning tool.

Aircraft Sizing Model

Eastern is also now evaluating a linear programming model that attempts to re-route aircraft so as to maximize the profitability of the deployment of a fleet. The model requires as input estimates of passengers gained or lost due to the availability of more or fewer seats for each flight. This application then, in a manner similar to TPACS, searches for the most optimal routing solution. Unlike TPACS the results are not deterministic and in fact often not even feasible. Much research remains before a model of this type can become an integral part of the schedule development process.

I mention schedule evaluation and aircraft routing models, primarily because in spite of their current unsettled status, there is a consensus with which I agree, that these types of models will be useful at some time in the future.

As I mentioned earlier, systems need to evolve in an orderly process. The value of both of these systems is largely dependent on the quality of available traffic forecasts. As traffic forecasting systems improve and gain the confidence of planners, the logical extensions of those systems will earn their place in the Planning process.

Concluding Remarks

I hope this discussion has served to illustrate not so much the specific systems that are used in Eastern's planning process, but more importantly the logical structure and sequential levels of proficiency through which the current state of affairs was achieved.

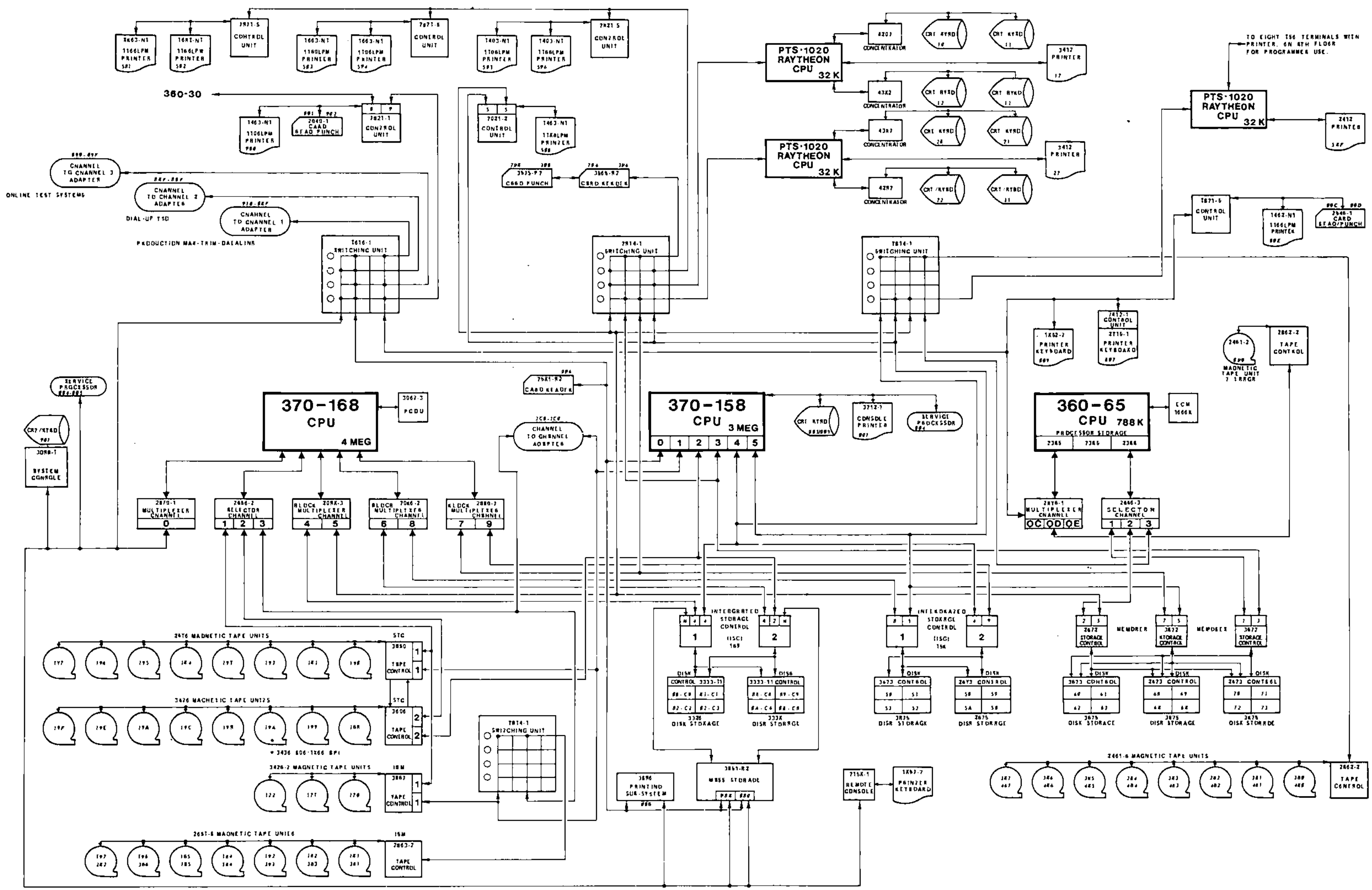
I believe that the use of advanced Management Information Systems is becoming increasingly important to the airline planning process.

With quantum improvements in aircraft technology now largely behind us, a substantial portion of the efficiency gains of the future will be derived through the development and use of advanced systems that provide management with the tools required to increase resource productivity.

For these reasons, continuing research and development, primarily with LEVEL FOUR systems is necessary for airlines to effectively perform their public and private roles.

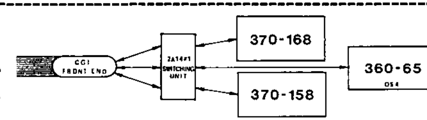
EQUIPMENT SCHEMATIC

UNIT ADDRESSES IN ITALICS



Simplified Communications Network

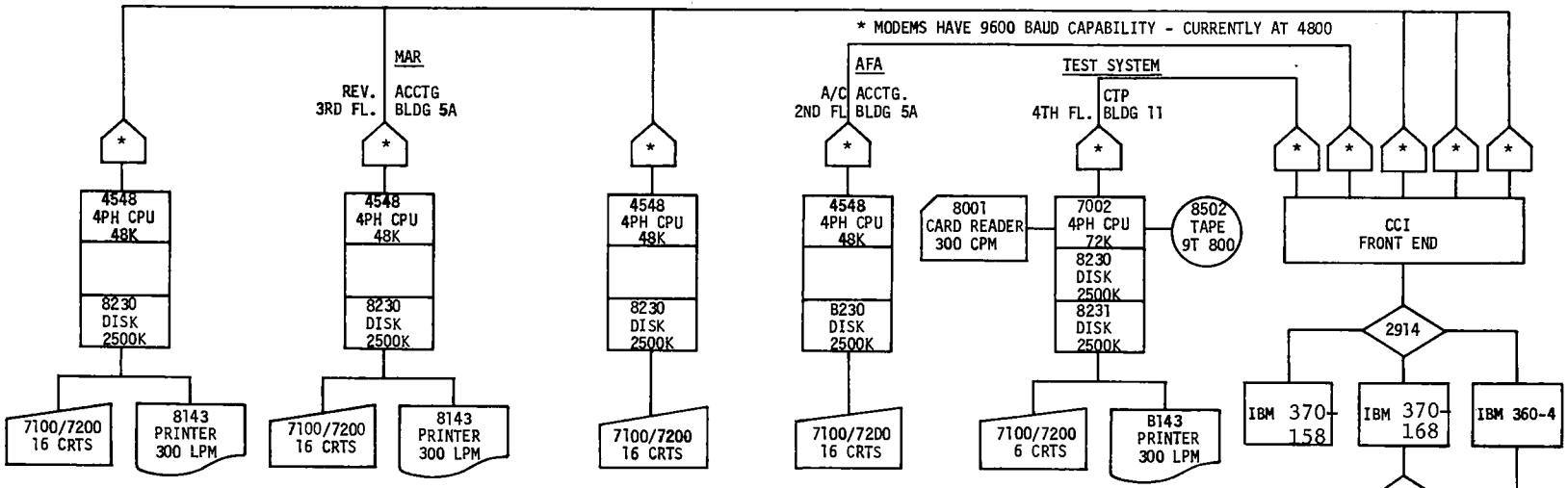
	CIRCUITS	MODEMS
TRIM USERS MIAMI AND OUTSIDE STATIONS -- 2740's, 1050's & 1421's	134.5 BAUD 600 BAUD	IBM 2711's TELCO 626D
MIAMI TSO USERS -- CRT's AND HARD COPY TERMINALS	300 BAUD	MIL CO 1130's
RJE OUTSIDE USERS	9600 BAUD 2000 BAUD	MIL CO 5500 96 MIL CO 2RL 51
EAL's CHARLOTTE, N. C. COMPUTER CENTER -- UNIVAC 494's DATALINK	2400 BAUD	MIL CO 48XR 92
ENV USERS SALES AUDIT AND RES CARGO -- FOUR PHASE CPU's	2200 BAUD	UNIVAC DCB's



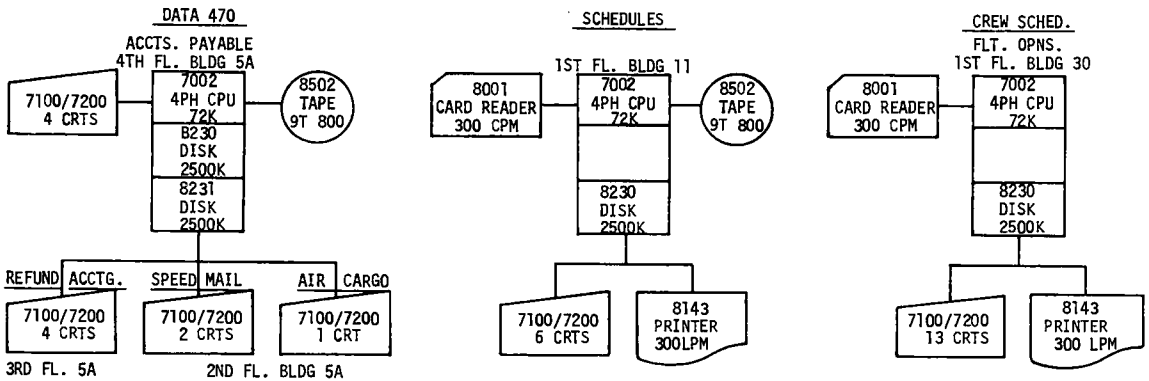
Appendix 1

4 PHASE & RAYTHEON SYSTEMS

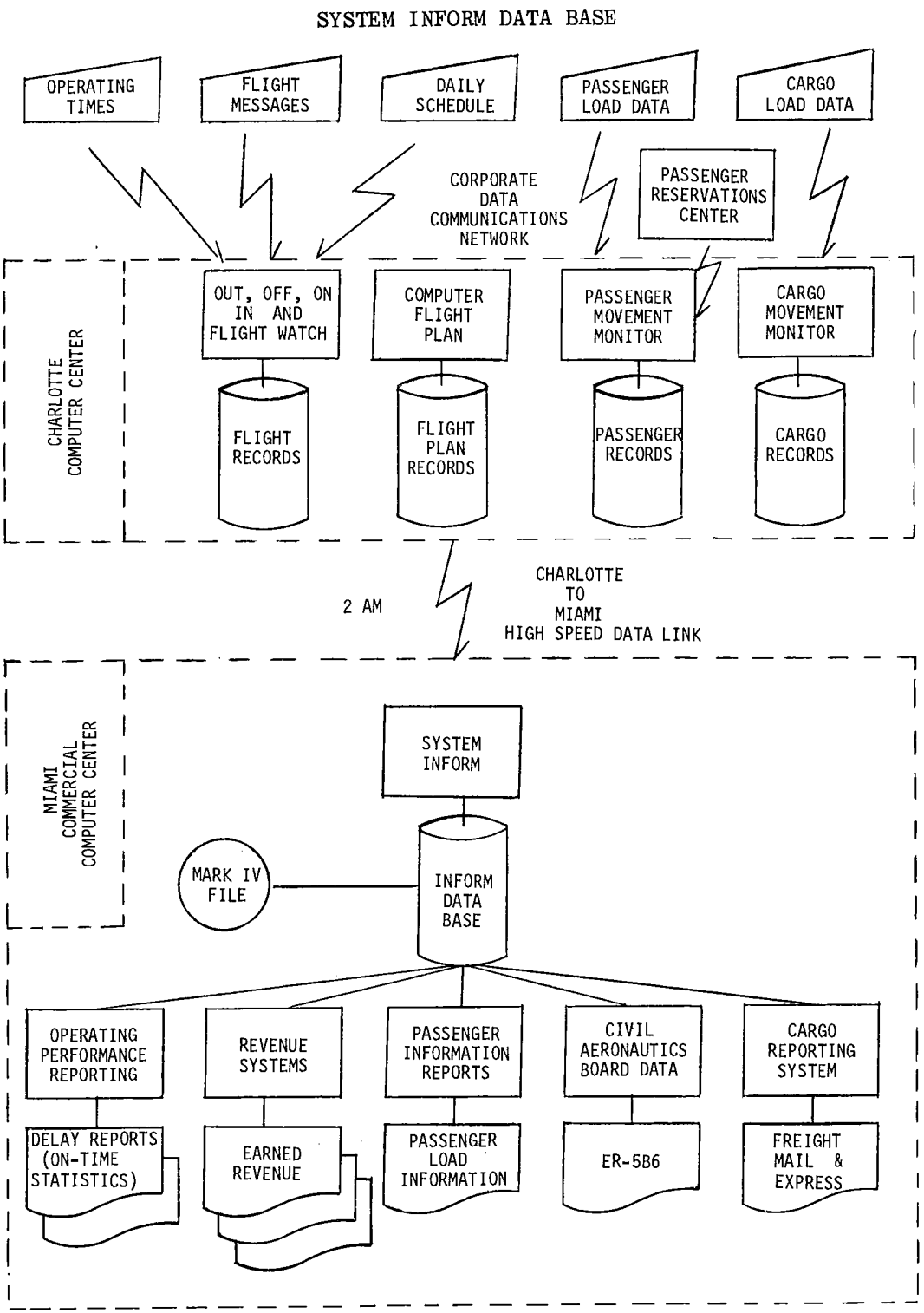
ON LINE DATA ENTRY SYSTEMS



STANDALONE SYSTEMS

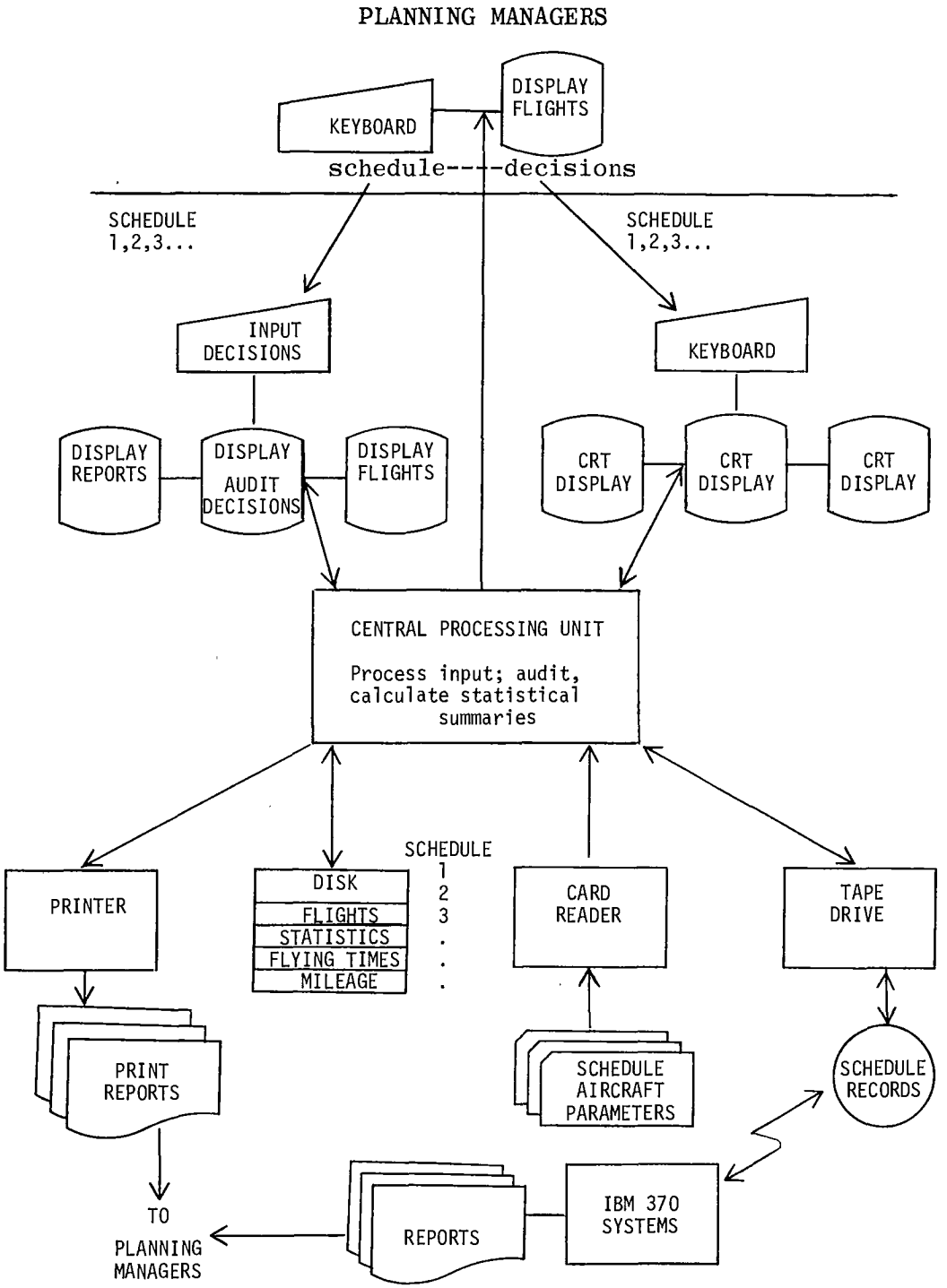


Appendix 2


SYSTEM INFORM DATA BASE
OPERATING TIMES
FLIGHT MESSAGES
DAILY SCHEDULE
PASSENGER LOAD DATA
CARGO LOAD DATA
CORPORATE DATA COMMUNICATIONS NETWORK
PASSENGER RESERVATIONS CENTER
CHARLOTTE COMPUTER CENTER
OUT, OFF, ON IN AND FLIGHT WATCH
COMPUTER FLIGHT PLAN
PASSENGER MOVEMENT MONITOR
CARGO MOVEMENT MONITOR
FLIGHT RECORDS
FLIGHT PLAN RECORDS
PASSENGER RECORDS
CARGO RECORDS
2 AM
CHARLOTTE TO MIAMI HIGH SPEED DATA LINK
MIAMI COMMERCIAL COMPUTER CENTER
SYSTEM INFORM
MARK IV FILE
INFORM DATA BASE
OPERATING PERFORMANCE REPORTING
REVENUE SYSTEMS
PASSENGER INFORMATION REPORTS
CIVIL AERONAUTICS BOARD DATA
CARGO REPORTING SYSTEM
DELAY REPORTS (ON-TIME STATISTICS)
EARNED REVENUE
PASSENGER LOAD INFORMATION
ER-5B6
FREIGHT MAIL & EXPRESS

Appendix 3

ON LINE SCHEDULE DEVELOPMENT SYSTEM



Appendix 4