The growing use of electronic mail by airlines

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INTRODUCTION

Electronic mail is one of several computer-based applications which is rapidly becoming a fundamental part of business life. Technology has supplied the data processing and communications industries with the necessary tools to enable them to make the transition from the mailman to direct electronic message delivery.

‘Electronic mail is defined as person-to-person communication of messages, using electronic means for capture, transmission and delivery of information. The information is communicated visually, including text and graphics—all the forms of information that can be communicated in letters via physical mail services. The messages can be displayed on a screen or a hard copy form can be generated.’1 As noted from the above definition, the scope of electronic mail is very broad; however, even this definition is not encompassing enough to include the automatic generation of messages being triggered by computer functions.

This paper describes several uses of electronic mail in the airline industry as an example of the importance and diversification of its employment. Likely hindrances to further advances are discussed along with some projection for the future.

HISTORY

The nature of an airline operation requires the rapid movement of considerable quantities and diverse forms of information. An airline passenger cannot only book space on a flight, he can also call for special food, special services like wheelchairs, book space in a hotel of his choice, reserve a rental car and request that his ticket be sent to him in the mail or available at the airport at a convenient self-ticketing device. The reservation can be for the airline called or for space on a combination of airlines. Each of these special services requires messages to be sent for confirmation and status.

The operation of a flight also involves considerable coordination and message movement. Flight crews must have numerous pieces of information including: (a) a release from a FAA Certified dispatcher, (b) a flight plan showing route, fuel, aircraft type, and alternate airports, (c) a takeoff analysis for the specific flight and load, and (d) weather information covering the origin and destination stations and the path in between. Station personnel gather, coordinate, and disseminate various necessary data relative to a flight such as: (a) aircraft time of arrival and departure, (b) passenger and freight data, and (c) weight and balance calculations.

Due to the need for current information, airlines have traditionally been heavy users of voice telephone services. These telephone services, however, did not capture the information for historical or analytical purposes. They generally lacked timeliness and proved to be inefficient as the message still had to be written down and usually copied for use by crew, station and General Office personnel.

Similarly, messages regarding needed aircraft repairs (called ‘squawks’) along with requests for and movement of materials and tools were handled by phone with similar results. With the rapidly increasing size and complexity of airline fleets, the FAA instituted requirements for accurate historical records of all actions relative to the operation of an aircraft.

The first computerized airline reservations systems became operational in the late 1950's. By the mid 1960's several airlines developed stored message or ‘Passenger Name Record’ systems. The most widely acclaimed of these was the American Airlines ‘SABRE’ system employing state of the art IBM 7090 computers and the telecommunications networks using the IBM 1006 Interchange discipline which became known as the ‘SABRE’ code.* Delta Airlines’ DELTAMATIC and Pan American Airlines’ PANAMAC Systems followed soon afterward. These systems and their successors (primarily the IBM Programmed Airlines Reservations System or PARS) were important in that they required message switching capabilities to service the quantities and diverse locations required. To service the message delivery need, the airlines used either the simplistic message switching system in PARS or developed independent systems such as the Univac 1108 system at United, the Univac 494 systems at Eastern and Northwest Orient, and the GE Datanet 30 system at Braniff. Essentially all the airlines supplemented these systems with teletype-oriented systems for operational traffic, servicing maintenance and flight operations.

* This code, also known as the Airline Line Code (ALC), is a 6-bit code, using a synchronous discipline with dual synchronizing characters at the start followed by addressing information, a variable length data field, an End of Message character and a Cyclic Check Character. This code is used by all but two of the major U.S. Scheduled Carriers and numerous international carriers.
Some of the above messages were originally handled through company pouches. Technically, physical delivery was possible for all correspondence; however, to be effectively utilized, information about passenger and aircraft movement required much more rapid delivery. The use of 110 Baud, 5 level Baudot codes spread throughout the industry and TWX and TELEX were extensively used between airlines. Papertape transmission and capture was used for the inter-station and inter-airline movement of data.

With the massive expansion in leased line networks and the high costs associated with these services, the United States Airlines formed a nonprofit organization, Aeronautical Radio, Inc. (ARINC)** to lease circuits at quantity discounts from the phone companies. Along with considerable demand for data services, the airlines are very large users of circuits for voice transmission principally servicing their reservations offices. The domestic carriers as a whole are second only to the U.S. Military in the use of common carrier communications services. Individual carriers like United and American with over 500,000 circuit miles each of leased lines for both voice and data would spend an estimated 46 percent more without the discounts available through ARINC.

The following section gives a sampling of several areas of current employment of electronic mail. The generation and transmission of messages has been an integral part of most real-time systems developed over the last decade to service such departments as Flight Operations and Maintenance and Engineering. A clear differentiation has been difficult between “mail,” whether manual or electronic, and the messages associated with computer stored on-line data bases with real-time access. Somewhat surprisingly the Flight Operating Systems and the Maintenance and Engineering Systems built by the airlines are amazingly diverse from an equipment and network standpoint. Functionally they are very similar especially in their need for message delivery services.

The prime purpose of a Flight Operating System is to track and control the movement of aircraft. A FAA licensed dispatcher is responsible for developing key information relative to the flight of a plane between two cities. He must also communicate this information to the station, flight personnel, and in some cases the FAA; copies of developed material must be saved for potential historical review. Weather needs to be reviewed for flight origin, destination, and en route conditions. Alerts from the Weather Services at Suitland, Maryland and Kansas City. Kansas centers, from pilot reports, and station observations are sent to the origin station after review by the dispatcher. A flight plan is calculated using weather, origin/destination characteristics and conditions, aircraft particulars, flight speed and altitude, and fuel weight and amount. The basic flight plan must be filed with the FAA and a detailed plan must be sent to the origin station. Before electronic mail a standard flight plan was filed with the FAA and flight station personnel. A standard profile was, by its very nature, general and conservative, leading to poor estimates of flight times and fuel burn. In-

tcreased optimization of the scheduling and use of aircraft, crews, and fuel has become possible by being able to send current information about weather and aircraft.

The management of aircraft movement is another area heavily serviced by electronic message transmission. Reported data are used for crew payroll, flight status, and accumulating the hours of aircraft flying. Traditionally, stations have used the teletype systems to inform downline stations and dispatchers of the out, off, on, and in times associated with aircraft movement. Summaries of these times by flight number were then sent by company mail to HDQ for analysis and storage. These same times are also recorded on Flight Logs which are kept on board the aircraft until a flight is completed. The Flight Logs are then placed in company pouches for delivery to HDQ. Flight Operating Systems have automated the retention and distribution of this essential information. U.S. Air has taken the additional step to incorporate this function into their integrated Crew Management data base system, taking advantage of current EDP technology to improve the access and management of the data. By real-time recording and automatic distribution, the urgency of the delivery of the Flight Logs has been reduced considerably and the station record delivery has been eliminated. A further enhancement has been the employment of on-board micro-processors (MPU) which have sensors allowing the collection of the needed out, off, on, and in times. Ground stations at the serviced airports are sent the accumulated messages over a VHF radio channel reserved for airline use. The ground receivers have a verify and retry capability allowing the checking and retransmission of messages, increasing the probability of accurate receipt of the aircraft movement information. The messages are then transmitted through the ARINC network to the industry Electronic Switching System in Elk Grove, Illinois and then on to the airline responsible for the original transmission. Airlines like Texas International and Piedmont use these messages in place of station generated messages. The benefits of the ARINC Addressing and Recording System (ACARS) are speed, accuracy, and improved employee productivity. Specifically, the ACARS system reduces the workload in the cockpit, at the stations, and in flight dispatch. The ACARS data can be input through communications interfaces into computers for payroll, aircraft flight time accumulation, and on-time performance reporting.

In the last decade several airlines have invested considerable resources in the development of integrated data base systems for the Maintenance and Engineering Divisions. Some of the more complete systems have respective costs as reflected at (a) Swissair—250 man years of effort, (b) Alitalia—140 man years, (c) Republic—100 man years, and (d) U.S. Air—80 man years. United is currently developing a system estimated to require more than 600 man years to complete. Republic Airlines and U.S. Air started work on their systems in the early 1970's. While numerous other airlines have on-line systems and are using data base concepts, the above two systems are further along in their development of fully integrated systems in the United States. These systems are similar to large manufacturing and inventory control.

** ARINC has the world's largest private line network servicing over 140 customers with more than 5 million circuit miles.
systems modified for the specific requirements of the airlines. Instead of multi-hour or even overnight delays in knowing the status of repairs and inventories, messages are sent to the schedule planners, shop foremen, inventory specialists and into the data base system allowing further reports and analyses to be accomplished. Automatic and demand messages are generated to order new parts when needed.

Through electronic message delivery more accurate and timely inventory control in the remote stations is achievable. Status of incoming aircraft relative to needed repairs, allowing improved scheduling of the work force and improved decision making to identify the best location for the repair can be accomplished. By replacing the manual process of scheduling aircraft repairs at each individual station with automatic preparation of schedules, work optimization and improved availability of the fleet can be achieved. Messages are sent to report available manpower and the estimated use of parts. Location of the aircraft and estimated time of arrival are obtained from the Flight Operating System. Reports are then transmitted to the affected stations showing the schedules and requesting movement and location of the necessary parts.

The Maintenance and Engineering Division is broken into several departments, each of which is a heavy user of electronic message transmission. One such department is Purchasing and Receiving which evaluates materials to be purchased, selects vendors, orders equipment and services, and takes receipt of purchased goods. Advancements in message delivery have resulted in lower inventory levels. Recently some of the larger suppliers of aircraft equipment have provided the ability for purchasers to access their data bases for stock levels, time to manufacture, and cost. Using terminals linked to their system, the entire cycle of phone calls and mail orders has been drastically reduced. Boeing, McDonnell Douglas, and Pratt and Whitney are three suppliers which offer such services to their customers. The overall benefits have been reduced manpower for handling orders, faster turn-around times, and fewer mistakes and misunderstandings.

By use of terminals attached to the integrated system, the processing and tracking of orders and receipts has resulted in the elimination of considerable amounts of paperwork and physical (vs. electronic) information delivery. When a shipment of goods is received, the receiving clerk updates the open order file for status, making available the pertinent information in the system. With this information the system can initiate payment, identify the storage locations for the material, and debit the budget of the requester. Also letters can be generated if the shipment is incorrect or not complete.

A message is transmitted to update the data base during the actual receipt process. Key information is then immediately available including the date of order, expected cost broken down by component for handling partial shipments and invoices, location material should be sent to, who placed the order, and budget assignment.

An important aspect of these integrated systems with access to message switching is the ability to use a given item of data to service multiple needs. This has the direct benefit of consistency and manageability. A specific example of the above is the flight movement data from the ACARS system which has the following multiple uses:

- for flight dispatch—for the tracking and controlling of aircraft movement,
- for collecting time of use—for aircraft maintenance,
- for crew payroll,
- for on-time performance reporting,
- for aircraft performance analysis,
- for notification of down-line stations regarding flight progress.

The most recent innovations in message send/receive have increased the computer's role in the process and reduced the manual intervention of recording the times and typing out many of the messages. The direct benefit is reduced manpower, along with more accurate and timely receipt and availability of the data.

Engineering orders are directives to maintenance to make modifications to aircraft and include the detailed instructions to accomplish the modification. Detailed records are required relative to these Engineering Orders. In addition, the aircraft manuals must be updated to reflect the current status of each aircraft. Copies of the updated manuals are then printed and distributed to all affected groups including remote maintenance locations. For urgent transmission, facsimile equipment is employed. Improved techniques in digitizing and transmitting material directly from a page or picture has allowed more maintenance to be performed in remote locations and still fulfill the requirement of having a current copy of the reference manual on hand. Facsimile processing times have fallen over the last 10 years from around 30 minutes per page to less than 1 minute per page. Using a combination of facsimile and the integrated on-line system with text editing and storage, changes can be incorporated directly into the computer system, accessed by scheduling, and referenced by the maintenance foreman and mechanic. The paperwork and time delays for the old system have thus been effectively reduced to a minimum. Even the report of the Engineering Order accomplishment is directly input, thus being available for immediate review and analysis.

RESERVATIONS

The capabilities of general airline reservations are relatively well known; thus, only a few examples are given to demonstrate some of the lesser known applications of reservations message transmission. Eastern Airlines developed a computer system to which most airlines subscribe, and submit descriptions of unclaimed bags, allowing the airlines to enter descriptions of the lost items and query the data base for likely matches. These queries are routed to Eastern by means of the ARINC network. If the item is located, the involved carrier is sent a confirmation message giving item location and contact point. Messages are then sent to make arrangements for delivery of the items to the desired location.

From the collection of the Computer History Museum (www.computerhistory.org)
For years airlines have printed tickets in commercial accounts and travel agencies. These were generated by agents sending teletype messages with ticket information to the industry standard TTY Model 28 RO printer in the account location. In 1972, United developed the "Teleticketing" capability to send tickets directly from the computer to a customer's printer at preselected times. Advances in automatic dialing and connect technology by terminal and communications equipment vendors allowed this cost effective service to be implemented. An aborted extension of this was developed by United and Braniff to send messages (tickets) to local Post Offices who would then mail the tickets to requesters. Technically the application was sound; however, objections by travel agencies and some control difficulties resulted in this application of electronic mail being shelved.

The biggest single expansion in the reservations services has been the development of travel agency services by several airlines. American and United currently dominate this offering which now includes the co-hosting of these services for other airlines on the American and United systems. Basically, the service includes the traditional reservations features; however, it now has been enhanced to handle itineraries, invoicing, and special reports. These systems provide a very cost effective shortcut to the traditional method of calling an airline's reservations office, handwriting tickets at the travel agency, performing credit checks, sending the credit card receipts to the credit card company for payment, and the eventual payment of the airlines in response to their invoicing. Today direct links between travel agencies, the airlines and the credit card companies are an early example of the merger of Electronics Funds Transfer with Electronic Mail.

PROBLEMS

The airlines have been aggressive in the use of telecommunications networks for reservations, real-time processing of maintenance and engineering and flight operations messages, and for corporate message transmission. Millions of dollars worth of terminals and communications equipment are currently installed using the very efficient but limited ALC line discipline. With the continued rapid introduction of new applications which go far beyond the original design specification of the networks and hardware, severe restrictions and costly redundancy are being experienced.

Computer and communications equipment reliability needs to be improved. Availability of 99.5 percent is still very difficult to achieve even at the central site. With the expanded networks automated detection, control and repair of the circuits is essential. A 95 to 98 percent availability using common carrier facilities is still a challenge, requiring sophisticated and expensive test equipment to assist the vendor in problem diagnosis.

Data security is becoming increasingly important. The preponderance of data being delivered across airline communications networks is easily susceptible to compromise. As further use is made of these networks for vital company information and financial transactions, data will need to be protected. The use of the current line disciplines will severely hamper this protection. Accompanying security is the need for improved message assurance. Recent developments in computer vendor offerings will need to be employed to improve the consistent quality of the delivered product.

The airlines have been slow to upgrade to the new vendor network architectures like the IBM System Network Architecture, DEC Network Architecture or the Communications Industry X.25 recommendation. The slowness can again be directly attributable to the high replacement costs and the lost efficiency for some of the systems with the highest performance requirements. Clearly, experience in past development will help for the future; however, due to the generally individual development of functions, and the solidly entrenched standards, integration and control of upgrading will be a sizable challenge.

FUTURE

The airline industry was an early user of Electronic Mail. It has been building on its base of applications and experience. Looking at the new technology coming from the R&D labs of the computer and communications industries gives a view of future capabilities. Fiber Optics and Satellites combined with increased use of LSI and VLSI chip technology, along with advances in bubble memories, will make available larger data paths with increased intelligence. Public Networks offering packet switching services such as TELENET and TYMNET will gain users, saving the trouble and expense of dedicated networks. Common carrier offerings like DDS and ACS will make access and use of networks easier and cheaper. The airlines are just now moving up into the use of broadband channels such as their recent introduction of 56 Kbps circuits. The airline industry requirement for real-time availability of information will force the continued expansion of the use of message switching.

This author believes the next phase of activity will be in further integration and interconnection of computer system data bases allowing more automatic generation of messages to service the operating divisions. With improved quality of digitizing techniques, facsimile processing for legal and administrative purposes will expand. Today's use of facsimile for sending contracts, personnel resumes, and technical manuals will also increase.

Unified networks are sure to be more heavily employed. The X.25 and SNA standards will be increasingly used. Applications will be modified to further reduce the manual intervention required today. Finally the increased logic capabilities of the computer and communications equipment are sure to be major contributors to the coming improvements.

Little has been said about the importance of the man-machine interface. The best offerings of new development can not be effective without taking into careful consideration the user. Today the preponderance of credit card, check-in, 

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1 Limited to 64 characters due to the 6-bit structure of the code.
boarding, and departure information is input manually. The use of concepts like Point of Sale is a needed enhancement. The accumulation of station data is also a manual process. Distributed Data Processing systems will be further employed to minimize the effect of communications failures and increase the computing power available for airport automation.

CONCLUSION

The airline industry is among the leaders in the use of electronic mail technology and concepts. The benefits have been rapidly realized, resulting in improved manpower efficiency, reduced aircraft inventories, improved availability of aircraft, and improved passenger handling.

The impediments to the employment of the rapidly improving technology are significant and costly. Timing will be dependent on when the return of investment for the new capabilities is sufficient to warrant the multimillion dollar investment. The pace is apt to be slow relative to the addition of new applications; however, with further improvements in communication front end processors and distributed processing power, the ability to gradually upgrade the networks is possible and will undoubtedly take place.

REFERENCES
