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"THE TERMINAL WEATHER INFORMATION FOR PILOTS (TWIP) PROGRAM*"

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1. INTRODUCTION

The Federal Aviation Administration (F.A.A.) is currently embarking on programs, such as the Integrated Terminal Weather System (ITWS) and Terminal Doppler Weather Radar (TDWR), that will significantly improve the aviation weather information in the terminal area. Given the great increase in the quantity and quality of terminal weather information, it would be highly desirable to provide this information directly to pilots rather than having to rely on voice communications. Providing terminal weather information automatically via data link would both enhance pilot awareness of weather hazards and reduce air traffic controller workload.

This paper will describe current work in the area of providing direct pilot access to terminal weather information via existing data link capabilities, such as ACARS (Addressing, Communications and Reporting System). During the summer of 1994, the ITWS testbed systems at Orlando, FL and Memphis, TN provided real–time terminal weather information to pilots in the form of text and character graphics–based products via the ACARS VHF data link. This effort follows an earlier successful demonstration during the summer of 1993 at Orlando (Campbell, 1994).

Two types of Terminal Weather Information for Pilots (TWIP) messages are generated: a text–only message and a character graphics map. In order to ensure their operational utility, these products were developed in consultation with an ad hoc pilot user group. The TWIP Text Message is intended for typical ACARS cockpit displays, which are roughly 20 characters wide by 10 lines high. The TWIP Character Graphics Depiction is intended for the cockpit printers available on some aircraft that are at least 40 characters wide. Both products are intended to provide strategic information to pilots about terminal weather conditions to aid flight planning and improve situational awareness of potential hazards.

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2. MESSAGE FORMATS

Figure 1 illustrates the TWIP Text Message. The left side of the figure shows the weather situation and the right side shows the corresponding text message. The first two lines indicate that the message is for Orlando International airport (MCO) and the Universal Time is 1810Z.

In this case, a 30 knot loss microburst is impacting one of the runways. Moderate (level 2) precipitation is touching the airport and extends from the north through the east; heavy precipitation (level 3 or greater) is 1 nm northeast of the airport. The storm is moving west at 15 knots.

An example of the TWIP Character Graphics Depiction is shown in Figure 2. In this case there is a microburst producing cell to the west of the airport. The moderate precipitation is in-

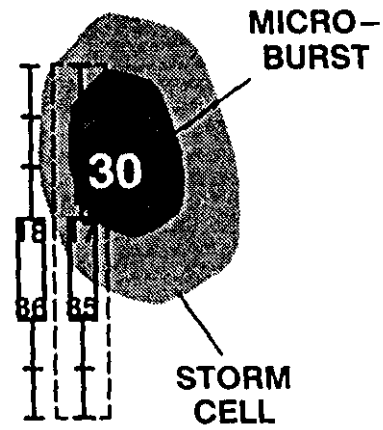
WEATHER SITUATION	TWIP TEXT MESSAGE
	MCO 1810 TERMINAL WEATHER DEMO *MICROBURST ALERT 30KT LOSS BEGAN 1805 -STORM(S) ARPT N-E MOD PRECIP 1NM NE HVY PRECIP MOVG W AT 15KT

Figure 1. Example of TWIP Text Message.

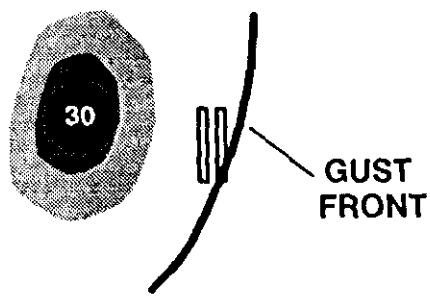
WEATHER SITUATION	TWIP CHARACTER GRAPHICS MAP
	MCO 1830 MAP 15NM 15 10 5 0 5 10 15 10 5 —+++— G —++++— G —++MM+— XX G 0 —+++++— XXG —+++— X* ——— G 5 GG G 10 15 10 5 0 5 10 15 +=HVY -=MOD M=MB G=GF X=RWY *=RWY MB/GF STORMS MVG SE AT 6KT

Figure 2. Example of TWIP Character Graphics Depiction.

dicated by "–", the heavy precipitation is indicated by a "+" and the microburst is indicated by the letter "M". There is a gust front impacting the airport in this case, indicated by the "G"s. The runway location is indicated by the "X"s, except where the gust front impacts them as indicated by an asterisk (*). A scale is provided in nautical miles in the horizontal and vertical directions plus a key to the symbols. The storm motion is also provided.

3. OPERATIONAL DEMONSTRATION

The TWIP demonstration for summer '94 was held in two locations, Memphis and Orlando. As shown in Figure 3, the ITWS testbed provided the TWIP text–based products over land–line connections to the ARINC Data Network Service (ADNS). The TWIP products were stored in a data base at ARINC headquarters in Annapolis, MD. Aircraft from five airlines (American, Delta, Federal Express, UPS and USAir) were able to request these products by making Digital ATIS requests via ACARS. Another airline (Northwest) was sent a special TWIP message whenever wind shear activity started or stopped at an airport; the airline host computer then relayed the message to its aircraft that were either within 20 minutes of landing or taxiing out for departure.

4. RESULTS

The Memphis demonstration was carried out from May 23rd through July 22nd. As shown in Figure 4, there were an average of 23 text messages requests per day through the end of June (note: the message traffic in July declined because the pilots for one airline were not able to make Memphis requests after June 30th). Over 1,000 requests were made over the two month period. There were 48 requests on June 9th, a day with a heavy weather impact at the Memphis International Airport. (Note: the Orlando demonstration was in progress at this writing).

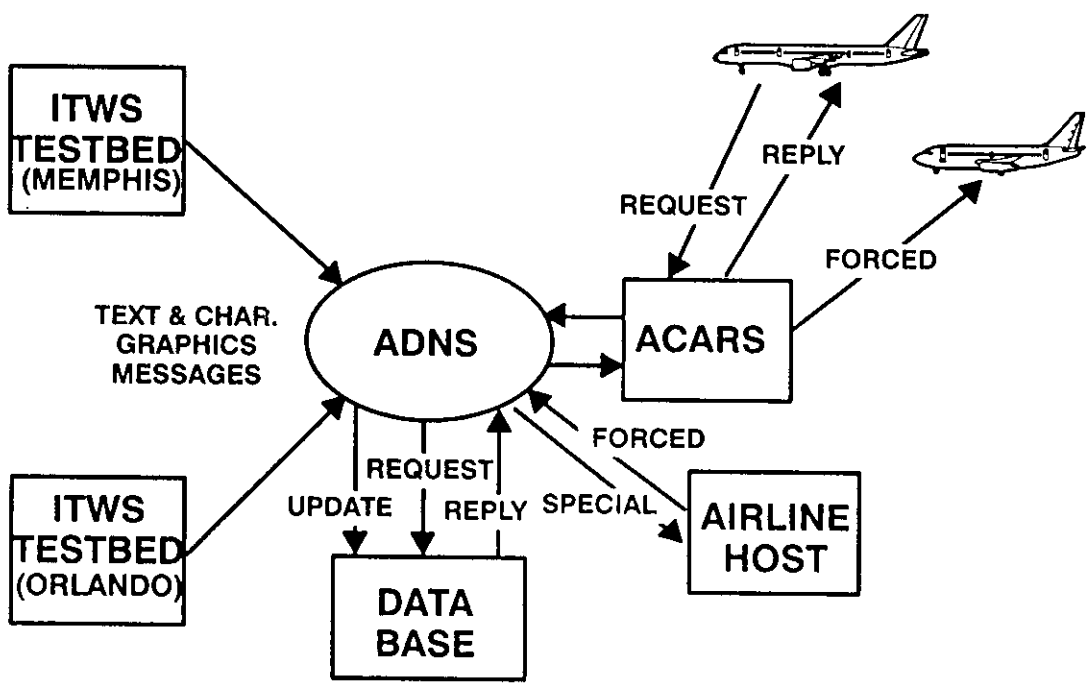


Figure 3. Terminal Weather Information for Pilots (TWIP) Summer '94 Demonstration at Memphis and Orlando.

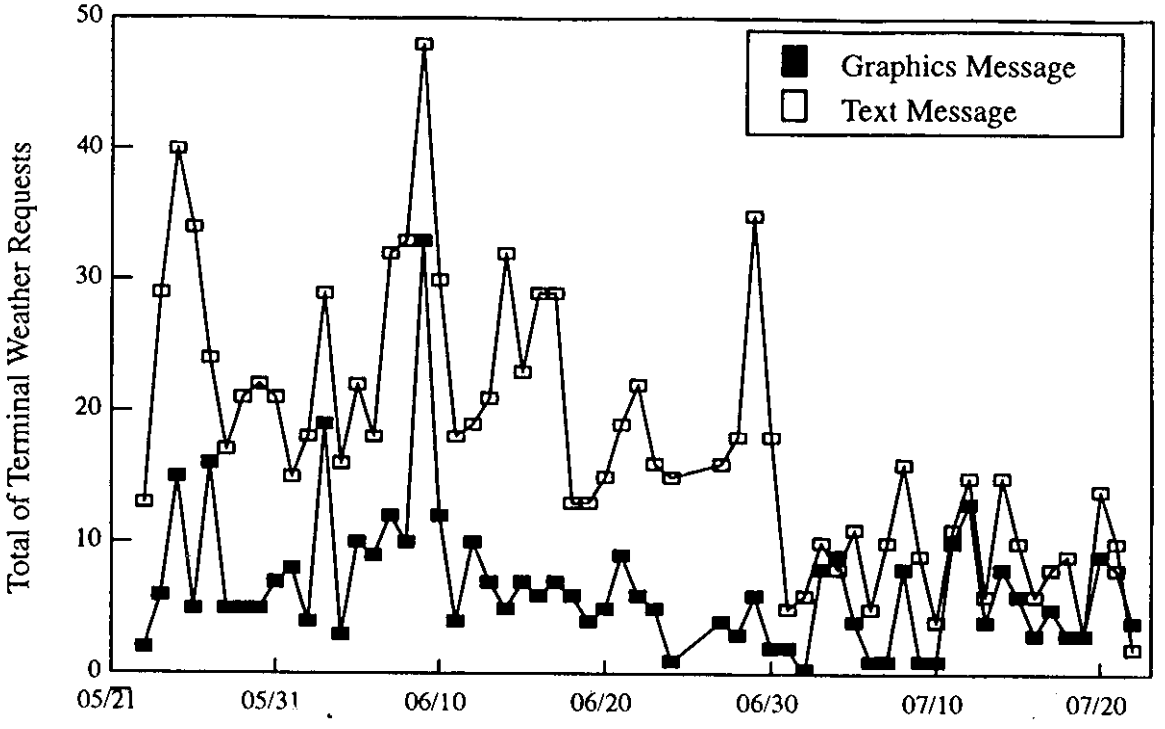


Figure 4. Terminal Weather requests by day for the Summer '94 Memphis, TN demonstration.

The TWIP Character Graphics Depiction did not receive as many requests as the Text Messages because only two airlines (American and Delta) had 40 character–wide printers capable of displaying the message. A total of 394 Character Graphics Depiction requests were made for an average of 7 requests per day.

To assess how valuable the product is to pilots, ARINC developed a questionnaire for the pilots involved in the Memphis and Orlando demonstration. Questionnaire requests compiled from the summer '93 demonstration show that the pilots support the TWIP product (note: the questionnaires from the 1994 demonstration were not available at this writing). A total of 142 questionnaires from four airlines [A (89), B (49), C (1), and D (3)], were returned for analysis. Figure 5 shows how the pilots rated the TWIP Text Message on a scale of 1 (low) to 5 (high). Overall pilots found the demonstration very useful (4.4) and that it provided situational awareness (4.3) They found it provided some assistance in making operational decisions (3.9) and that it slightly decreased workload (3.2).

Pilots also had the opportunity to rate the importance of various products provided in the text message. It was anticipated that microburst alerts would receive the highest rating. However microburst alerts were rated as a 4.1 out of a possible 5. Interestingly, pilots rate expected microburst as being of greater importance with a rating of 4.9. Pilots also rated the expected gust front(4.9) as being more important than gust front impacts (4.6).

This preference is probably explained by the phase of flight at which pilots are making requests for terminal weather information. Of the 142 questionnaires received, 52 (36%) pilots indicated that they requested the message during the initial descent. Other times of requested included 30 during initial approach, 27 during top of descent , and 24 during cruise. Only 3 pilots indicated that they requested the

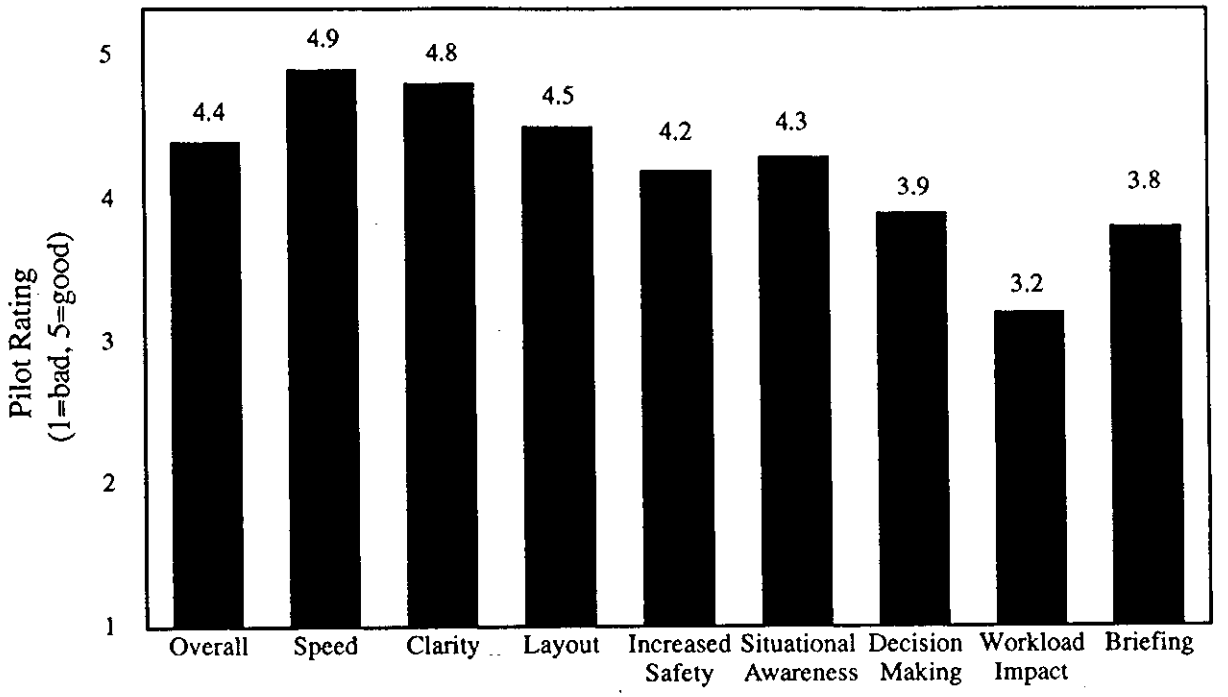


Figure 5. Pilot rating of TWIP message service (1993 demonstration questionnaire results)

message during final approach. Therefore, pilots are most frequently requesting the message about 15–30 minutes before landing. Thus information about anticipated weather hazards would naturally be of greatest interest.

5. FUTURE WORK

The TWIP demonstrations during the past two summers operated for limited hours per day and for limited time periods. A key objective is to provide a 24 hour per day, 7 day per week TWIP demonstration for an extended period of time. In order to do this, it is necessary to adapt the existing the TWIP software to operate from products generated by an operational TDWR.

Figure 6 shows a proposed method for such a TDWR–based demonstration during the summer of 1995. A Sun workstation will be modified to accept TDWR data, generate the TWIP messages and provide these messages over the FAA's NADIN Packet Switched Network (PSN). This TWIP Data Processor (TDP) will accept TDWR products from a serial port on the TDWR DFU (Display Function Unit) and interface to the NADIN PSN via the Digital Multiplexing Network (DMN). The TDP will also be able to supply the standard TDWR graphical products to dispatchers and other users via the NADIN connection.

Once the TWIP products are made available on the NADIN PSN, they can be requested by airline host computers directly, or indirectly via gateways between the NADIN PSN, ARINC Packet Network (APN) and ARINC Data Network Service (ADNS). Alternatively, the products could also be provided directly via a connection from the TDP to ADNS. The messages can be requested directly from the TDP over the network or indirectly from a central database that the TDP updates once per minute. The messages can also be sent automatically by the TDP to the airline host based on certain cri-

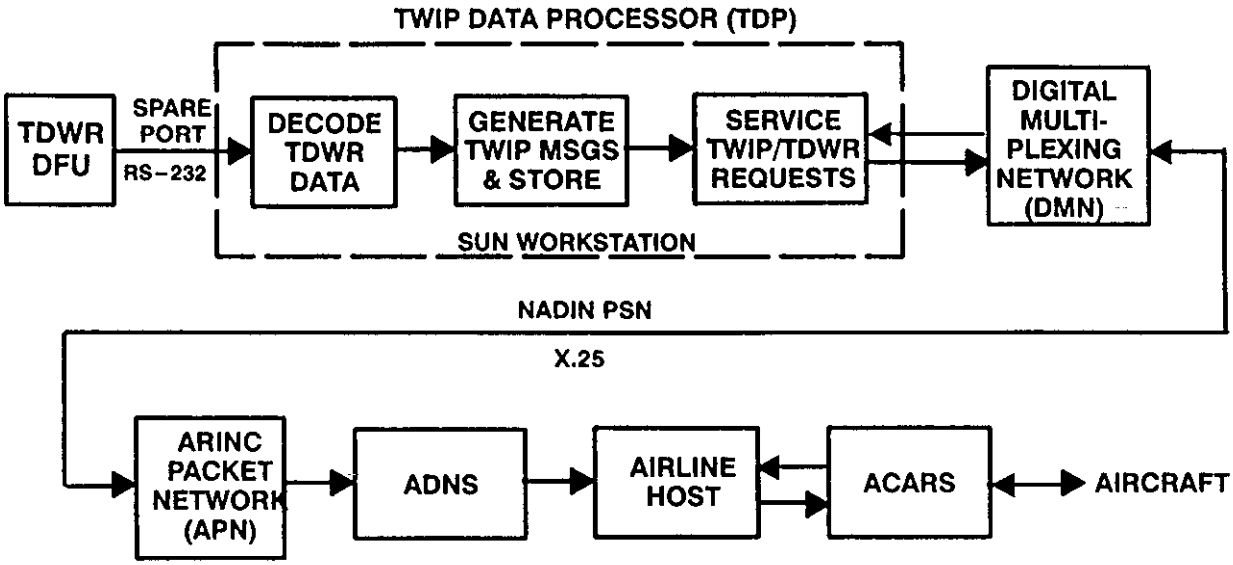


Figure 6. Proposed TDWR–based demonstration for summer '95.

teria, such as onset of wind shear activity at the airport.

Once received at the airline host, the TWIP message can be sent to aircraft via ACARS or other data link methods. The TDWR products can also be provided to the airline host for use by dispatchers and meteorologists. In the future, the graphical TDWR products will also be made available to aircraft for full color cockpit display.

6. SUMMARY

This paper has presented work in providing terminal weather information to pilots in the form of text and character graphics messages. The advantage of this approach is that it utilizes new weather sensors currently being deployed by the FAA and employs existing aircraft data link and display capabilities.

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8. REFERENCES

Campbell, S.D., 1994: Terminal Weather Message Demonstration at Orlando, FL, Summer 1993, *Lincoln Laboratory Journal* (in press).