DOT/FAA/CT-ACD32092/3

A SURVEY OF DATA LINK AIR TRAFFIC SERVICES AND FUNCTIONS: RESULTS SUMMARY

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May 7, 1992

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1. INTRODUCTION.

As one of its first activities, Working Group 1 (WG1) of RTCA Special Committee (SC) 169 initiated an effort to catalogue air traffic services and functions that have been proposed for implementation on an air-ground Data Link communications system. Information compiled during 1991 yielded descriptions of over 100 proposed Data Link applications. One purpose of creating this documentation was to provide a basis for recommending Data Link service development and implementation priorities to the main body of SC 169. The survey presented in this report was conducted to provide inputs to these recommendations.

2. SURVEY OBJECTIVES.

The primary purpose of the survey was to gather data on the relative benefits of the documented Data Link services as perceived by members of SC 169 WG1 representing system developers and users. For each service, all participants were asked to estimate the levels of benefit that would be received by aircrew members, air traffic controllers, air line operators, and the ATC system. A secondary objective of the survey was to obtain global estimates from the respondents regarding the general time frame during which it would be technically feasible to implement each service.

3. BACKGROUND.

Because a large number of candidate services were identified during the documentation process, it was determined that the task of developing implementation recommendations would be conducted in two stages. In November 1991, a volunteer subgroup of WG1 met to define evaluation criteria and to outline a survey format. The survey, covering all 123 services in the data base, was subsequently circulated to these eleven subgroup members of whom five represented controller and ATC concerns and six represented aircrew and airline concerns. The intent of this initial data collection task was to screen the candidate services and produce a more manageable set for evaluation by the membership of WG1. The survey discussed in this document was developed from the results compiled by the subgroup.

4. METHODOLOGY.

The survey distributed to the full membership of SC 169 WG1 presented 40 services for full evaluation. Two criteria were used to select these services from the original set of 123 that were evaluated during the initial subgroup screening. First, services were selected which ranked in the top 40 in terms of their combined ratings of perceived benefits to aircrew, controllers, airlines, and the ATC system. Second, services were added to the list which had ranked in the top ten in any of the

four individual benefit categories, but had not made the top 40 on the combined ratings. Editing to eliminate ten duplicate items yielded the final list of 40 services (see Table 1.) A sample of the form used to obtain the benefit ratings and the estimates of feasible implementation time frames for each of the top 40 services is presented in Figure 1.

In order to guard against selection bias that may have existed during the initial screening, a second section of the survey listed the 83 services that had not been included in the full evaluation group. Respondents were given the opportunity to examine the descriptions of the services that did not meet the criteria for full evaluation, and designate those which they felt should be added to the high priority group.

5. RESULTS.

Seventeen members of WG1 provided survey responses. Of these, 6 indicated that they completed the survey as air traffic controller/ATC representatives, 5 as pilot and/or airline representatives, and 6 as system designers/developers. While this sample appears to adequately reflect the demographic composition of WG1, the small total number of respondents precluded any detailed analyses of the relationship between affiliation and benefit ratings. As a consequence, results derived from all respondents were pooled to assess the relative benefits of each service and predicted implementation time frames.

5.1 Individual Group And Shared Benefits.

Table 2. presents the pooled ratings assigned to the 40 services in each of the four benefit categories. The values shown in this table are median ratings on a five-point scale (1 - low benefit to 5 - high benefit). The columns appearing next to the median ratings present the lowest and highest ratings obtained for each service. It should be noted that the broad range of ratings received by a majority of the services suggests that caution be observed when interpreting small differences between services using the median scores.

The data suggest that, if all 40 services yielded by the initial screening were implemented, the greatest median total benefit would accrue to aircrews (4.75 on the 1-5 scale), followed by controllers (4.00), the ATC system (3.5), and airlines (3.0). Non-parametric analysis of variance and subsequent Wilcoxon tests indicated that the predicted differences in benefit levels all were significant ($p<.03$).

Differences among the groups in terms of the services which were predicted to provide the highest benefits can be determined by detailed examination of Table 2. The following lists are

TABLE 1.
40 Data Link Services Presented for
Full Survey Evaluation

Service Code Number		
	General Data Link Functions (Utilities)	
123	Utilities:	Facility in Control
120	Utilities:	Controller Acknowledgment
119	Utilities:	Flight Crew Acknowledgment
121	Utilities:	Technical Acknowledgment
122	Utilities:	Error
	Information Services	
60	Terminal:	Departure ATIS
72	Terminal:	Arrival ATIS
74	Terminal:	Terminal Information
	ATC Services & Service Requests	
62	Terminal:	Predeparture Clearance
7	All Regimes:	Transfer of Communication
100	All Regimes:	Initial Contact
77	All Regimes:	Altimeter Setting
33	All Regimes:	Speed Change
34	All Regimes:	Speed Request
14	All Regimes:	Altitude Assignment With Restrictions
12	All Regimes:	Altitude Assignment
17	All Regimes:	Cruise Flight Level Assignment/ Confirmation (aka Modification of Planned Flight Level)
13	All Regimes:	Request Altitude
18	All Regimes:	Requested Flight Level Amendment (aka Modification of Requested Flight Level)
30	All Regimes:	Heading (aka Vectors)
20	All Regimes:	Route Amendment
21	All Regimes:	Route Amendment Request
3	All Regimes:	Flight Plan Amendment Request
83	Terminal:	ATC Approach Instructions
	Oceanic Services	
108	Oceanic:	Oceanic Clearance
109	Oceanic:	ADS Periodic Report Contract Establishment
111	Oceanic:	ADS Periodic Report
113	Oceanic:	ADS Event Report Contract Establishment

114	Oceanic:	ADS Event Report
110	Oceanic:	ADS Single Report Request
115	Oceanic:	Air-to-Air Datalink Message Routing

Emergency & Special Communications

4	All Regimes:	Flow Management Advisory
96	En Route:	Top-of-Descent Preference
19	All Regimes:	Time-of-Arrival Metering Goal
44	All Regimes:	Communication Backup - Uplink
45	All Regimes:	Communication Backup - Downlink
29	All Regimes:	Emergency Landing Vectors
28	All Regimes:	In-Flight Emergency (Critical Situation Announcement)
92	Terminal:	Windshear Advisory Service
53	All Regimes:	Hazardous Weather Advisory

FIGURE 1.

SERVICE RATINGS DATA FORM

CATEGORY: Terminal

SERVICE NUMBER: 83

SERVICE DESCRIPTION: ATC Approach Instructions

ATC transmits to aircraft clearance to perform an indicated approach.

BENEFITS

For each of the four groups listed below, place an "X" below the number which best describes your perception of the level of benefit that will be provided by this service. Be sure to rate the benefit level for each group -- not just the one which you are representing in completing this questionnaire.

BENEFITS

	LOW 1	2	3	4	HIGH 5
AIRCREW	_____	_____	_____	_____	_____
CONTROLLER	_____	_____	_____	_____	_____
AIRLINE	_____	_____	_____	_____	_____
ATC SYSTEM	_____	_____	_____	_____	_____

FEASIBLE TIME FRAME

Place an "X" next to the earliest time frame during which you feel that this service could be implemented.

For the purposes of this rating, the following definitions of implementation time frames should be used:

NEAR TERM (0 to 5 years) - Current ATC and aircraft systems with minor modifications.

MID TERM (6 to 10 years) - Prior Data Link service implementation required or significant ATC and/or aircraft system enhancements needed.

LONG TERM (11+ years) - Advanced ATC and aircraft system capabilities are required.

_____ NEAR TERM IMPLEMENTATION IS FEASIBLE
_____ MID TERM IMPLEMENTATION IS FEASIBLE
_____ LONG TERM IMPLEMENTATION IS FEASIBLE

COMMENTS:

TABLE 2.
Median Benefit Ratings for Individual Groups

Service Code Number*	Aircrews Med.	Aircrews Range	Controllers Med.	Controllers Range	Airlines Med.	Airlines Range	ATC System Med.	ATC System Range
123	4.0	2-5	5.0	1-5	2.0	1-5	4.0	1-5
120	4.0	1-5	4.0	1-5	2.0	1-5	3.0	1-5
119	4.0	1-5	5.0	1-5	2.0	1-5	4.0	1-5
121	5.0	2-5	5.0	2-5	3.0	1-5	5.0	3-5
122	5.0	2-5	5.0	2-5	3.0	1-5	5.0	3-5
60	5.0	3-5	4.0	1-5	3.0	1-5	3.0	1-5
72	5.0	3-5	4.0	2-5	3.0	1-5	3.0	2-5
74	5.0	3-5	5.0	4-5	3.0	1-5	4.0	2-5
62	5.0	4-5	5.0	4-5	4.0	2-5	5.0	2-5
7	5.0	2-5	5.0	3-5	3.0	1-5	4.5	2-5
100	5.0	1-5	5.0	3-5	2.5	1-5	4.0	1-5
77	5.0	2-5	4.0	2-5	2.0	1-5	3.5	2-5
33	4.0	1-5	4.0	2-5	2.0	1-5	3.0	1-5
34	4.0	1-5	3.0	2-5	2.5	1-5	3.0	2-5
14	4.0	2-5	4.5	3-5	2.5	1-5	3.0	2-5
12	5.0	3-5	5.0	3-5	3.0	1-5	3.5	2-5
17	4.0	2-5	4.0	2-5	3.0	1-5	3.5	1-5
13	4.0	3-5	4.0	2-5	3.0	1-5	3.0	2-5
18	4.5	3-5	4.0	2-5	3.0	1-5	3.0	2-5
30	4.0	2-5	4.0	2-5	2.0	1-3	3.0	2-5
20	4.0	2-5	4.5	3-5	3.0	1-5	4.0	2-5
21	4.0	3-5	3.5	2-5	4.0	1-5	3.0	2-5
3	5.0	2-5	4.0	2-5	3.5	1-5	3.5	2-5
83	3.0	2-5	4.0	1-5	2.0	1-5	3.0	1-5
108	5.0	3-5	4.5	3-5	4.0	1-5	4.0	2-5
109	5.0	2-5	5.0	2-5	4.0	2-5	4.5	2-5
111	5.0	2-5	5.0	1-5	5.0	2-5	5.0	2-5
113	5.0	2-5	5.0	2-5	5.0	2-5	4.0	2-5
114	5.0	2-5	5.0	3-5	4.0	2-5	4.0	2-5
110	4.0	2-5	4.0	2-5	3.0	1-5	3.0	2-5
115	4.0	1-5	3.0	1-5	4.0	1-5	3.0	1-5
4	4.0	1-5	3.5	1-5	3.0	1-5	3.5	1-5
96	4.0	3-5	3.0	2-5	4.0	2-5	3.0	2-5
19	4.0	2-5	4.0	2-5	4.0	2-5	4.0	3-5
44	4.0	1-5	4.0	1-5	4.0	1-5	4.0	1-5
45	4.0	1-5	4.0	1-5	3.0	1-5	4.0	1-5
29	5.0	1-5	4.0	1-5	3.0	1-5	2.0	1-5
28	5.0	1-5	4.0	1-5	3.5	1-5	4.5	1-5
92	5.0	2-5	4.0	2-5	4.0	2-5	3.0	1-5
53	5.0	3-5	4.0	1-5	3.0	1-5	3.5	1-5

* See Table 1. for Service Names

presented as a brief overview of these differences. In each case, the lists contain the six services which received the highest median ratings with the narrowest rating range. Additional services are included if their median ratings and rating ranges were tied with the sixth ranked service. The median rating for each service is shown in parentheses.

Aircrews:

Predeparture Clearance (5), Arrival ATIS (5), Departure ATIS (5), Oceanic Clearance (5), Terminal Information (5), Altitude Assignment (5), Hazardous Weather Advisory (5).

Controllers:

Terminal Information (5), Predeparture Clearance (5), Initial Contact (5), ADS Event Report (5), Transfer of Communication (5), Altitude Assignment (5).

Airlines:

ADS Event Report Contract Establishment (5), ADS Periodic Report (5), ADS Periodic Report Contract Establishment (4), Time-of-Arrival Metering Goal (4), Windshear Advisory Service (4), ADS Event Report (4), Top-of-Descent Preference (4), Predeparture Clearance (4).

ATC System:

Technical Acknowledgement (5), Error Message (5), Predeparture Clearance (5), ADS Periodic Report (5), ADS Periodic Report Contract Establishment (4.5), Transfer of Communication (4.5), In Flight Emergency Announcement (4.5).

Regardless of these group differences, examination of the most highly rated services across groups indicates that they will receive considerable shared benefits from a relatively small number of services. The top 20 services for each of the four groups were composed of a total of 35 of the 40 candidates. Six of these appeared in all four preferred lists (Predeparture Clearance, Terminal Information, Altitude Assignment, Technical Acknowledgement, Transfer of Communication, and Initial Contact). Nine were shared by three of the groups, and additional nine by two of the groups. Only 11 of the services appeared in the top 20 of a single group.

5.2 Combined Benefit Scores and Implementation Time Frames.

Table 3. presents a combined benefits score for each service and the median time frame during which the respondents felt it would be feasible to implement the services. The combined benefit score was derived by summing the median ratings across all four

TABLE 3
Combined Benefit Scores and Time Frame Estimates

Service Code Number*	Combined Benefit Score	Median Implementation Time Frame **
123	15.0	1.00
120	13.0	1.00
119	15.0	1.00
121	18.0	1.00
122	18.0	1.00
60	15.0	1.00
72	15.0	1.00
74	17.0	1.00
62	19.0	1.00
7	17.5	1.00
100	16.5	1.25
77	14.5	1.00
33	13.0	1.00
34	12.5	2.00
14	14.0	1.75
12	16.5	1.50
17	14.5	1.50
13	14.0	1.50
18	14.5	1.25
30	13.0	2.00
20	15.5	2.00
21	14.5	2.00
3	16.0	2.00
83	12.0	2.00
108	17.5	1.00
109	18.5	1.00
111	20.0	1.00
113	19.0	1.00
114	18.0	1.00
110	14.0	1.00
115	14.0	2.00
4	14.0	2.00
96	14.0	2.00
19	16.0	2.00
44	16.0	1.25
45	15.0	1.25
29	14.0	2.00
28	17.0	2.00
92	16.0	2.00
53	15.5	1.00

* See Table 1. for Service Names
** 1.0 = Short Term (0-5 yrs.), 2.0 = Mid Term (6 to 10 yrs.), 3.0 = Long Term (11+ yrs.)

benefit categories.

Based on this combined score, the 20 most highly rated services were: ADS Periodic Report, Predeparture Clearance, ADS Event Report Contract Establishment, ADS Periodic Report Contract Establishment, Error Message, Technical Acknowledgement, ADS Event Report, Transfer of Communication, Oceanic Clearance, Terminal Information, In Flight Emergency Announcement, Initial Contact, Altitude Assignment, Communication Back-Up Uplink, Time-of-Arrival Metering Goal, Flight Plan Amendment Request, Windshear Advisory Service, Hazardous Weather Advisory, Route Amendment, and Flight Crew Acknowledgement Message.

Inspection of the median estimated time frame in which the respondents felt it would be technically feasible to implement these highly rated items shows that 12 of the 20 could be fielded in the near term (0 to 5 years), while only five would require technical development possible within the next 6 to 10 years, and three would be feasible in a period falling between the near and mid-term. The median estimates indicate that none of the top twenty services on the combined rating list would have to be deferred to the long term time frame (11 + years) for technical reasons.

5.3 Recommended Additions to the High Priority List.

Table 4. presents a list of the Data Link services which did not pass the initial screening, but were designated by two or more respondents in the full group survey as belonging in the higher benefit/priority category. The value shown in parentheses next to the service names indicates the number of survey participants that selected the service for inclusion.

TABLE 4.
Services Recommended by Two or More Respondents for Inclusion in the High Benefit Category

(7) Aircraft Log-In

(6) Log Off

(5) IFR Clearance Activation Request

(3) PIREPS

(3) Air Observation Downlink

(2) FMS Trajectory Computation

(2) Hold Instructions

(2) Out of Conformance

(2) TCAS Advisory

(2) Minimum Safe Altitude Warning

(2) Terminal Forecast

(2) Winds and Temperatures Aloft

(2) Radar Summary

(2) NOTAMS

(2) FMC to FMC Direct Communications

(2) Runway Visual Range