

Controller-Pilot Data Link Communication Build 1 (CPDLC-1) Benefits



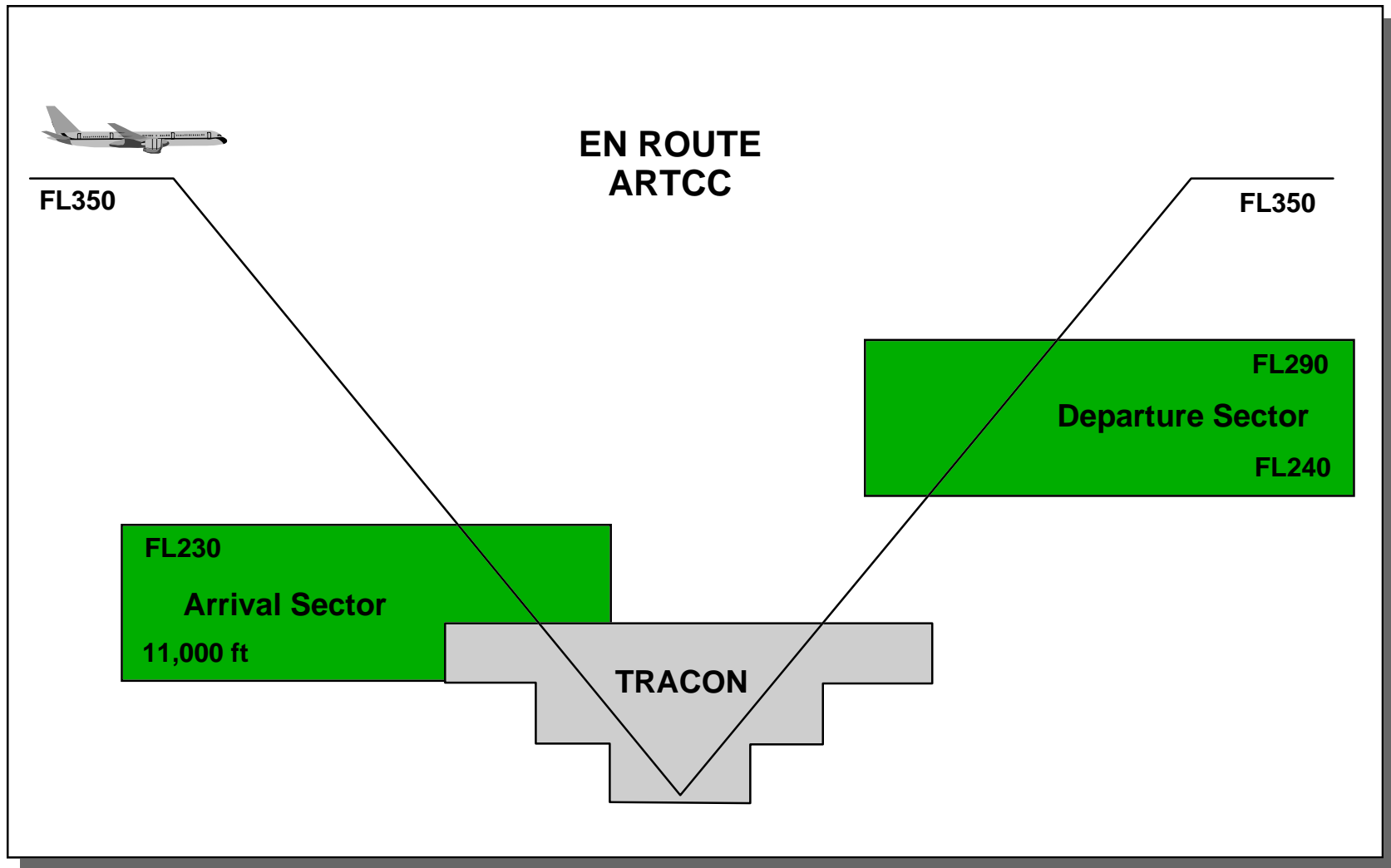
Frank W. Buck
James F. Simpkins

30 December 1997

Organization: F065
Project: 0298012Q-NW

MITRE

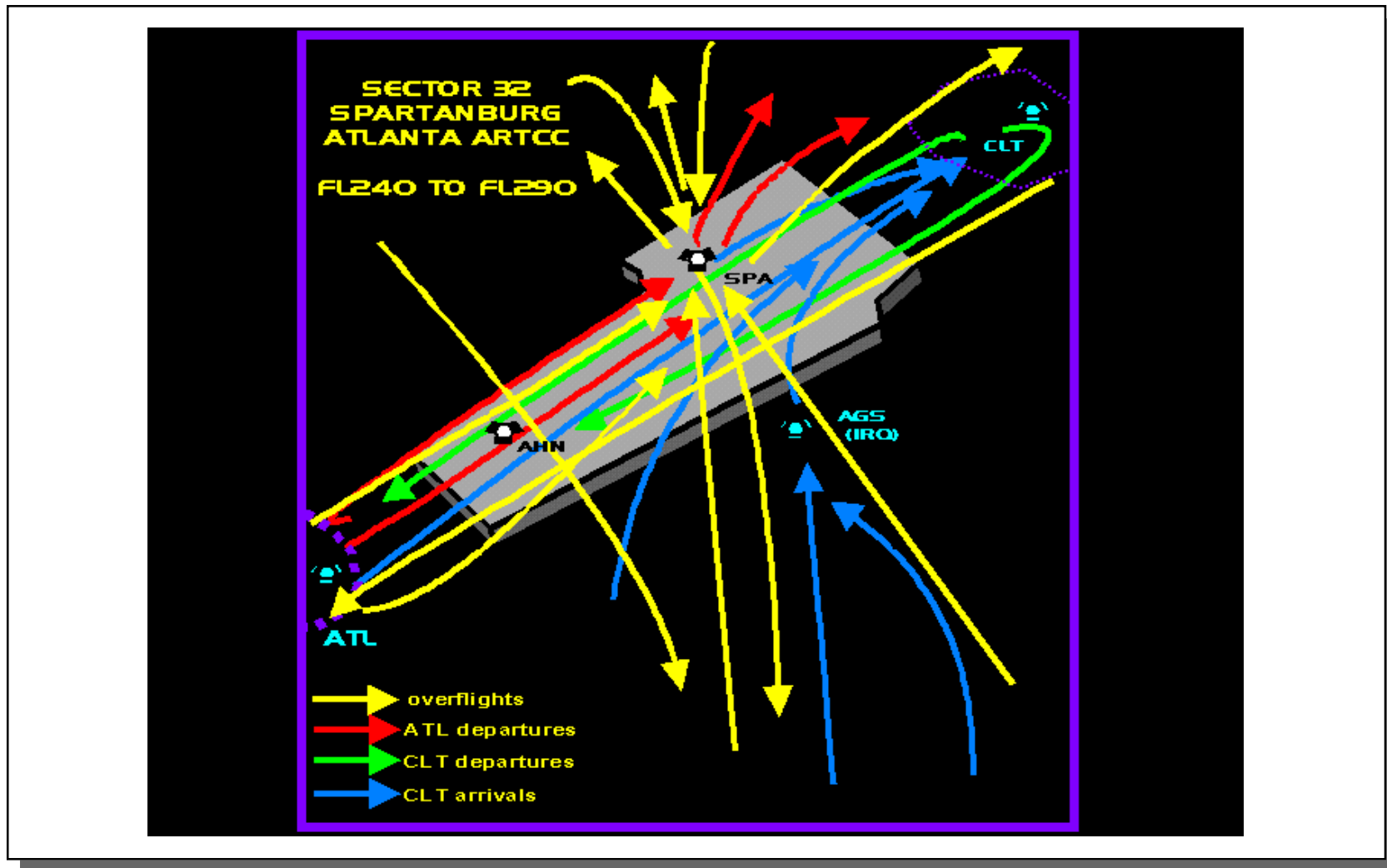
En Route and Terminal Airspace Relationship



CPDLC Benefits Overview

- **Total \$\$ savings:**
 - **Savings at the two sectors in Atlanta is in excess of 8.6 million annually**
 - **43 sectors nationally where identified to have the same characteristics of sectors 32 and 09**
 - **Savings nationally is in excess of 337 million dollars**

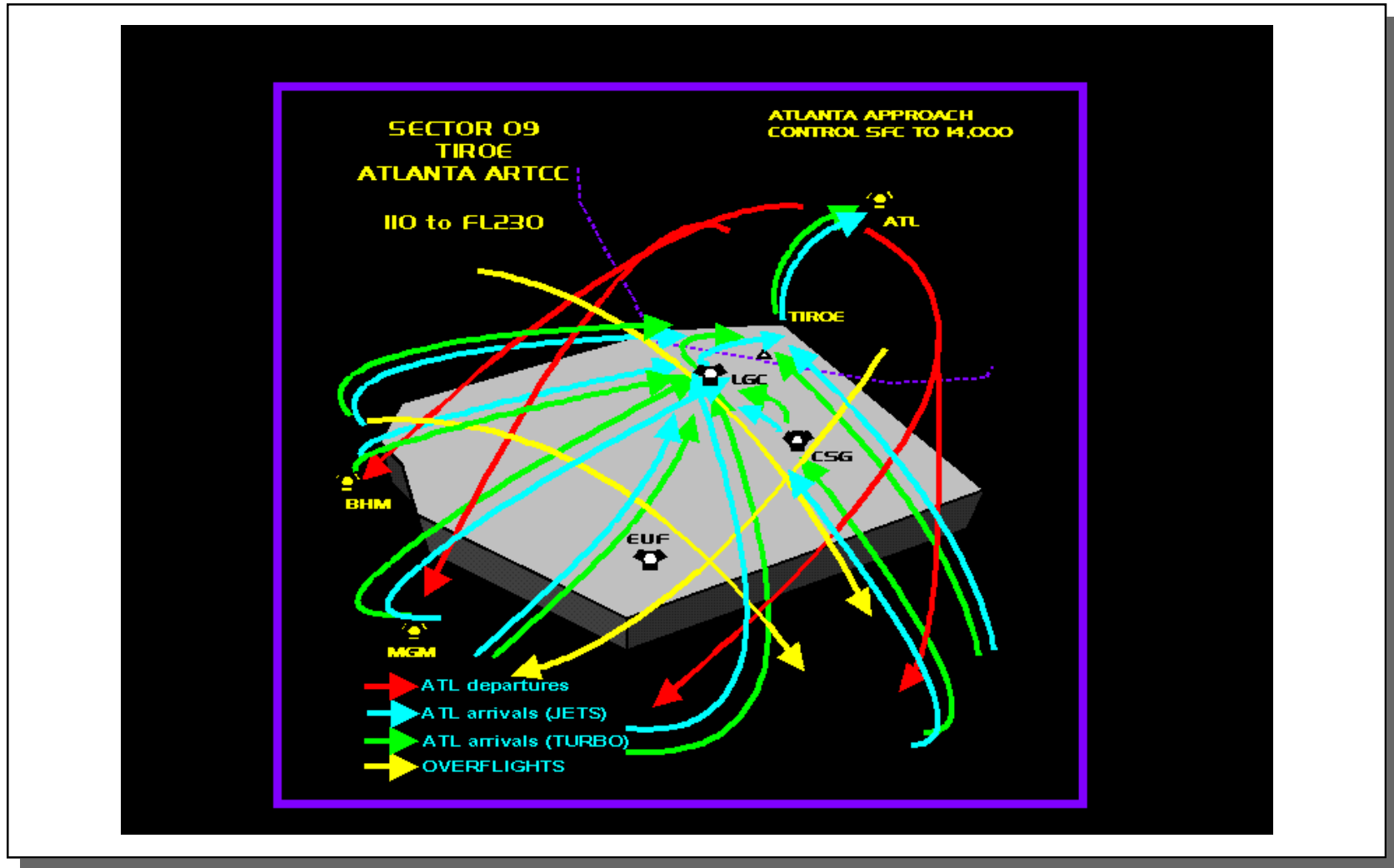
Atlanta ARTCC Sector 32, Spartanburg



Sector 32 - Departure Sector

- **Sector 32, Spartanburg, is an Atlanta departure sector whose primary task is to control departures of jet aircraft climbing from the Atlanta airport**
- **During peak traffic periods, 20 miles in trail (MIT) are required for departures entering this sector**
 - **This translates into ground delays for aircraft entering sector 32 as well as other aircraft waiting behind these aircraft on the ground**
- **Data link allowed the reduction of the 20 MIT to minimum MIT (5 miles)**
 - **This resulted in total delays for all 48 aircraft in the study from 1,795 minutes to 687 minutes or a 62% reduction (p37)**
- **Controller teamwork/delegation of tasks, with the additional communications capacity led to more efficient and higher capacity use of the existing airspace**

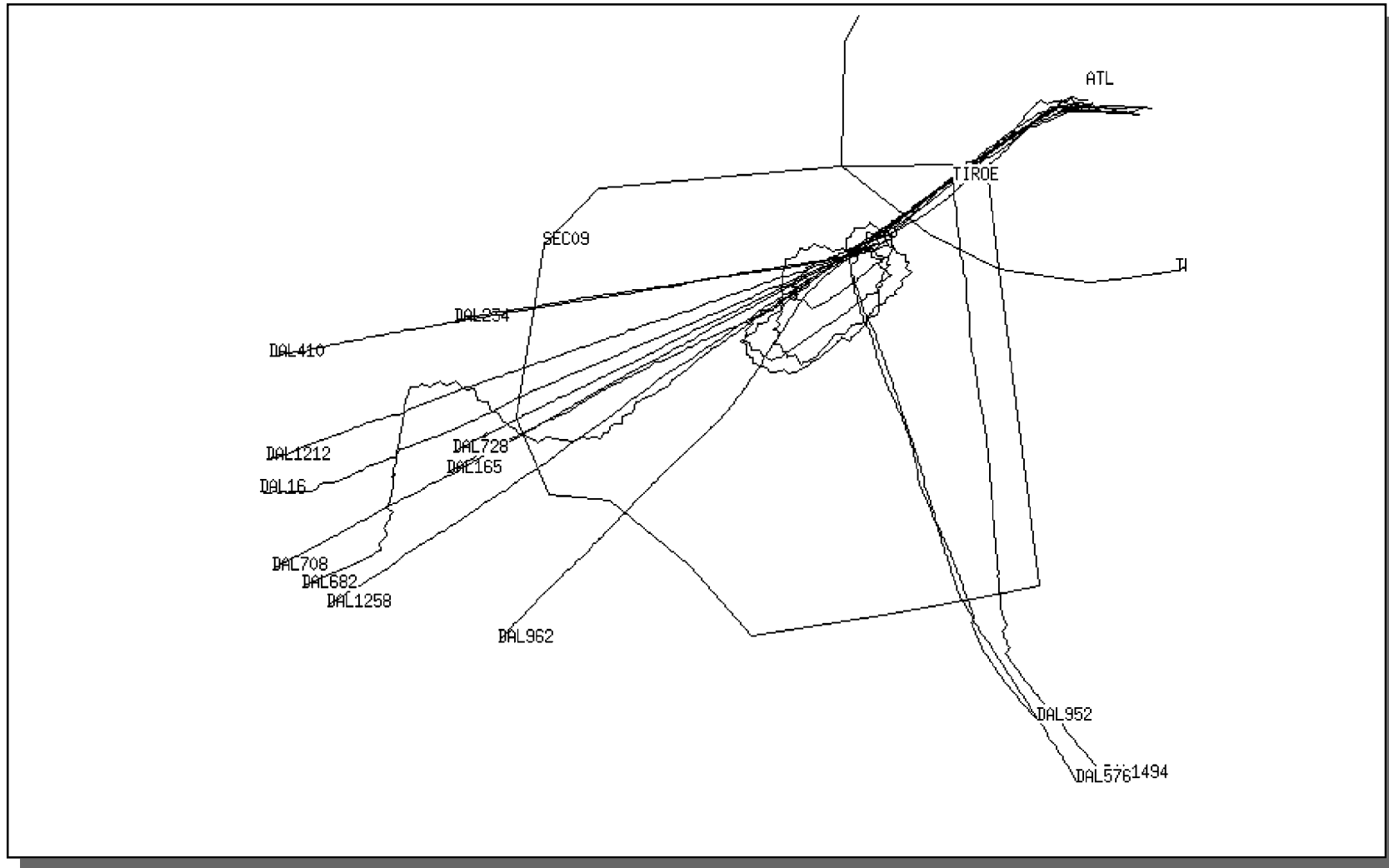
Atlanta ARTCC Sector 09, Tiroe



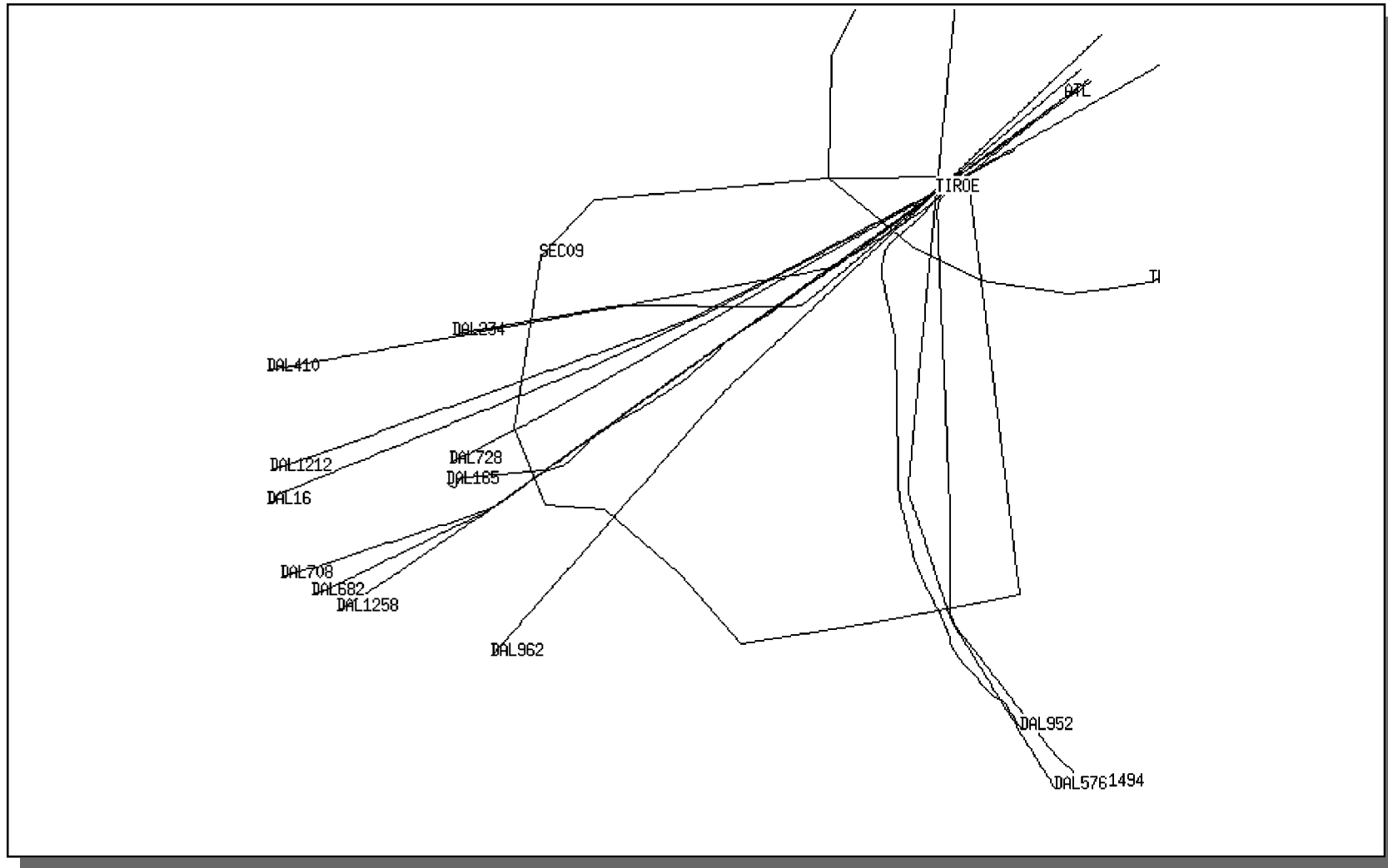
Sector 09 - Arrival Sector

- **Sector 09, Tiroe, is an Atlanta arrival sector whose primary task is to sequence aircraft inbound to the Atlanta approach**
- **During the peak periods, controllers in sector 09 cannot consistently provide the minimum MIT to the approach control**
 - **This prevents efficient merging of traffic and forces extensive vectoring and holding**
- **Data link provided the controller team to work more efficiently resulting in elimination of holding and improved vectoring**
 - **The average flight time was decreased from 18 to 14 minutes**
 - **The total miles flown was decreased from an average of 111 miles to 89 miles**

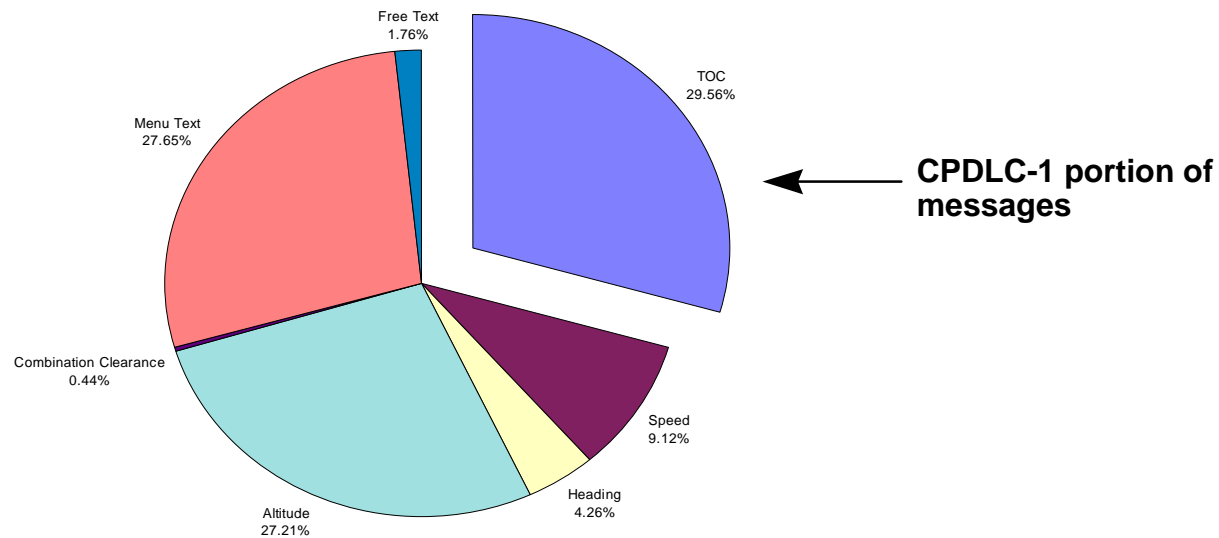
Selected Atlanta Arrivals from the En Route Benefit Study Baseline



Effect of CPDLC Usage with the Selected Atlanta Arrivals, Team 2



En Route Benefit Study Uplink Messages



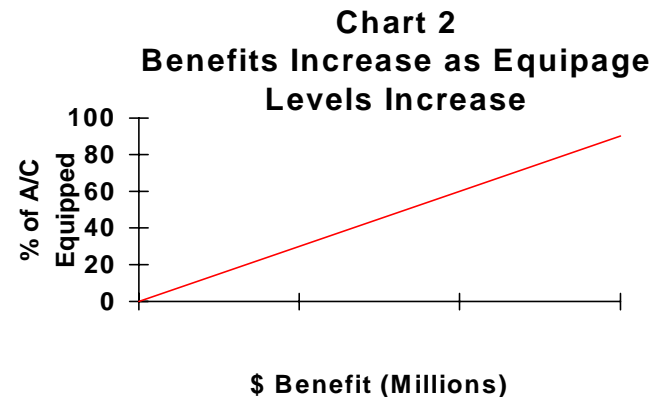
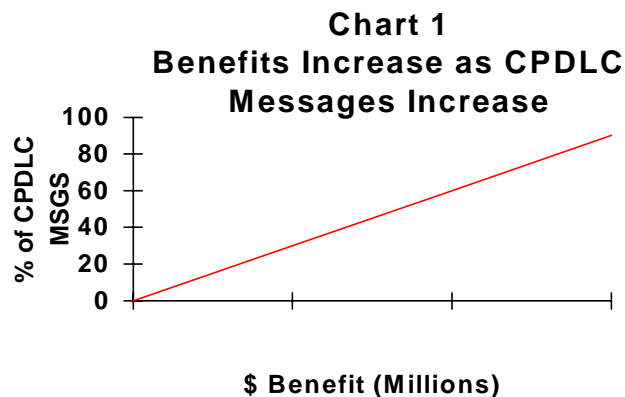
- Initial contact was used in the benefits study (i.e., no voice check in)
- Altimeter setting, while not used in the benefits study, is part of CPDLC-1 and is required below 18,000 ft.

CPDLC-1 Application Definition for Benefits

- **Current Definition based on Air Traffic and Airline input**
 - **Transfer of Communication (TOC)**
 - **Initial Contact (IC)**
 - **Altimeter Setting (ASM)**
 - **Pre-defined Controller Message Text (PDM)**
- **Ops Concept from AT**
 - **Safety Hazard Assessment on-going to determine if CPDLC-1 is a Minor Hazard**
- **Benefits for TOC, IC, and altimeter setting can be derived from benefits study data**
- **Other benefits derived from CPDLC-1 for sectors not included in the en route benefits study are not included in this analysis**

CPDLC-1 Benefit Calculation Assumptions

- Data Link benefits are a direct result of the reduction in frequency congestion
- Reduction in frequency congestion is directly proportional to the data link messages transmitted; each data link message transmitted has an equal amount of benefit (Chart 1)
- Benefit is directly proportional to the equipage level in the ATC airspace (Chart 2)



Benefit Calculations

Detailed Sector Breakdown Approach

- The En Route Benefit study team performed a national sector survey in 1994, to identify which sectors throughout the National Airspace System (NAS) experience inefficiencies due to communications problems similar to the 2 Atlanta sectors used in the study
- The number of days per year, daily time periods, and percentage of departures, arrivals and overflights were also identified for these sectors. The SIMMOD model was used to calculate the total airborne and ground delay that could be avoided with CPDLC
- The airborne and ground operating costs used in the benefit study were:
 - Airborne Rate = \$31.50/min
 - Ground Rate = \$26.20/min

Detailed Sector Breakdown Approach (Concluded)

- We assumed that the sectorization in the targeted centers have not changed and the sector characterizations identified during the site survey are still valid. NOTE: The targeted ARTCC airspaces may need to be re-evaluated to identify the benefit sectors, time periods, and delay rates
- We analyzed 7 days worth of ETMS data position reports from October 1996 along with the sector boundaries from the 1994 adaptation to determine the specified airline percentage of aircraft in the benefit sectors at the identified time periods
- We then used these percentages to calculate the minutes saved in the air and on the ground due to the use of CPDLC-1

CPDLC-1 Benefits for Airline1 at Atlanta

Airline1 at Atlanta

- **The national sector survey completed for the En Route benefit study identified 5 sectors in the Atlanta Center that would benefit from CPDLC:**
 - **Sector 19 (Sinca) during 3 time periods**
 - **Sector 31 (Unarm) during 3 time periods**
 - **Sector 29 (Leeon) during 3 time periods**
 - **Sector 09 (Tiroe) during 3 time periods**
 - **Sector 32 (Spartansburg) during 2 time periods**

Airline1 at Atlanta (Continued)

- Airline1 % of aircraft in these sectors is the following (all times are Zulu time):

Sector and Time	Airline1 % of Aircraft
Sector 19 13:15 - 13:45	4.55%
Sector 19 15:45 - 17:15	.67%
Sector 19 22:15 - 23:00	0%
Sector 31 13:30 - 16:15	26.36%
Sector 31 18:30 - 19:30	23.42%
Sector 31 21:45 - 22:30	18.83%
Sector 29 14:00 - 18:30	29.94%
Sector 29 20:15 - 21:15	7.91%
Sector 29 23:15 - 0:15	35.48%
Sector 09 12:10 - 13:10	0%
Sector 09 14:45 - 17:00	.37%
Sector 09 21:15 - 23:45	0%
Sector 32 14:00 - 15:30	22.12%
Sector 32 17:50 - 18:50	24.63%

Airline1 at Atlanta (Continued)

- The SIMMOD model determined the airborne and ground delay that could be avoided for sectors 19, 31, 29, 09, and 32. This number is then multiplied by the CPDLC-1 Benefit Factor, as shown below:

Sector and Time	SIMMOD CPDLC Airborne Minutes	*	CPDLC-1 Benefit Factor %	CPDLC-1 Airborne Minutes Saved	Sector and Time	SIMMOD CPDLC Ground Minutes	*	CPDLC-1 Benefit Factor %	CPDLC-1 Ground Minutes Saved
Sector 19 13:15 - 13:45	4,447	*	1.49%	66	Sector 19 13:15 - 13:45	0	*	1.49%	0
Sector 19 15:45 - 17:15	8,337	*	0.22%	18	Sector 19 15:45 - 17:15	0	*	0.22%	0
Sector 19 22:15 - 23:00	3,891	*	0%	0	Sector 19 22:15 - 23:00	0	*	0%	0
Sector 31 13:30 - 16:15	80,929	*	8.66%	7,007	Sector 31 13:30 - 16:15	0	*	8.66%	0
Sector 31 18:30 - 19:30	35,069	*	7.69%	2,697	Sector 31 18:30 - 19:30	0	*	7.69%	0
Sector 31 21:45 - 22:30	25,178	*	6.18%	1,557	Sector 31 21:45 - 22:30	0	*	6.18%	0
Sector 29 14:00 - 18:30	115,099	*	9.83%	11,320	Sector 29 14:00 - 18:30	0	*	9.83%	0
Sector 29 20:15 - 21:15	26,976	*	2.60%	701	Sector 29 20:15 - 21:15	0	*	2.60%	0
Sector 29 23:15 - 0:15	25,178	*	11.65%	2,934	Sector 29 23:15 - 0:15	0	*	11.65%	0
Sector 09 12:10 - 13:10	36,300	*	0%	0	Sector 09 12:10 - 13:10	0	*	0%	0
Sector 09 14:45 - 17:00	58,080	*	0.12%	70	Sector 09 14:45 - 17:00	0	*	0.12%	0
Sector 09 21:15 - 23:45	51,727	*	0%	0	Sector 09 21:15 - 23:45	0	*	0%	0
Sector 32 14:00 - 15:30	37,800	*	7.26%	2,746	Sector 32 14:00 - 15:30	238,463	*	7.26%	17,323
Sector 32 17:50 - 18:50	33,228	*	8.09%	2,688	Sector 32 17:50 - 18:50	162,949	*	8.09%	13,184

Airline1 at Atlanta (Continued)

- The CPDLC-1 Benefit factor on the previous page was calculated by using the following equation:

$$\text{CPDLC-1 Benefit Factor} = \frac{\text{Airline1 \% of Aircraft}}{\text{\% CPDLC equipage (90)}} * \text{CPDLC-1 \% of CPDLC (29.56)}$$

Airline1 at Atlanta (Continued)

- To calculate the Airline1 minutes saved for each sector and time period, multiply the CPDLC-1 airborne and ground delay avoided by the Airline1 % of aircraft. This yields the following results:

Sector and Time	CPDLC-1 Airborne Minutes Saved	*	Airline1 % Aircraft	Airline1 Airborne Minutes Saved
Sector 19 13:15 - 13:45	66	*	4.55%	3
Sector 19 15:45 - 17:15	18	*	0.67%	0
Sector 19 22:15 - 23:00	0	*	0%	0
Sector 31 13:30 - 16:15	7,007	*	26.36%	1,847
Sector 31 18:30 - 19:30	2,697	*	23.42%	632
Sector 31 21:45 - 22:30	1,557	*	18.83%	293
Sector 29 14:00 - 18:30	11,320	*	29.94%	3,390
Sector 29 20:15 - 21:15	701	*	7.91%	55
Sector 29 23:15 - 0:15	2,934	*	35.48%	1,041
Sector 09 12:10 - 13:10	0	*	0%	0
Sector 09 14:45 - 17:00	70	*	0.37%	0
Sector 09 21:15 - 23:45	0	*	0%	0
Sector 32 14:00 - 15:30	2,746	*	22.12%	607
Sector 32 17:50 - 18:50	2,688	*	24.63%	662

Sector and Time	CPDLC-1 Ground Minutes Saved	*	Airline1 % Aircraft	Airline1 Ground Minutes Saved
Sector 19 13:15 - 13:45	0	*	4.55%	0
Sector 19 15:45 - 17:15	0	*	0.67%	0
Sector 19 22:15 - 23:00	0	*	0%	0
Sector 31 13:30 - 16:15	0	*	26.36%	0
Sector 31 18:30 - 19:30	0	*	23.42%	0
Sector 31 21:45 - 22:30	0	*	18.83%	0
Sector 29 14:00 - 18:30	0	*	29.94%	0
Sector 29 20:15 - 21:15	0	*	7.91%	0
Sector 29 23:15 - 0:15	0	*	35.48%	0
Sector 09 12:10 - 13:10	0	*	0%	0
Sector 09 14:45 - 17:00	0	*	0.37%	0
Sector 09 21:15 - 23:45	0	*	0%	0
Sector 32 14:00 - 15:30	17,323	*	22.12%	3,831
Sector 32 17:50 - 18:50	13,184	*	24.63%	3,248

Airline1 at Atlanta (Concluded)

- **The Total Airline1 Time Saved per year**
 - **Airborne Minutes = 8,531**
 - **Ground Minutes = 7,079**
- **This produces the annual cost saving for Airline1 at Atlanta to be \$454,215**

Disclaimer /Copyright and Data Rights

The contents of this material reflect the views of the author. Neither the Federal Aviation Administration nor the Department of Transportation makes any warranty or guarantee, or promise, expressed or implied, concerning the content or accuracy of the views expressed herein.

© 1998 The MITRE Corporation. All rights reserved.

This is the copyright work of The MITRE Corporation and was produced for the U.S. Government under Contract Number DTFA01-93-C-00001 and is subject to Federal Acquisition Regulation Clause 52.227-14, Rights in Data-General, Alt. III (JUN 1987) and Alt. IV (JUN 1987). No other use other than that granted to the U.S. Government, or to those acting on behalf of the U.S. Government, under that Clause is authorized without the express written permission of The MITRE Corporation. For further information, please contact The MITRE Corporation, Contracts Office, 1820 Dolley Madison Blvd., McLean, VA 22102, (703) 883-6000.