

NRA Workshop AATT Project Office

March 23, 1999

Task Order 19

Air Traffic Management: History and Technical Trends

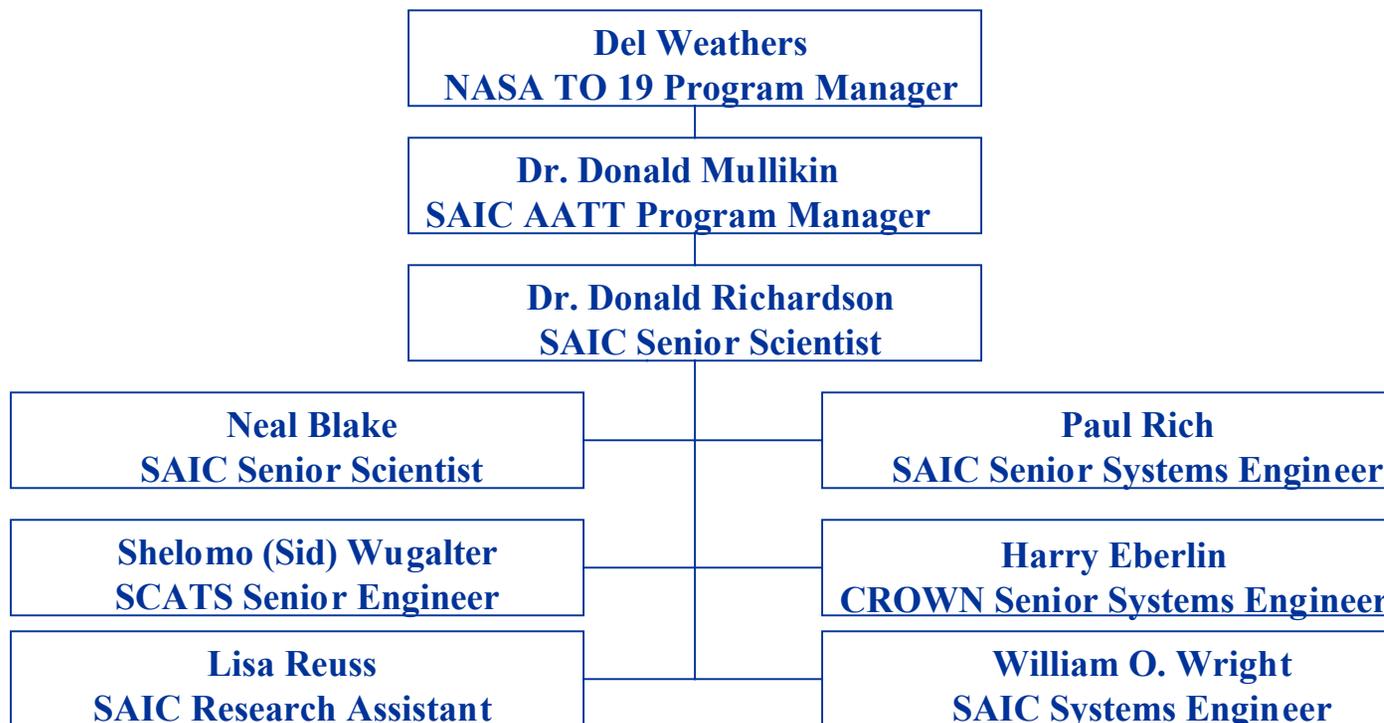
**NRA Workshop
Review**



Project Summary

- **Data as of Date: March 5, 1999**
- **Contract Number: NAS2-98002**
- **Contract Type: FP LOE**
- **Period of Performance: November 11, 1998 thru November 11, 1999**
- **Contract Value: Fully Funded**
 - **SAIC: \$ 199,924**
 - **Actuals to Date: \$ 38,936**
 - **Remaining: \$ 160,988**
- **SOW Summary: The purpose is to create a set of documents that will aid developers and users in understanding Air Traffic Management from the start of Federal Air Traffic Control in 1938 until the latest Free Flight plans.**

Project Staffing Plan



Objective

- ✓ **Conduct research to create a set of reference documents based on History and Technical Trends over last 60 years of ATC/ATM to:**
 - **Allow future systems to be developed based on experiences of the past.**
 - **Provide a better understanding of ATC/ATM history to both new and existing participants in ATC/ATM Development and R&D**
 - **Document Lessons–Learned**

Tasking

- ✓ **Task 1: Document the History of ATM from 1938 to 1998: CDRL#1**
- ✓ **Task 2: Document the Technical Trends in ATM (CDRL#2) to include:**
 - i **Identification, Listing, & Description of ATM Functional Decomposition**
 - i **Primary data and control interfaces**
 - i **Elements of the NAS Architecture**
 - i **Relationship to NAS Architecture and Evolution over time**

Tasking(Cont.)

- i Performance parameters**
- i Evolution of parameters over time**
- i Assessment of the state-of-the art of relevant R&D over time**
- i Recommendations as to further R&D that may be warranted**
- i Listing and assessment of major technical issues or challenges that could improve the state of R&D**

Deliverables/Schedule

- ✓ **CDRLs #1 & #2 are required to be delivered in preliminary conceptual, Draft, and Final versions**
 - i Preliminary Versions due three (3) months after task award**
 - i Draft Versions due nine (9) months after task award**
 - i Final Versions due eleven (11) months after task award**

Technical Approach

- ✓ **Task 1: Document History of ATM: CDRL#1**
 - i Identify, list, and research ATC/ATM historical documentation**
 - i Utilize extensive records and documentation of the FAA Historian**
 - i Identify key events and categorize relative to government, legislative, aviation industry, and technological breakthroughs**
 - i Identify impact of events on operations and R&D/related developments**

Preliminary Results

✓ Task 1: Document History of ATM: CDRL#1

- i Compiled a source list of 56 significant documents with 53 in hand –continuing to identify and add new sources
- i Utilizing sources and research with FAA and ATCA, have compiled extensive event list from 1926 to 1979 – currently completing first draft of event list to 1998
- i Completed format and structure for CDRL#1 and provided preliminary concept to NASA (next two slides)

NRA Workgroup Review **Currently translating event list into CDRL#1 format** 9 - 9

CDRL#1 TWO PAGE DEPICTION

SUPPORTING PAGE	PRIMARY PAGE
TIME FRAME EVENT DESCRIPTION	TIME FRAME EVENT DESCRIPTION
OPERATIONS/USER DOMAINS	GOV., REGULATORY, & LEGISLATIVE
R&D/ASSOCIATED PROGRAMS	AVIATION INDUSTRY AND USERS
	TECHNOLOGY

COLOR SLIDE
SHOWING
PRESENTATION CONCEPT

NOT INCLUDED DUE TO MEMORY REQUIREMENTS

CDRL#1 TRANSITION CHAPTER

SUPPORTING PAGE	PRIMARY PAGE
TIME FRAME	TIME FRAME
OPERATIONS/USER DOMAINS < Significant Events < Lessons-Learned	GOV., REGULATORY, & LEGISLATIVE < ATC statistics < Significant Events < Trends
R&D/ASSOCIATED PROGRAMS < Significant Events < Lessons-Learned < Cost/Benefits < Successful/Nonsuccessful initiatives	AVIATION INDUSTRY AND USERS < User statistics < Significant Events < Trends
	TECHNOLOGY < Significant Events Trends

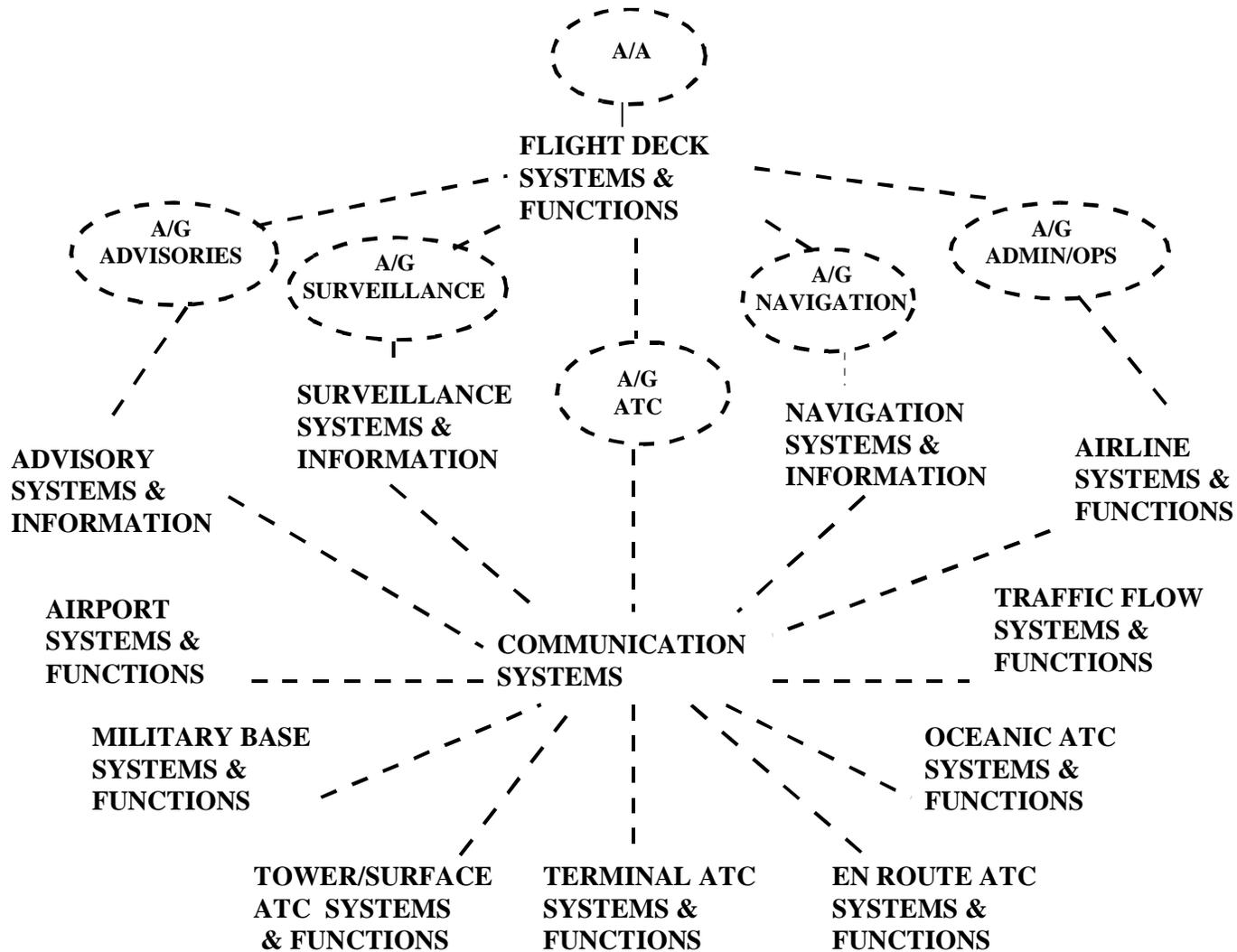
Technical Approach

- ✓ **Task 2: Document Technical Trends in ATM:
CDRL#2**
 - i **Develop ATM System and Functional Model that is consistent with NAS Architecture and Operations, AATT Concepts, and can be utilized to describe evolution over time from 1926 to 1998.**
 - i **Identify Technical Trend charts that can depict the evolution of systems, facilities, procedures, and functions over time as linked to significant events identified in CDRL#1**
 - i **Identify interface and performance definitions that can be defined over time**

Preliminary Results

✓ Task 2: Document Technical Trends in ATM: CDRL#2

- i Completed first draft of ATM Integrated System and Functional Model
- i Drafted set of functions supporting each element of ATM Model along with information set supporting functions
- i Completed preliminary ATM Interface Definition and method of displaying interfaces
- i Completed candidate set of performance parameters
- i Completed concept for depicting functional elements during phases of flight



ATM INTEGRATED SYSTEM AND FUNCTIONAL MODEL

DECOMPOSITION FOR SYSTEM ELEMENTS

ADVISORY SYSTEMS	INFORMATION TYPE
ATIS	CLEARANCES
ASOS	FLIGHT PLANS AND AMENDMENTS
AWOS	WEATHER ALERTS/STATUS/FORECASTS
WARP	SYSTEM AVAILABILITY
ITWS	SYSTEM STATUS
NWS/RUC	SYSTEM INTEGRITY
VISUAL SIGHTINGS/WEATHER OBSERVERS	
OASIS	
NAVIGATION SYSTEMS	INFORMATION TYPE
LIGHT BEACON	AIRCRAFT POSITION
RADIO RANGING	RANGE/TIME
OMNI-DIRECTIONAL RANGING	DIFFERENTIAL CORRECTIONS
DISTANCE MEASURING	BEARING
RUNWAY LIGHTING	RADIAL/DISTANCE
GPS	COURSELINE/GLIDEPATH SIGNALS
ILS	SYSTEM STATUS
GROUND CONTROL (RADAR)	SYSTEM INTEGRITY
AUTONOMOUS	SYSTEM ACCURACY
AUGMENTED GPS	SYSTEM AVAILABILITY
SURVEILLANCE SYSTEMS	INFORMATION TYPE
VISUAL SIGHTING	AIRCRAFT POSITION/ID
PILOT POSITION DETERMINATION	AIRCRAFT INTENT(PROJECTED POSITION)
FLIGHT PLAN PROJECTION	AIRCRAFT STATE(HEADING, SPEED)
PRIMARY RADAR	WEATHER DATA (MULTIPLE LEVELS)
SECONDARY RADAR	SYSTEM STATUS
ADS-A	SYSTEM INTEGRITY
ADS-B	SYSTEM ACCURACY
SURFACE SURVEILLANCE SENSORS	SYSTEM AVAILABILITY

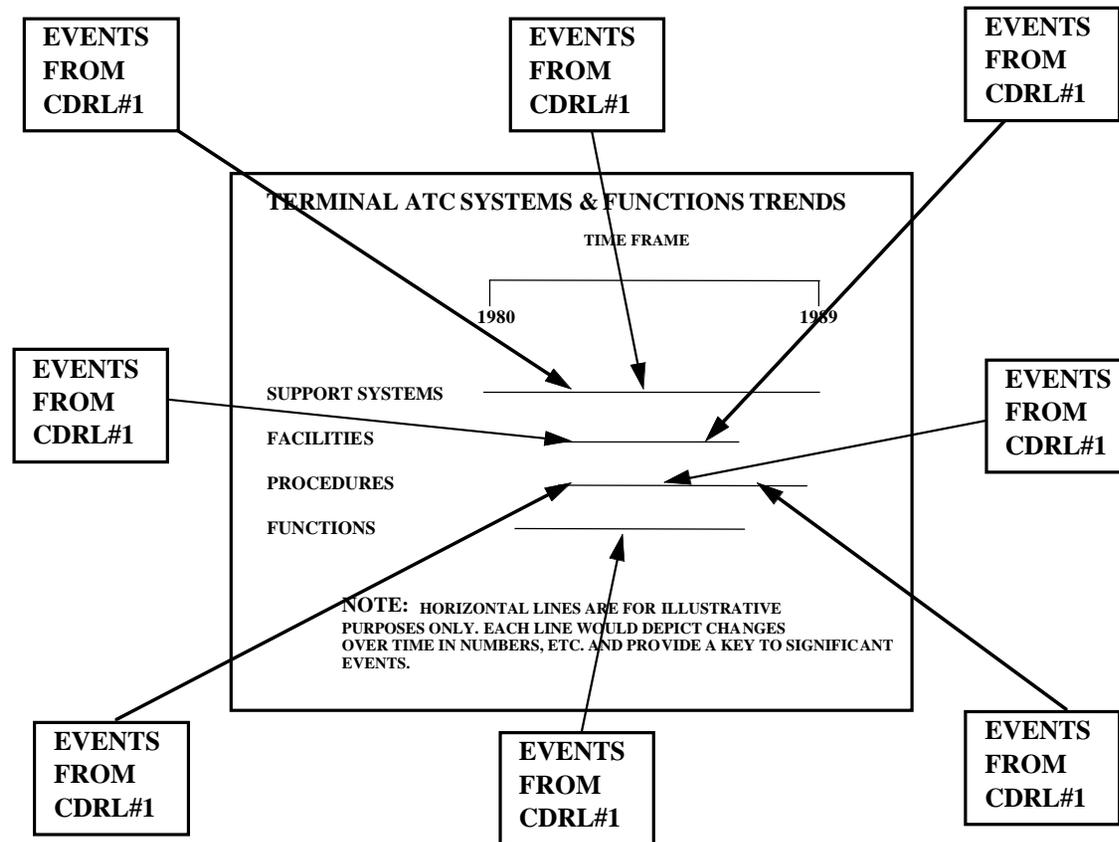
DECOMPOSITION FOR FUNCTIONAL ELEMENTS

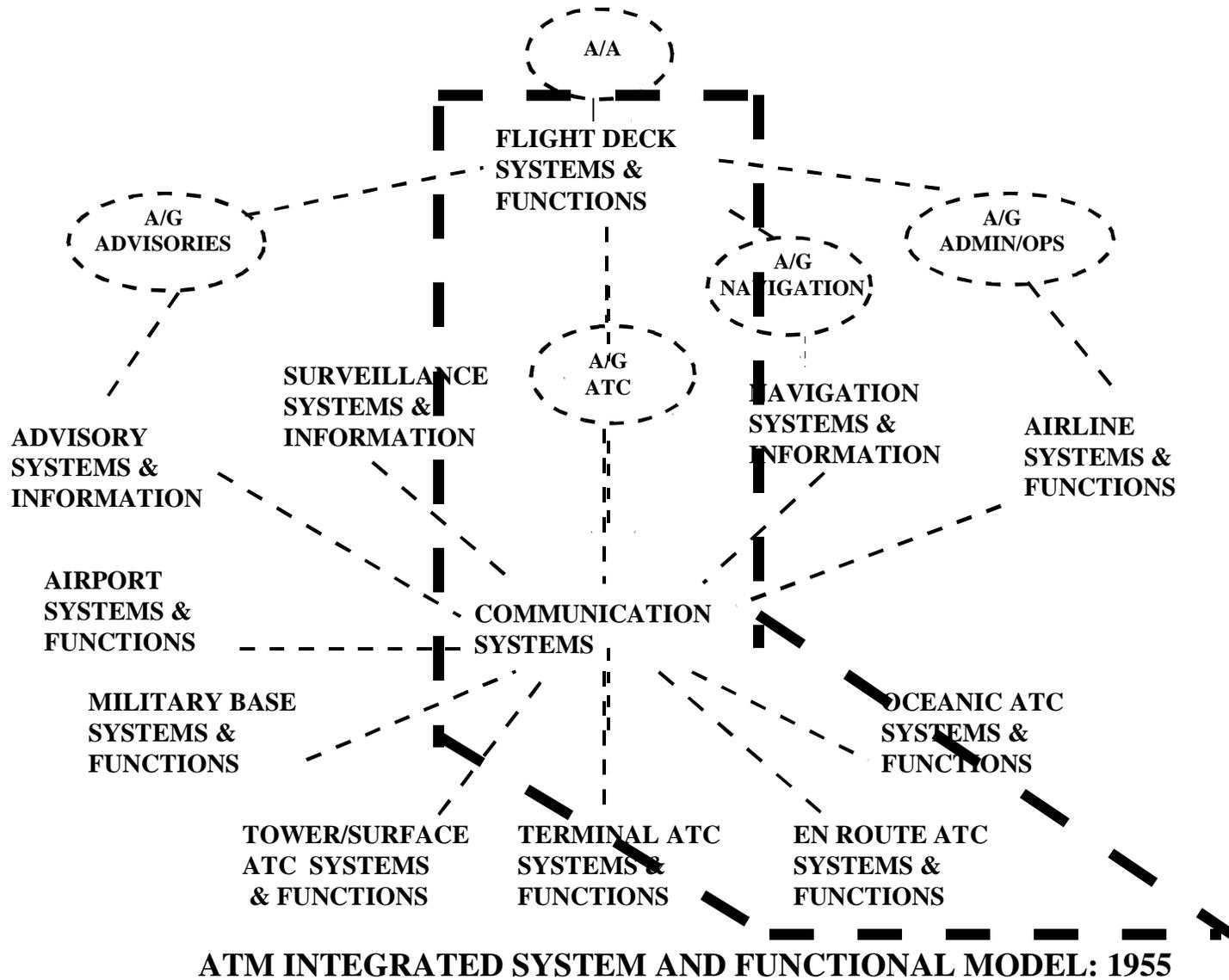
AIRPORT FUNCTIONS	INFORMATION RECEIVED	INFORMATION TRANSMITTED
MONITOR GATE/RAMP STATUS	<ul style="list-style-type: none"> • AIRLINE GATE ASSIGNMENTS • VISUAL OBSERVATIONS • ARRIVAL AND DEPARTURE STATUS 	<ul style="list-style-type: none"> • GATE/RAMP STATUS
SEQUENCE ARRIVALS & DEPARTURES IN RAMP AREA	<ul style="list-style-type: none"> • TRAFFIC FLOW RESTRICTIONS • ARRIVAL AND DEPARTURE STATUS • GATE/RAMP STATUS • AIRPORT CONFIGURATION STATUS(RUNWAY/TAXIWAY/RUNWAY SPLITS) 	<ul style="list-style-type: none"> • AIRCRAFT SEQUENCE IN AND OUT OF RAMP AREA
MONITOR ARRIVAL AND DEPARTURE STATUS	<ul style="list-style-type: none"> • ARRIVAL LISTS • DEPARTURE SEQUENCE • RUNWAY ASSIGNMENTS • GATE/RAMP STATUS 	<ul style="list-style-type: none"> • ARRIVAL AND DEPARTURE STATUS

DECOMPOSITION FOR FUNCTIONAL ELEMENTS

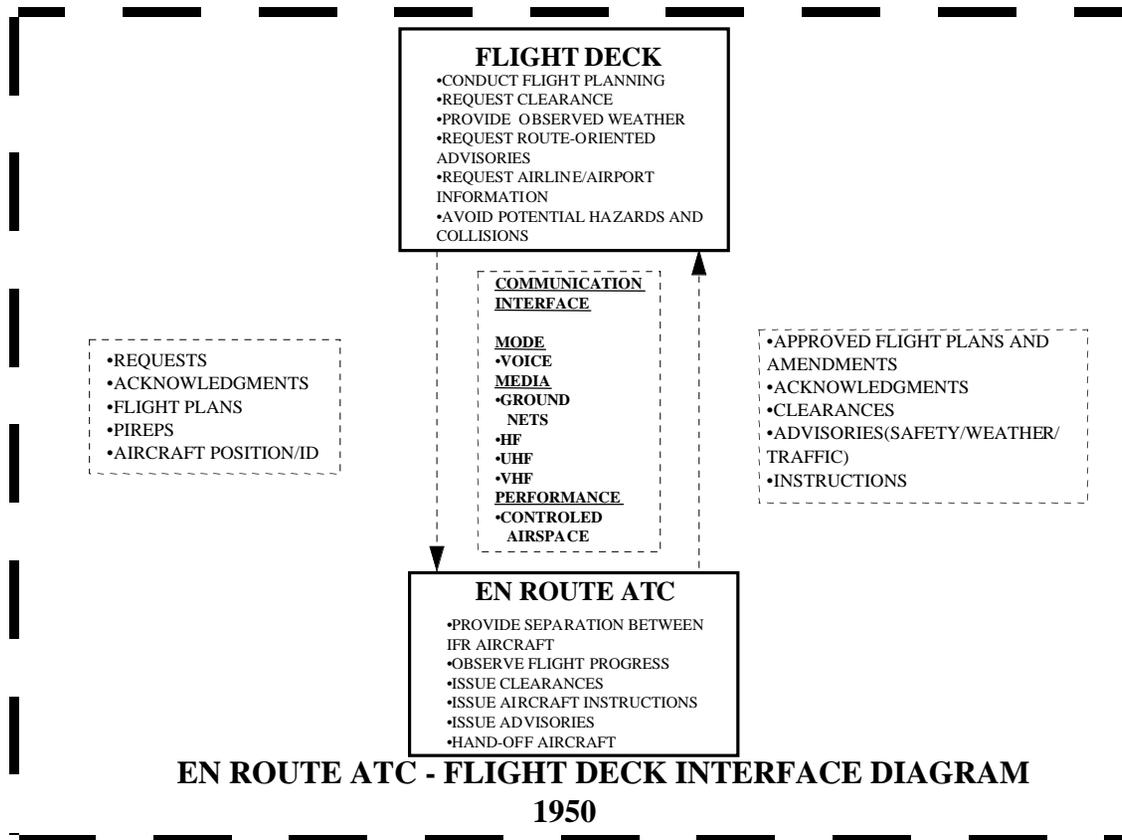
TRAFFIC FLOW (TF) FUNCTIONS	INFORMATION RECEIVED	INFORMATION TRANSMITTED
CONDUCT CAPACITY PLANNING	<ul style="list-style-type: none"> < AIRLINE SCHEDULES/CHANGES < APPROVED FLIGHT PLANS AND AMENDMENTS < AIRPORT CONFIGURATION STATUS(RUNWAY/TAXIWAY/RUNWAY SPLITS) < WEATHER STATUS/FORECASTS/ALERTS < ATC SYSTEM STATUS ALERTS AND SUMMARIES 	<ul style="list-style-type: none"> < AIRSPACE CAPACITY ESTIMATES
OBSERVE FLIGHT PROGRESS	<ul style="list-style-type: none"> < FLIGHT TRACKS < APPROVED FLIGHT PLANS AND AMMENDMENTS 	<ul style="list-style-type: none"> < AIRSPACE FLIGHT TRACK SUMMARY
ESTABLISH AND REMOVE TRAFFIC FLOW RESTRICTIONS	<ul style="list-style-type: none"> < AIRLINE SCHEDULES/CHANGES < APPROVED FLIGHT PLANS AND AMENDMENTS < WEATHER STATUS/FORECASTS/ALERTS < AIRSPACE CAPACITY ESTIMATES < AIRPORT CONFIGURATION STATUS(RUNWAY/TAXIWAY/RUNWAY SPLITS) 	<ul style="list-style-type: none"> < RELEASES < AIRPORT GATE HOLDS < GROUND DELAYS AND STOPS < REROUTES < SPEED RESTRICTIONS < AIRSPACE MODIFICATION
MANAGE TF SYSTEM STATUS	<ul style="list-style-type: none"> < TF SYSTEM STATUS 	<ul style="list-style-type: none"> < TF SYSTEM STATUS SUMMARIES
COORDINATE WITH AIRLINES ON TRAFFIC FLOW DECISIONS	<ul style="list-style-type: none"> < PROPOSED SCHEDULE CHANGES < USER PREFERRED ROUTE REQUESTS 	<ul style="list-style-type: none"> < PROPOSED RESTRICTIONS < USER PREFERRED ROUTE REQUESTS < USER PREFERRED ROUTE DECISION

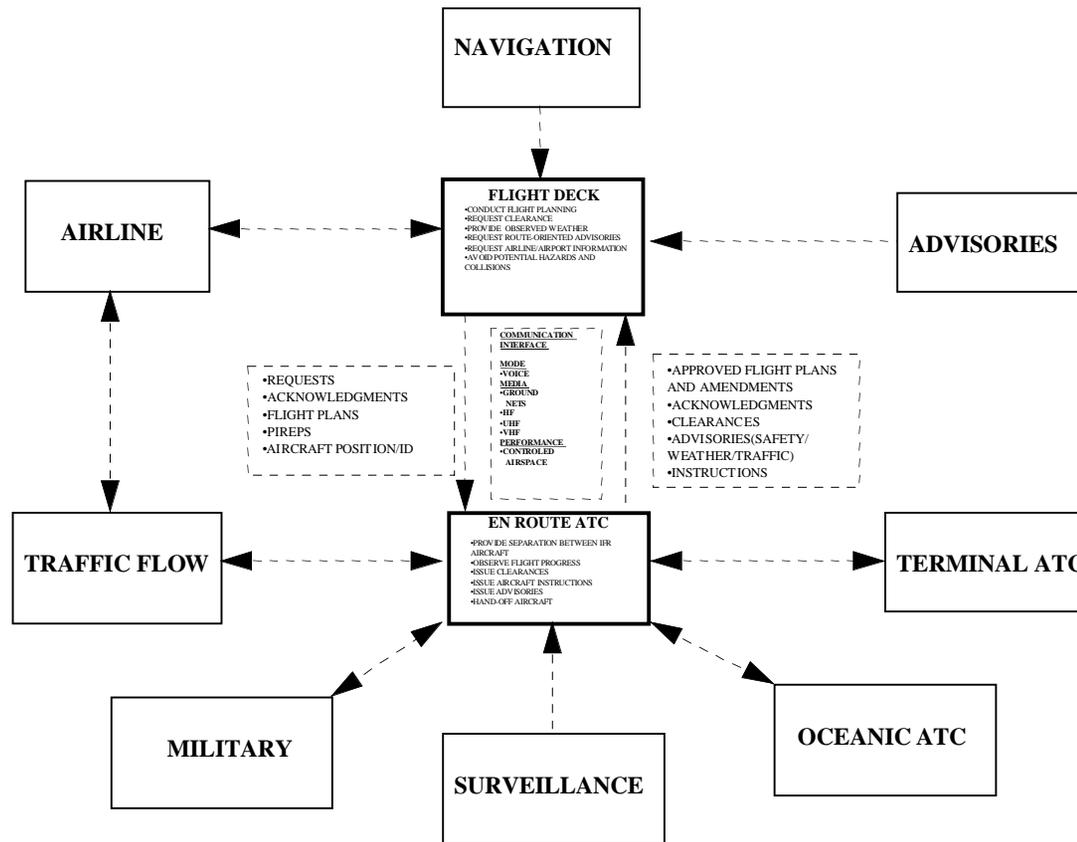
TECHNICAL TREND CHART





INTERFACE DEFINITION
COMMUNICATIONS MODE < VOICE < DATA < TTY < TEXT < CODE
COMMUNICATIONS MEDIA < VISUAL < MANUAL < GROUND NETWORK < SATELLITE < HF/LF < UHF/VHF
COMMUNICATIONS PERFORMANCE < LATENCY(ONE WAY DELAY) < COVERAGE < AVAILABILITY < INTEGRITY (PROB. OF UNDETECTED ERROR
EN ROUTE FUNCTIONS SUPPORTED
FLIGHT DECK FUNCTIONS SUPPORTED
TYPE INFORMATION TRANSFERRED FROM FLIGHT DECK TO EN ROUTE ATC
TYPE INFORMATION TRANSFERRED FROM EN ROUTE ATC TO FLIGHT DECK





ATM OPERATIONAL DEPICTION

FUNCTIONAL/SYSTEM PERFORMANCE PARAMETERS

ATM MODEL ELEMENTS	PREDICTABLE	RANDOM
COMMUNICATIONS	<ul style="list-style-type: none"> < FREQUENCY SPECTRUM < AVIONICS EQUIPAGE < COVERAGE 	<ul style="list-style-type: none"> < INTEGRITY < LATENCY < AVAILABILITY
NAVIGATION	<ul style="list-style-type: none"> < FREQUENCY SPECTRUM < AVIONICS EQUIPAGE < COVERAGE 	<ul style="list-style-type: none"> < ACCURACY < AVAILABILITY < INTEGRITY < INTERFERENCE
SURVEILLANCE	<ul style="list-style-type: none"> < COVERAGE 	<ul style="list-style-type: none"> < ACCURACY < TARGET CAPACITY < INTEGRITY < AVAILABILITY
ADVISORY	<ul style="list-style-type: none"> < ACCURACY OF WEATHER FORECASTS FOR PREFLIGHT PLANNING 	<ul style="list-style-type: none"> < ACCURACY AND TIMELINESS OF SEVERE WEATHER ALERTS FOR FLIGHT OPERATIONS
AIRPORT	<ul style="list-style-type: none"> < RUNWAY, RAMP, AND GATE CAPACITY 	<ul style="list-style-type: none"> < AVAILABILITY OF GATES/RAMP AREA
TRAFFIC FLOW	<ul style="list-style-type: none"> < SYSTEM AIRSPACE CAPACITY ESTIMATING CAPABILITY /CRITERIA 	<ul style="list-style-type: none"> < TRAFFIC LOADS BALANCE DURING PEAK OPERATIONS < NUMBER OF TRAFFIC FLOW RESTRICTIONS