N91-10958

TIME-BASED OPERATIONS IN AN ADVANCED ATC ENVIRONMENT

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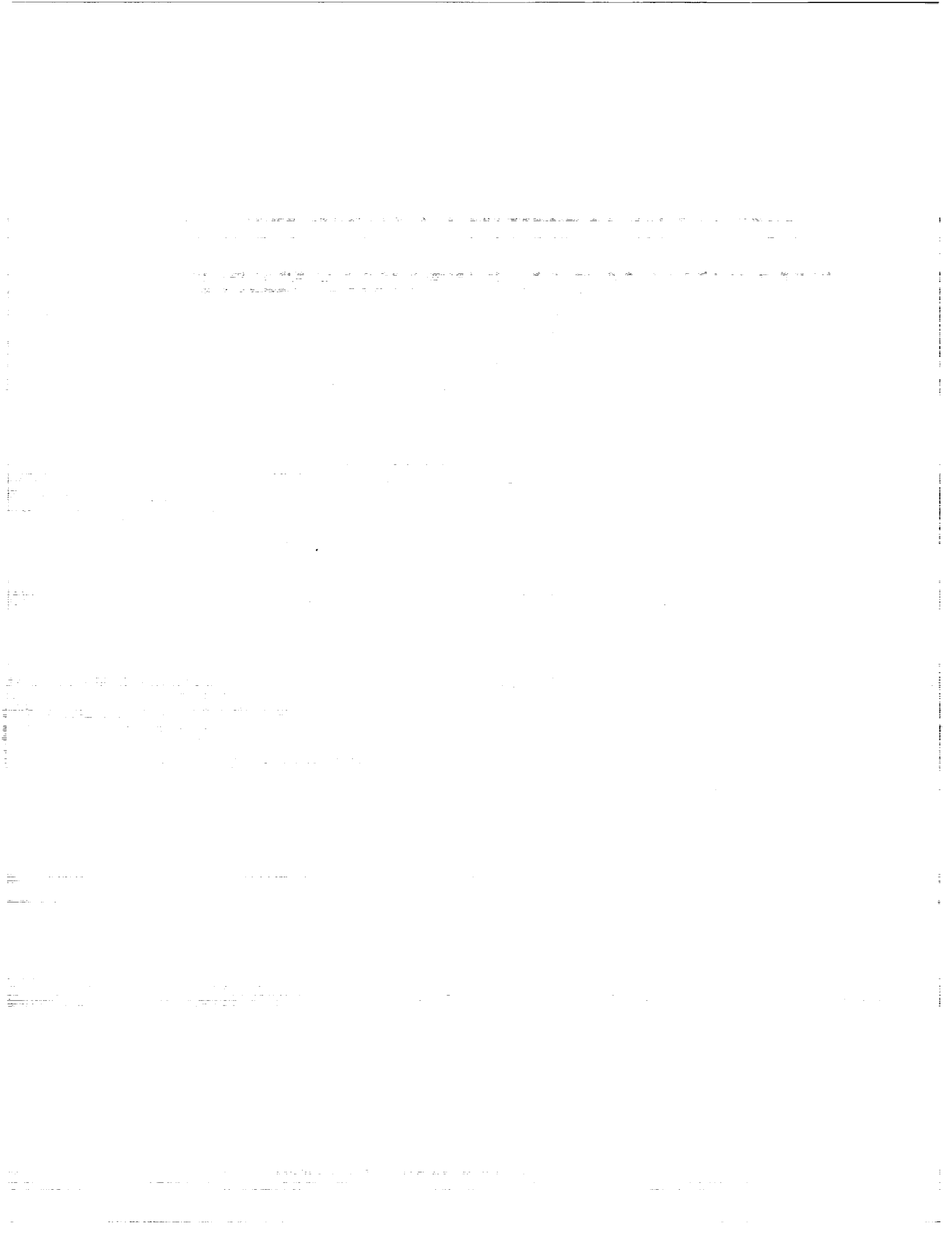


OUTLINE

- **OBJECTIVES**
- **EXPERIMENT DESCRIPTION**
- **RESULTS**
- **SUMMARY**

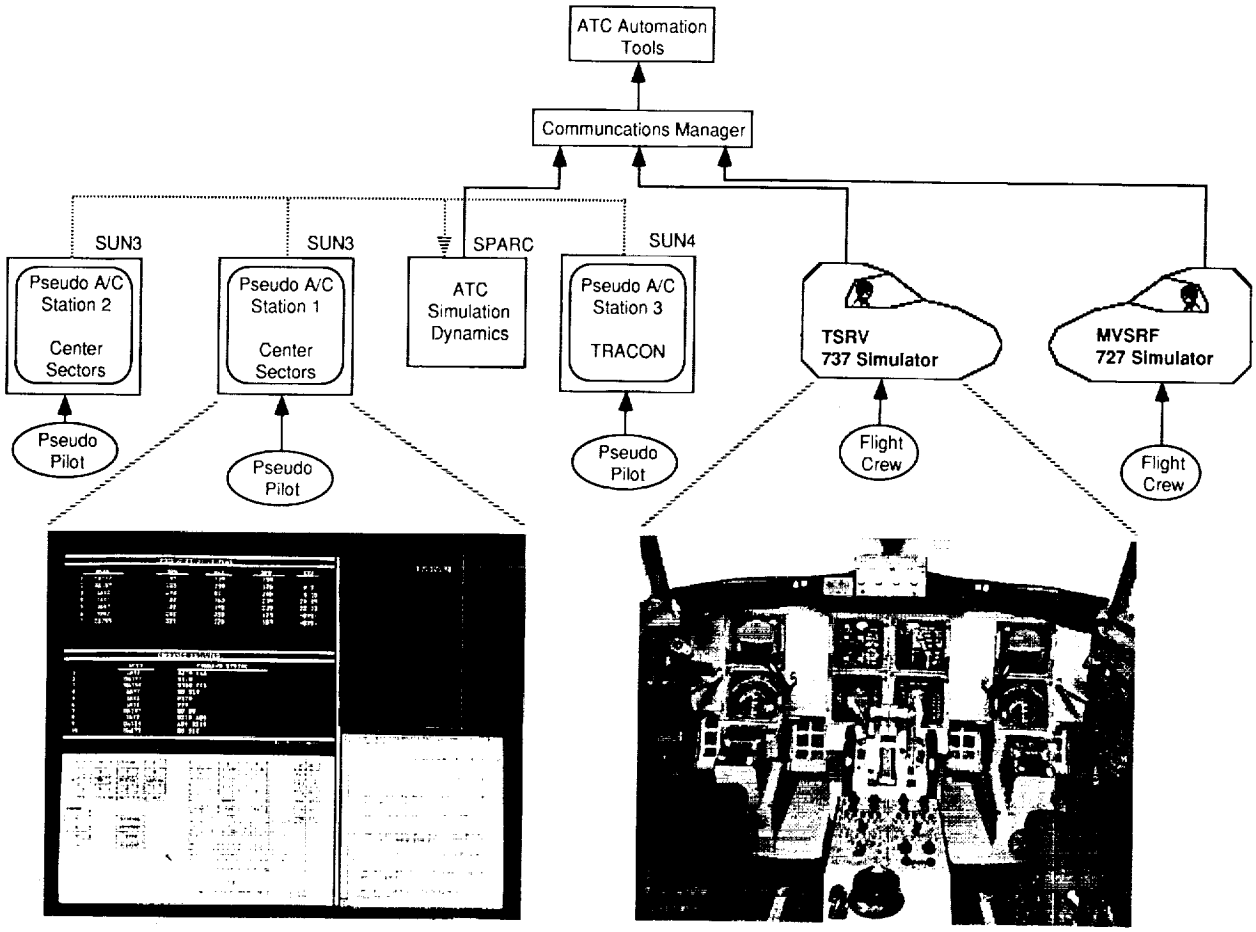
OBJECTIVES

- DEVELOP AND EVALUATE PROCEDURES AND CLEARANCES FOR 4D EQUIPPED AIRCRAFT
- STUDY THE EFFECT OF DISSIMILAR AIRBORNE AND GROUND-BASED SPEED STRATEGIES
- EVALUATE THE EFFECTIVENESS AND ACCEPTABILITY OF ATC AUTOMATION TOOLS

EXPERIMENT SET-UP

- **TEST SUBJECTS**
  - 6 ACTIVE ARTCC CONTROLLERS
  - 3 AIRLINE PILOTS
- **SIMULATION FACILITY**
  - AIR TRAFFIC SIMULATION
  - ATC AUTOMATION AIDS
- **DENVER ARRIVAL AIRSPACE**
- **TIME-BASED PROCEDURES**

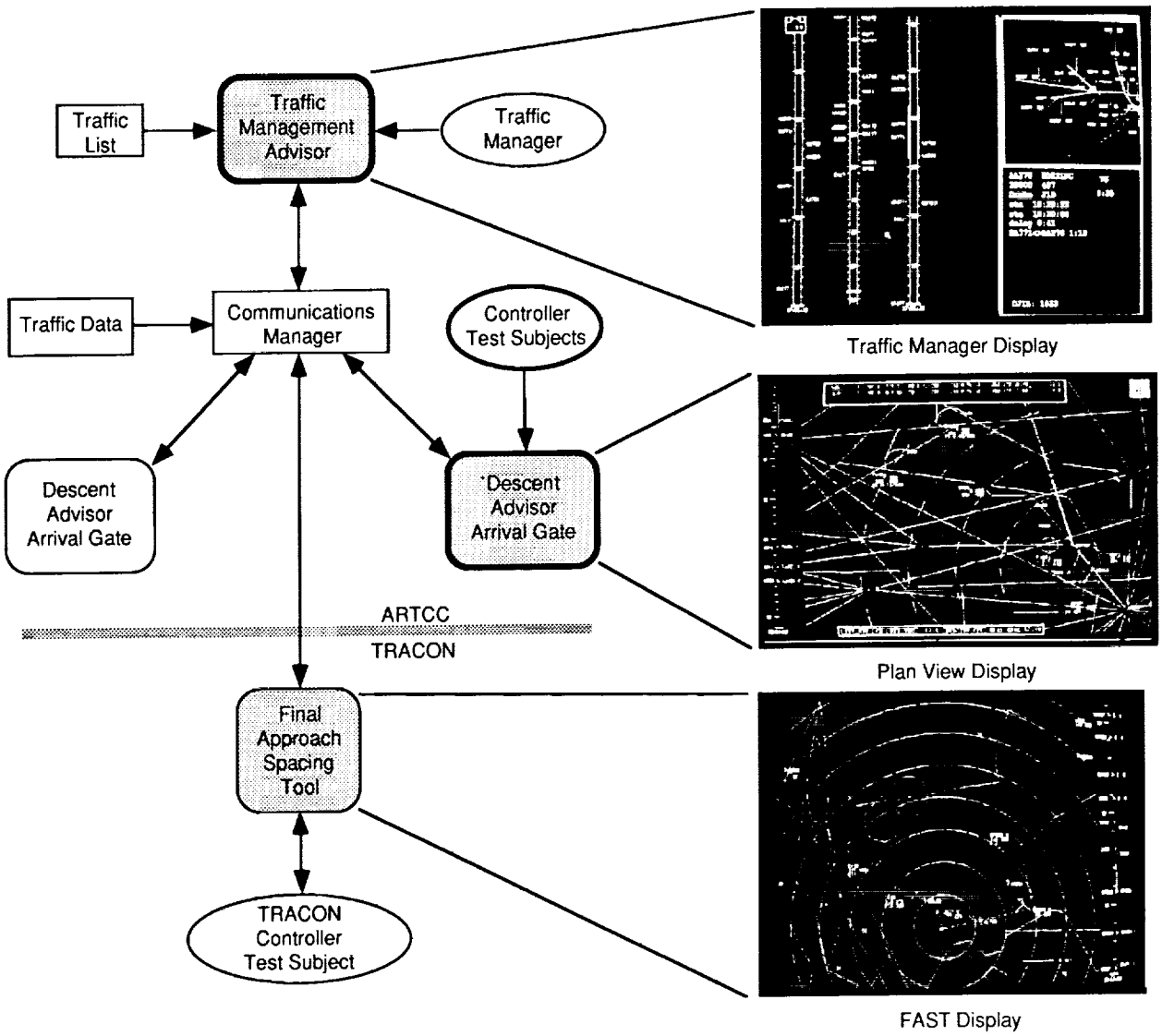
AIR TRAFFIC SIMULATION



Pseudo-Pilot DIsplay

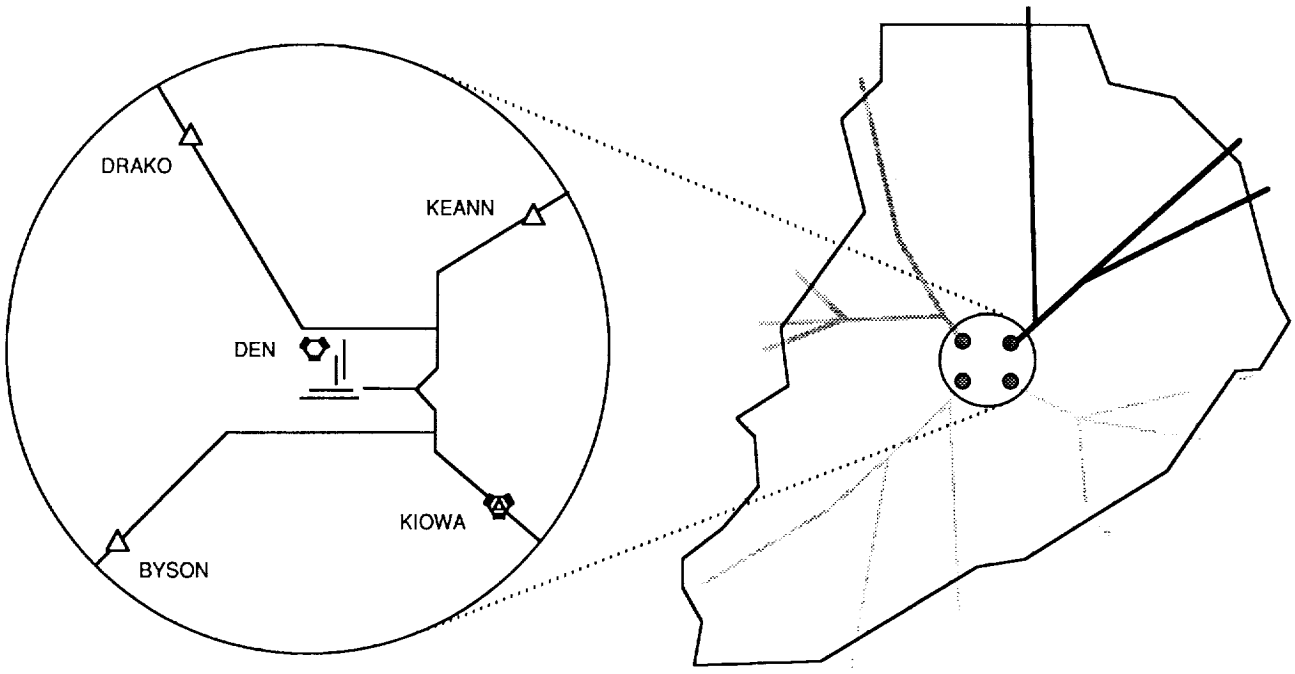
TSRV Simulator

ATC AUTOMATION TOOLS



DENVER ARRIVAL AIRSPACE

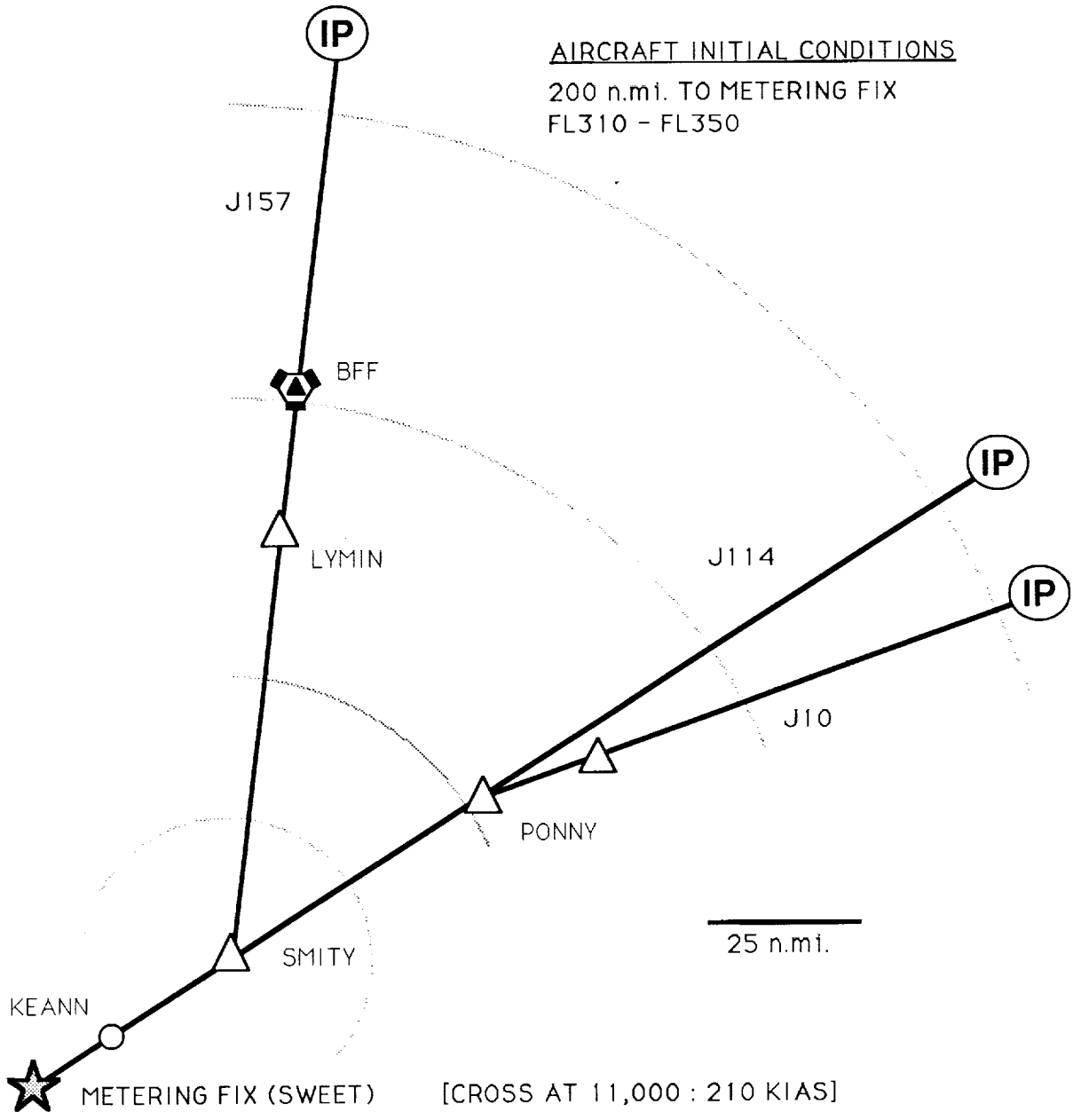
(4 CORNER POSTS)



TRACON AIRSPACE

ARTCC AIRSPACE

DENVER'S
NORTHEAST ARRIVAL AIRSPACE
(KEANN GATE)



TIME-BASED ATC PROCEDURES

- **UNEQUIPPED AIRCRAFT**
  - **CRUISE/DESCENT CLEARANCE**
    - *CRUISE SPEED ADJUSTMENT*
    - *TOP OF DESCENT*
    - *DESCENT SPEED PROFILE*
- **4D EQUIPPED AIRCRAFT**
  - **TIME CLEARANCE**
    - *METERING FIX TIME*
    - *PILOT DISCRETION DESCENT*
    - *PILOT DISCRETION CRUISE/DESCENT SPEED PROFILES*
  - **TIME DELAY VECTOR CLEARANCE**
    - *NAVIGATION RESTRICTIONS*
    - *TIME CLEARANCE*

TRAFFIC

- 100 % OF SINGLE RUNWAY CAPACITY (APPROX. 40 A/C PER HOUR)
- TRAFFIC "RUSH" (80% OF ALL ARRIVALS) THROUGH KEANN (NORTHEAST GATE)
- TRAFFIC THROUGH TWO ARRIVAL GATES MERGED FOR LANDING
  (BASED UPON FAA REGULATIONS FOR INTERARRIVAL SPACING)
- DELAY CONDITIONS
  - MODERATE (3 MINUTE DELAYS, SPEED CONTROL)
  - HEAVY (8 MINUTE DELAYS, PATHSTRETCHING REQUIRED)
- SINGLE 4D EQUIPPED A/C INJECTED INTO EACH RUSH
  - COMPATIBLE ALGORITHMS
  - INCOMPATIBLE ALGORITHMS
  - INCOMPATIBLE ALGORITHMS / OFFSET ROUTING

RESULTS SUMMARY

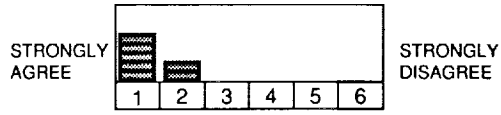
- **TRAFFIC DATA**
  - 30 EXPERIMENT RUNS
  - 28 HOURS OF AIR TRAFFIC SIMULATION

- **PRELIMINARY RESULTS**
  - EXPERIMENTAL OBSERVATIONS

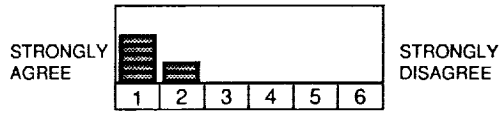
    EXAMPLE: SIMILARITY / DISSIMILARITY
  - CONTROLLER QUESTIONNAIRES

"EVALUATION OF PROCEDURES/CLEARANCES FOR 4D AIRCRAFT"

THE TIME CLEARANCES AND PROCEDURES WERE EXPLICIT AND UNDERSTANDABLE.

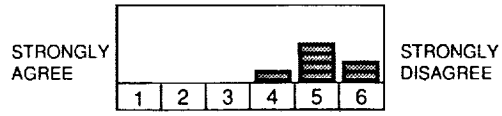


IT IS IMPORTANT TO KNOW THE 4D AIRCRAFT'S PLANNED DESCENT STRATEGY (i.e., final cruise speed, descent speed, and top of descent).



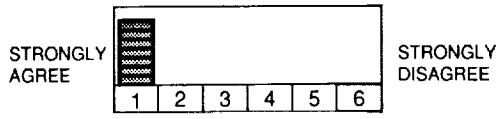
"EFFECT OF DISSIMILARITY BETWEEN AIR AND GROUND SYSTEMS"

NO DIFFICULT TRAFFIC SITUATIONS AROSE WITH THE 4D AIRCRAFT AFTER A TIME CLEARANCE WAS ISSUED.

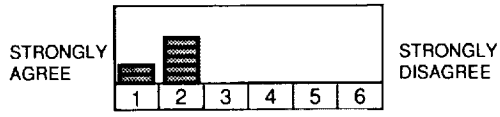


"EFFECTIVENESS/ACCEPTABILITY OF ATC AUTOMATION TOOLS"

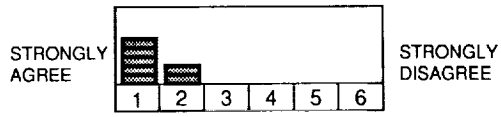
THE VERTICAL TIMELINE PROVIDED USEFUL INFORMATION ON THE SEQUENCE AND SCHEDULE.



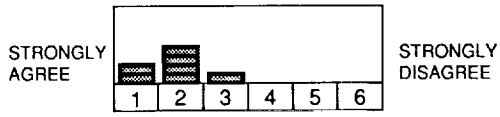
THE AUTOMATION PROVIDED REASONABLE INFORMATION UPON WHICH ONE CAN RELY.



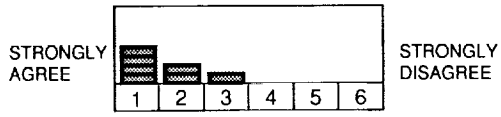
THE AUTOMATION PROVIDES A BETTER AND EARLIER IDEA ABOUT FUTURE CONFLICTS AND SEPARATION AT THE METERING FIX.



IT WAS EASY TO COMBINE MY OWN SPEED, ALTITUDE, AND VECTOR CLEARANCES WITH THE AUTOMATION'S ADVISORIES.



OVERALL, THE AUTOMATION REDUCED WORKLOAD.



CONCLUDING REMARKS

- TIME CLEARANCES AND PROCEDURES WERE USED EFFECTIVELY BY THE CONTROLLERS
- CONTROLLERS WANT TO KNOW THE PLANNED DESCENT STRATEGY OF 4D AIRCRAFT (SEPARATION)
- DISSIMILARITY IN SPEED STRATEGIES MAINLY AFFECT CONTROLLER WORKLOAD AND TRAFFIC FLOW EFFICIENCY
- ATC AUTOMATION TOOLS PROVIDE AN EFFECTIVE AID FOR THE SEQUENCING OF ARRIVAL FLOWS
- ATC AUTOMATION TOOLS WERE WELL RECEIVED BY THE CONTROLLER SUBJECTS

FUTURE PLANS

- TEST SOLUTIONS TO IMPROVE SYSTEM EFFICIENCY AND REDUCE WORKLOAD FOR DISSIMILARITY CASES :
  - CONFLICT DETECTION / RESOLUTION AIDS
  - SEPARATION PROCEDURES / CRITERIA FOR 4D
- EXPLORE DATA LINK APPLICATIONS TO REDUCE COMMUNICATIONS WORKLOAD FOR TIME-BASED OP'S.
- DETERMINE ATMOSPHERIC AND PERFORMANCE MODELLING REQUIREMENTS
- TEST SCENERIOS WITH MULTIPLE 4D EQUIPPED AIRCRAFT