Atlanta Collocation Study
Final Report

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Prepared for:

Federal Aviation Administration
Free Flight Phase One Integration Management, AOZ-40
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Table of Contents

Appendices

List of Illustrations

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EXECUTIVE SUMMARY

The Atlanta Air Route Traffic Control Center (ZTL) is one of the field sites scheduled to receive Free Flight Phase One (FFP1) capabilities. Specifically, it will receive both the User Request Evaluation Tool (URET) and the Traffic Management Advisor (TMA). The concurrent use of both capabilities at ZTL gave rise to possible operational issues that needed to be evaluated and resolved prior to the implementation of these capabilities. The FFP1 Integration Manager, AOZ-40, identified the need to conduct a human-in-the-loop (HITL) evaluation to better understand the issues.

A real-time HITL study was conducted from February 27 through March 2, 2001 at the William J. Hughes Technical Center's (WJHTC) En Route Integration and Interoperability Facility (EI^2F) with support from the Target Generation Facility (TGF) and the Traffic Flow Management (TFM) Laboratory. The specific objective of the study was to evaluate controller interactions associated with the concurrent use of URET and TMA in ZTL airspace.

The airspace was modeled around ZTL sectors 49 (Logen, a low altitude sector) and 50 (Lanier, a high altitude sector) which feed arrivals into Hartsfield International Airport (ATL) from the northeast. These sectors were selected due to their heavy arrival flows, merging of arrival streams, crossing traffic, and climbing aircraft that depart from Charlotte and other airports. The MACEY arrival (one of the busiest in the country) is located in these sectors.

Since ZTL airspace was used, it would have been ideal to involve only ZTL controllers. However, prior to this study URET and TMA were not operational at ZTL and controllers there had little or no proficiency in their use. The accuracy and applicability of the data collected was very dependent on controller proficiency with the tools. Therefore, controllers from other enroute facilities who had URET and TMA experience were also invited to participate. They came from ZME, ZDV, ZFW, and ZMP. A total of eleven controllers provided input to the data collection process.

Only subjective data was collected during the study. This was accomplished through individual participant questionnaires and group debriefing sessions.

Based on the traffic and sector configuration examined in this study, the participant consensus was that URET and TMA are quite independent tools and their collocation had no negative impact on safety or the interaction of the R and D controllers (both intra and inter sector). There was also no negative impact on individual controller operation. Although not related to the collocation issue, the ZTL participants were not completely comfortable with the time-based metering concept. Perhaps more training and familiarization would help them overcome any initial bias towards this concept. The participants also identified individual tool specific considerations. It was determined that most are planned to be addressed in future versions of the tools. There were no procedural issues identified in this study. This study also provided an opportunity for all participants to gain familiarization with the tools. If a follow-on study is to be conducted, it should focus on high altitude sectors with more over flights. Such a study would complement this study which focused on arrivals.

1 INTRODUCTION

1.1 Background

The FAA, in partnership with the aviation community, is committed to the development an air traffic management concept that will ultimately give pilots operating under instrument flight rules the freedom to select their path and speed in real time. This concept is called “free flight”. A program called “Free Flight Phase One” (FFP1) has developed a strategy to deliver early benefits of free flight by installing at key field sites certain low risk capabilities designed to increase system safety and capacity while reducing fuel and crew costs. The FFP1 Program encompasses the following core capabilities:

- Traffic Management Advisor (TMA)
- User Request Evaluation Tool (URET)
- Passive Final Approach Spacing Tool (pFAST)
- Collaborative Decision Making (CDM)
- Surface Movement Advisor (SMA)

The Atlanta (ZTL) Air Route Traffic Control Center (ARTCC) is one of the field sites scheduled to receive FFP1 capabilities. Specifically, it will receive both URET and TMA. The concurrent use of both capabilities at ZTL gave rise to possible operational issues that needed to be evaluated and resolved prior to the implementation of these capabilities. The FFP1 Integration Manager, AOZ-40, identified the need to conduct a human-in-the-loop (HITL) evaluation to better understand the issues.

A real-time HITL study was then planned and conducted from February 27 through March 2, 2001 at the William J. Hughes Technical Center’s (WJHTC) En Route Integration and Interoperability Facility (EI^2F) with support from the Target Generation Facility (TGF) and the Traffic Flow Management (TFM) Laboratory.

This report describes the study objective, approach, data collection and analysis, results, discussion, conclusions, and recommendations.

1.2 Objective

The objective of the study was to evaluate controller interactions associated with the concurrent use of URET and TMA in Atlanta airspace. Under the conditions simulated, the specific objectives were to:

- Gain understanding of the operational impacts of URET and TMA collocation;
- Evaluate the operational interaction between the R-side and D-side controllers; and
- Evaluate the operational interaction between sectors, if appropriate.

2 APPROACH

The study was designed as a real-time, medium fidelity, HITL, en route facility simulation. The simulated airspace was based on actual ZTL sectors (see figure 2). A joint team of ZTL, WJHTC, and MITRE CAASD personnel determined the sectors. The traffic scenarios were realistic and provided a level of volume and complexity that engaged (but did not overwhelm) the participants.

TMA Build 2 (software version: 2.1.2.6, adaptation set: ZTL_ATL_2.2.0_mod) and URET (CCLD hardware, D3.3_R3P1 software) were operational concurrently in both high (sector 50) and low altitude (sector 49) en route sectors.

Certified Professional Controllers (CPCs) and supervisors participated in this study. The participating controllers interacted with individuals functioning as pilots (simulation pilots) and ghost controllers. The simulation pilots manipulated computer-generated targets in response to controller instructions. The ghost controller took hand-offs from and sent hand-offs to the adjacent non-simulated sectors.

2.1 Constraints

Since this study was based on ZTL airspace, it would have been ideal to involve only ZTL controllers. However, prior to this study URET and TMA were not operational at ZTL and controllers there had little or no proficiency in their use. The accuracy and applicability of the data collected was very dependent on controller proficiency with the tools. Therefore, controllers from other facilities who had URET and TMA experience were invited to participate.

Unfortunately, no controllers were proficient in using both tools. Therefore, all controllers were provided familiarization with URET and TMA via a formal briefing and an informative CD-ROM.

The common message set (CMS) was not available for this study. Therefore, the host interface for URET and TMA was provided by the 320 patch. Consequently, information could flow simultaneously from the host to URET and TMA, *but* not simultaneously from URET and TMA back to the host. The available version of the 320 patch permitted return communication to the host from either URET or TMA - but not both. Time constraints did not allow for patch modification to alleviate this problem. Consequently, any flight plan amendments resulting from URET trial planning would have to be re-entered via the D-side keyboard. These constraints would have had an adverse impact on controller workload. Therefore, workload measurements were not collected in this study. Additionally, this version of URET did not permit entering headings and speeds via the keyboard. Participants had to select from a menu using the URET trackball. All participants were briefed prior to the study on these constraints.

Additionally, the voice communications system used during the simulation was not fully representative of the live operational environment.

2.2 Test Bed Configuration

The simulation test bed was a combination of the EI^2F, TGF, and TFM Laboratory. See Figure 1 for a diagram of the test bed configuration.

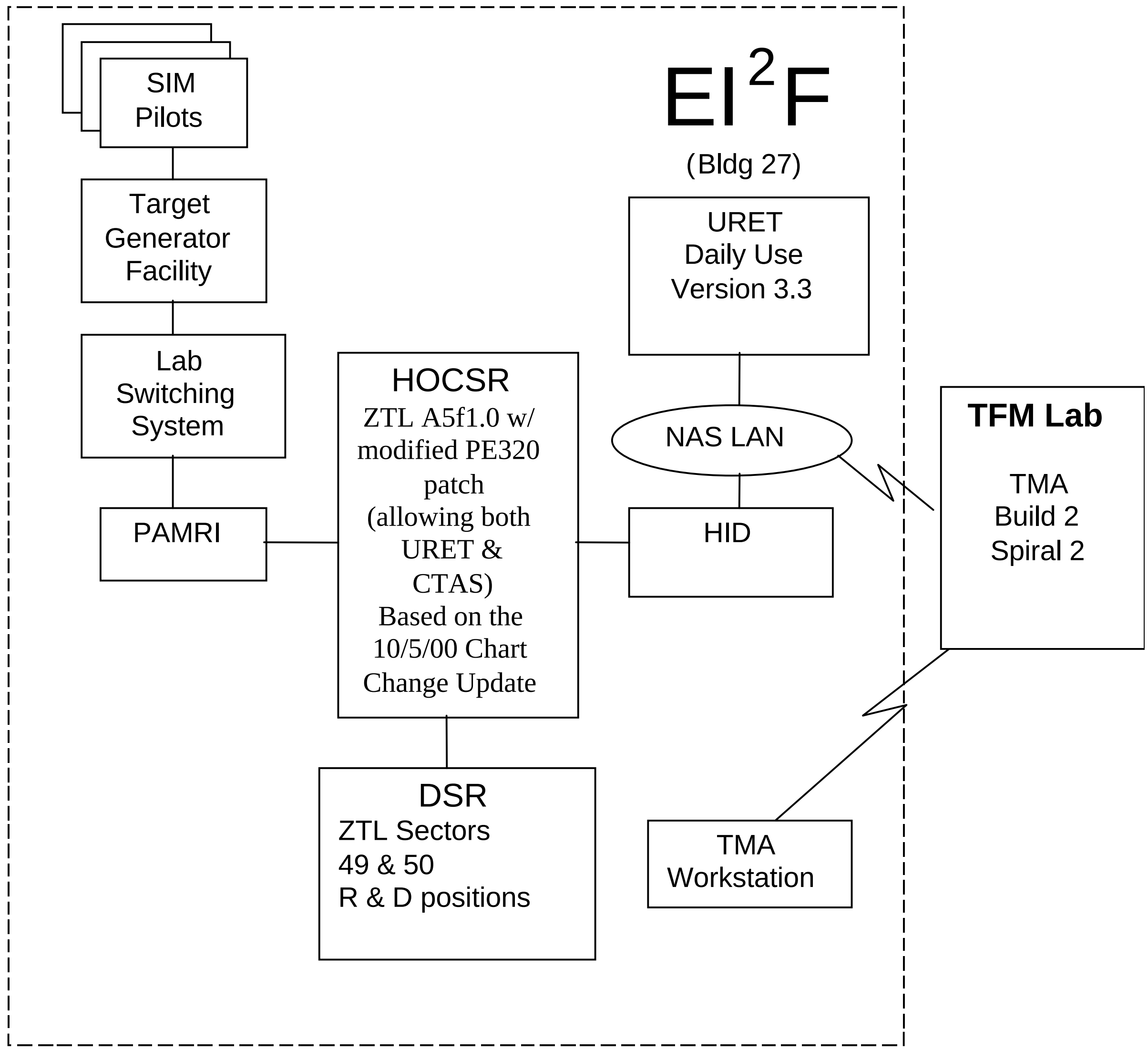

Figure 1. Test Bed Configuration

2.2.1 EI^{2}F

The EI²F enables the FAA to evaluate prototypes and system-level integration, prove concepts, and verify interoperability in a realistic, high fidelity, en route environment without impacting live air traffic operations. The EI^{2}F included dedicated host emulators, a host interface device (HID)/NAS local area network (LAN), display system replacement (DSR) consoles (both live and simulated), a mini-DSR system support control (DSSC) complex, an FAA interfacility and radar simulator (FIRS), and a mini-TGF.

The test bed included full DSR workstations with all functions normally expected in an operational setting. The R-side DSR displayed TMA meter lists. The D-side used a 20" flat panel display mounted on a moveable arm to make it accessible from both the R-side and D-side positions. The D-side display was used for both URET and the computer readout display (CRD). A single D-side keyboard was used for both URET and CRD operations. A TMA workstation resided in a mock traffic management unit (TMU).

2.2.1.1 Use of Flight Strips

Although flight strips were available during the study, participants chose not to use them. They used standard note pads when necessary.

2.2.2 TGF

The TGF generated digital radar messages for targets in a simulated airspace environment. The messages mimicked actual NAS characteristics by including the radar and environmental characteristics of ZTL. Simulated primary and beacon radar data were generated for each target and processed by the Multiple Radar Processing function of the NAS in a manner similar to normal radar data. Flight data blocks contained the flight identification, beacon code, and altitude. Target positions were automatically updated at the same rate that is experienced in the ARTCC. To simulate actual aircraft operations, the radar targets were maneuvered based on route segments from a flight plan and by the actions of the simulation.

2.2.3 TFM Laboratory

The TFM Laboratory generated and provided TMA lists for this experiment. The TFM Laboratory provided the technical infrastructure to support the testing and demonstrations of decision support systems such as the Center/TRACON Automation System (CTAS), SMA, and URET. Track data and flight plans from the EI^2F HOCSR were sent to the CTAS main engine in the TFM Laboratory via the HID NAS LAN. Data in turn was sent back to the EI^2F for display on a TMA workstation in a mock TMU located at the end of all DSR workstations.

2.2.4 URET

URET was developed by MITRE CAASD to assist the controller in predicting potential conflicts between aircraft. URET functionality consists of:

- Trajectory modeling
- Conformance monitoring and re-conformance
- Current plan and trail plan processing
- Automated problem detection
- Interfaces with the Host and external data sources
- Computer Human Interface

For each ARTCC controlled aircraft, the system creates a "current plan" from Host supplied flight plan and radar data. This plan and its modeled trajectory are continuously updated as the flight progresses through the system via Host supplied flight plan amendments. For each flight for which the system is receiving radar data, URET compares the actual trajectory with the “current plan” trajectory. If the flight is not within the lateral, longitudinal or vertical conformance bounds, the system recalculates the 'current plan' trajectory and attempts to re-conform this trajectory with the plan. The flight plan data, trajectory and conformance regions form the basis of URET's knowledge of aircraft intent. Using this information, URET provides the controller with four levels of Automated Problem Detection with a "look-ahead" time of approximately 20 minutes. The alerts are presented to the controller in both tabular and graphic form. Using this information the controller may then create "trial plans" to try and resolve the predicted conflicts. This consists of entering specific flight plan amendments (e.g., altitude changes, routing changes, etc.) into the URET program. URET re-computes the "current plan's" trajectory on a "trial" basis with this new information and reports the results to the controller. If the system reports the problem is resolved, the controller may then issue the clearance to the aircraft and enter the new flight plan data into the HOST.

2.2.5 TMA

TMA is part of the CTAS tool set and is designed to assist CPCs and Traffic Management Coordinators (TMCs) in the management of air traffic arrivals. TMA increases situational awareness of TMCs through graphical displays along with generating statistics and reports about traffic flow. TMA computes the undelayed estimated time of arrival to the outer meter arc, the meter fix, the final approach fix, and the runway threshold for each aircraft predicated upon aircraft type, filed flight plan data, weather data, and winds aloft data. It also computes the sequences and scheduled times of arrival to the outer meter arc, the meter fix, the final approach fix, and the runway threshold for each aircraft to meet the scheduling and sequencing constraints entered by the TMC, such as airport configuration and airport arrival rate.

TMA Build 2 adds enhanced scheduling functionality and a two-way Host interface. In the facility, Build 2 displays TMA generated times to the R-side controllers in the form of a meter list on their DSR.

2.2.6 Voice Communication System

The Voice Switching and Control System (VSCS) was not available in the EI^2F for this study. Instead, a Telex Model CS9500 Digital Intercom System was used for voice communication. Though this system was adequate, the participants considered it to be cumbersome.

2.3 Participants

Participation in this study was strictly voluntary and the privacy of participants was protected. Strict adherence to all Federal, Union, and ethical guidelines were maintained throughout the study. Participants were allowed to withdraw from the study at any time. The purpose of this study was to examine controller interaction issues associated with using URET and TMA within the same facility and *not* to evaluate controller performance.

The participants were selected from ZTL, ZME, ZDV, ZFW and ZMP. Their demographic information is presented in Table 1.

2.3.1 Participants with URET experience

Two participants had URET experience. Both participants were selected from ZME. These participants worked as D controllers for sectors 49 and 50.

Table 1. Participant Demographic Summary

Question:	Controller Data:	Observer Data:
Current facility	ZME = 2 ZMP = 1 ZFW = 1	ZTL = 3 ZDV = 1
Years worked at current facility	*M* = 16, *SD* = 3.56	*M* = 15.75, *SD* = 3.40
Total experience as an air traffic controller	*M* = 16, *SD* = 3.56	*M* = 18.13, *SD* = 1.35
Years worked as an en route air traffic controller	*M* = 16, *SD* = 3.56	*M* = 17.38, *SD* = 1.11
Facilities worked at, as an en route air traffic controller	ZME = 2 ZMP = 1 ZFW = 1	ZAL / ZTL = 1 ZTL (only) = 2 ZSE / ZDV = 1
Trained on URET? a. If Yes, years using URET b. Number of hours using URET weekly	Yes=3, No=1 *M* = 1.33, *SD* = 1.15 *M* = 15, *SD* = 13.23	Yes=2, No=2 *M* = 0, *SD* = 0 *M* = 0, *SD* = 0
Trained on TMA? a. If Yes, number of years using TMA b. Number of hours using TMA weekly	Yes = 2, No = 2 Inadequate data *M* = 5.5, *SD* = 4.95	Yes = 2, No = 2 *M* = 4.75, *SD* = 4.60 *M* = 8.5, *SD* = 0.71

2.3.2 Participants with TMA experience

Three participants had TMA experience. These participants were selected from ZFW, ZMP, and ZDV. One participant from ZFW and one from ZMP worked as R-controllers for sectors 49 and 50. One participant from ZDV provided the traffic management function via a TMA workstation in the mock traffic management unit. Arrival rates (among other things) were manipulated to keep the delay numbers in the meter lists manageable.

2.3.3 Participants from ZTL

Three participants were from ZTL and acted as Expert Observers (EO). These participants were subject matter experts for sectors 49 and 50. These participants observed the operation of sectors 49 and 50 and provided subjective feedback through several forms and questionnaires. EOs recorded data on the *Observer During the Run Form* (Appendix C).

2.3.4 Ghost Sector Controllers

One individual acted as the ghost controller for all adjacent, non-simulated sector positions. This individual accepted, made hand-offs and performed ground-to-ground communications.

2.3.5 TGF Simulation Pilots

Five trained simulation pilots supported the two-sector operation. Simulation pilots emulated pilot communications and actions. They initiated pre-scripted air-to-ground communications and responded to ATC instructions. The simulation pilots also entered data into the TGF computers in response to controller-issued instructions (e.g., turn right heading one two zero, climb to and maintain FL270, etc).

3 EXPERIMENTAL DESIGN

3.1 Airspace

The airspace was modeled around ZTL sectors 49 (Logen, FL110 – 230) and 50 (Lanier, FL240-330) which feed arrivals into Hartsfield International Airport (ATL) from the northeast. These sectors were selected due to their heavy arrival flows, merging of arrival streams, crossing traffic, and climbing aircraft that depart from Charlotte and other airports. The MACEY arrival (one of the busiest in the country) is located in these sectors.

3.2 Traffic Characteristics

A joint team of ZTL, WJHTC, and MITRE CAASD personnel observed actual traffic at ZTL during various periods of the day. Realistic traffic samples were then created based on these observations. The focus of this simulation was not to create worst-case traffic scenarios but rather moderate or moderate-to-heavy scenarios that ensured use of both URET and TMA. LOGEN was the inner meter fix. The outer meter arc ran approximately through the ODF fix.

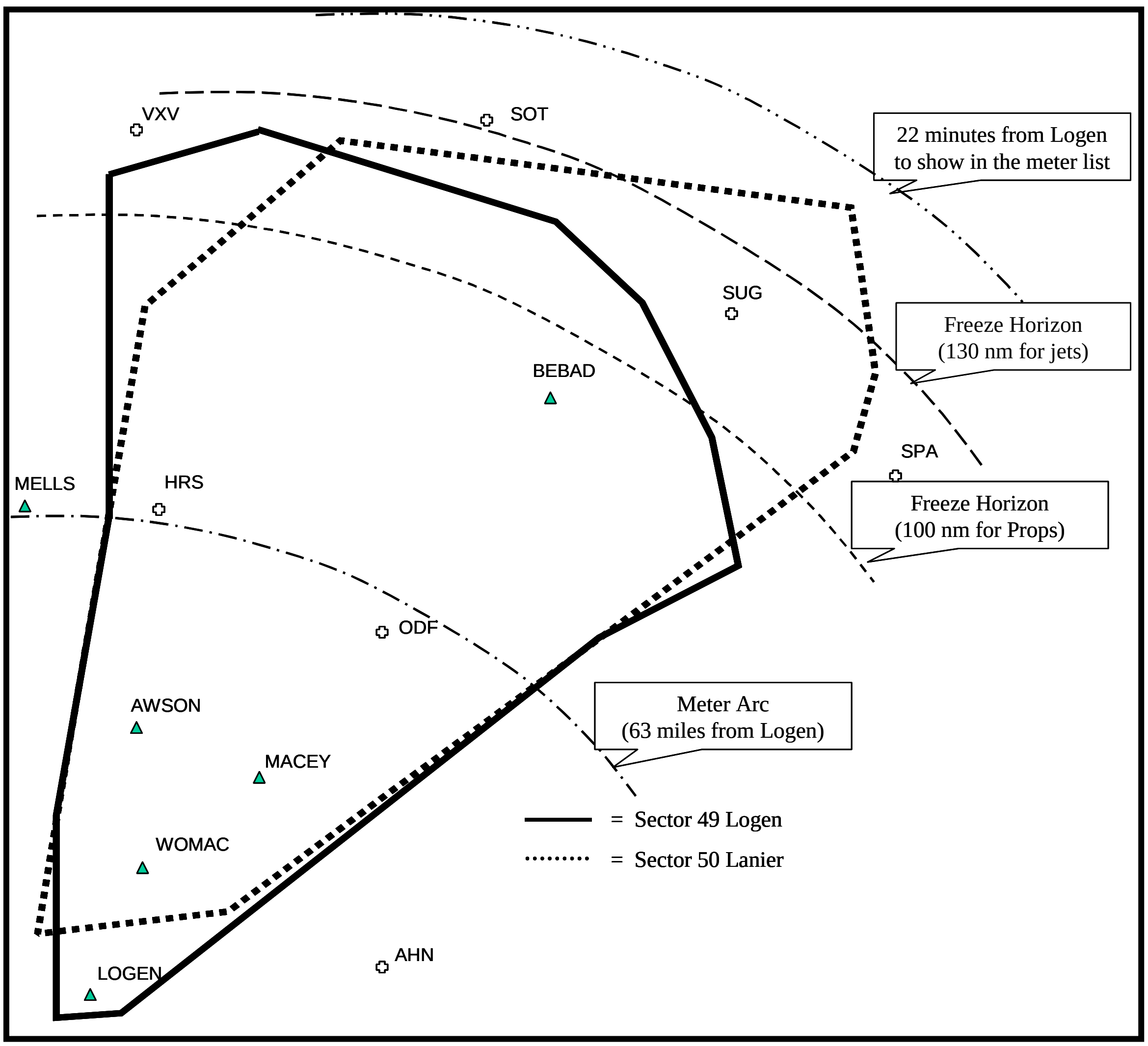

Figure 2. Airspace

Figure 2 shows the Logen and Lanier sectors used in the study

3.3 Scenarios

The scenarios were developed from System Analysis and Recording (SAR) and Adaptation and Control Environment System (ACES) tapes. The data allowed for the realistic representation of sector boundaries, jet routes, and fixes for the chosen and adjacent sectors. To suit simulation needs, the traffic was modified by adding aircraft and/or altering traffic flow. To the extent possible, realistic density and complexity for the sectors was maintained. ZTL personnel and ATC subject matter experts assisted in developing and validating scenarios. Table 2 depicts the four types of scenarios used in the study.

Table 2. Scenario Characteristics

Scenario	Volume/Complexity	Type
1	Light to Moderate	Data Collection
2	Moderate to Heavy	Data Collection
3	Moderate	Data Collection
T1	Light	Training

Scenarios corresponded to different traffic patterns that are experienced at ZTL. Scenarios differed in terms of arrival and departures, traffic mix, and volume. Each scenario was approximately 60 minutes in duration and consisted of a mix of jet aircraft operating in instrument flight rules (IFR) conditions. All scenarios started with a low-level aircraft volume already accepted in the sector.

3.4 WJHTC Orientation Sessions

3.4.1 ATC Briefing

Representatives from the simulation team and AOZ briefed the participants in a classroom setting prior to entering the laboratory area. The participants were provided with all appropriate briefing materials. The briefing covered the following topics:

1. Human Research Minimal Risk Consent Document
2. Participant’s role in the study
3. Objectives
4. Methodology and schedule
5. Airspace structure
6. Air traffic characteristics
7. Laboratory equipment and configuration
8. Rules and procedures

Following the briefing, the participants were requested to complete the Participant Consent Form contained in Appendix A and the ATC Background Questionnaire contained in Appendix B.

3.4.2 ZTL Airspace and Procedures Training

Controller participants from ZME, ZID, ZMP, and ZFW were given the opportunity to become familiar with ZTL airspace and procedures. Airspace training related to sectors 49 and 50 operation was provided by ZTL subject matter experts. This training was provided in a classroom setting at the WJHTC on the first day. Each participant was also provided a document that included sector narratives and maps.

3.4.3 URET/TMA Familiarization

Controller participants from ZME needed to become familiar with the operation of TMA. Likewise, the ZMP and ZFW participants needed to become familiar with the operation of URET. Therefore, all participants were provided an overview of URET and TMA via a CD-ROM prepared by the FFP1 Program Office. After the CD-ROM presentations, the participants discussed their experiences. The participants were then given an opportunity to see the working TMA and URET in the laboratory.

3.4.4 ATC Laboratory Familiarization

Although the EI²F was configured to simulate ZTL sectors 49 and 50, slight differences existed because of the laboratory environment. All differences were briefed in detail and instruction on equipment usage was provided. Equipment training and laboratory familiarization lasted approximately 2 ½ hours.

3.4.5 Scenario Training

Training runs were provided to allow participants to gain experience with ZTL sector operations and the laboratory equipment to be used during the simulation. A brief discussion followed each training run.

4 DATA COLLECTION

Subjective data was collected throughout this study. No objective data was collected since the focus was on familiarization of tools and evaluation of interactions.

4.1 Subjective Data

The subjective data was collected through questionnaires and debriefing sessions (See Table 3. Subjective Data Summary).

4.1.1 Questionnaire Data

All participants completed the *ATC Background Questionnaire* (see Appendix B) during the initial briefing session. The background questionnaires solicited information related to experience and other relevant information.

EOs completed the *Observer During the Run Form* (see Appendix C) throughout the simulation. This questionnaire recorded critical events, controller actions, and observations related to the interactions. At the end of each run, the participants completed the *Participant Post Run Questionnaire* (see Appendix D) which solicited information regarding the traffic, simulation environment, impact of URET and TMA interactions, and coordination.

At the end of all runs, the participants and EOs were to complete a *Post Simulation Questionnaire* (see Appendix E). This questionnaire solicited information regarding simulation fidelity, adequacy of training for simulation, automation needs, and the effects of concurrent URET and TMA operations. However, due to inclement weather, the participants went home before this form could be completed.

4.1.2 Debriefings

4.1.2.1 Post Run Debriefing

There was a debriefing session at the end of each run. A run is defined as a successful completion of a scenario. All participants, EOs, and human factors staff were present in this debriefing session. Each debriefing session lasted for about 30 minutes. The purpose of this debriefing was to discuss interesting events and issues involved in the run, if any. A human factors researcher moderated the debriefings. The debriefings were recorded on audiocassettes. All tapes are secured by ACT-540.

4.1.2.2 Post Simulation Debriefing

Additionally, there was a semi-structured group debriefing session at the end of all runs. All participants, EOs, experimenters, human factors and simulation experts were present in this debriefing. The purpose of the debriefing was offer an opportunity for those involved to provide information that might not have been addressed by the questionnaires and post-run debriefings. A human factors researcher conducted this post simulation debriefing. Free Flight program office personnel also attended this and all other debriefings. The final debriefing was recorded on audiocassettes.

Table 3. Subjective Data Summary

Method	Users	Frequency	Completed	Objective
Background Questionnaire	Participants	Once	Before first training run	Gather controller demographic information.
Background Questionnaire	EOs	Once	Before first training run	Gather EO demographic information.
During the Run Questionnaire	EOs	Every run	During each run	Record interesting observations and events.
Post Run Questionnaire	Participants	Every run	After each run	Elicit controller comments related to the URET and TMA concurrent operations, scenario information, situation awareness, etc.
Post Run Questionnaire	EOs	Every run	After each run	Record EO observations related to procedures, interactions, etc.

Method	Users	Frequency	Completed	Objective
Post Simulation Questionnaire	Participants	Once	End of all runs	Gather information on interesting issues related to concurrent URET and TMA operations, simulation fidelity, future studies, procedural implications, etc.
Post run Debriefing	Participants, EOs & others	Every run	After each run	Gather interesting events and issues related to that run.
De-briefing	Participants, EOs & others	Once	End of all runs	Gather information that was not previously acquired.

4.2 Video and Audio Recordings

Video and audio of each run were recorded to capture the interaction between controllers. These recordings would only be used to provide a mechanism to explore issues that may have been unclear in the data obtained in this simulation. The recordings would not be used for any other purpose. It was not necessary to examine the recordings since all clarifications were made in debriefings. All tapes were securely held by ACT-540 and subsequently were erased upon completion of this Final Report.

5 DATA ANALYSIS

The subjective data gathered from the questionnaires and debriefing sessions was categorized below based on its relevance to the objectives of the study:

1. Interaction between R and D controllers within a sector
2. Interaction between sectors
3. Interaction with individual tools
4. Operational considerations
5. Other miscellaneous items

It should be noted that the focus of the data collection and analysis was on the interaction between controllers and not necessarily their individual interaction with the tools.

6 RESULTS AND DISCUSSION

This study was looking to identify any URET/TMA collocation issues that would negatively affect controller interaction. None were found. The study yielded the type of interaction the controllers would have and why. A total of two training runs and five data collection runs were conducted over the four-day period. After playing the role of expert observers for the first three data collection runs, the ZTL participants actually worked the traffic using the tools during the fourth and fifth runs. This was very beneficial to the study and for the ZTL participants. The study had to be cut short by one day due to inclement weather. This day would have been used to give the ZTL participants additional experience using URET and TMA in their environment. The specific experiences and observations are described below.

6.1 Intra-Sector Interaction (interaction between R and D controllers within a sector)

The following items describe the overall experiences and observations related to intra-sector interactions:

1. The participants did not use flight strips. As a result, the information that controllers typically recorded on the strips was either written on a pad of paper (which was provided) or input into URET. Not having strips changed the note keeping tasks. It was necessary for the D controller to monitor the R controller's instructions to pilots, and then enter all speed and heading assignments into URET. If the D controller was busy with other communications or tasks, then he needed to obtain this information again from the R controller by verbal communication. This resulted in increased communication and data entry tasks for the D controller. URET CCLD Build 2 should mitigate this when speed and headings can be entered by the R controller using the fourth line in the data block.
2. After accepting hand-offs, the D controller used URET's check box option to note the hand-off.
3. The R controller occasionally asked the D controller to provide route read out using URET (e.g., where is this guy is going?). This also happened if the R controller noticed any potential conflicts.
4. The R controller typically relied on the D controller to conduct point outs and ground-ground coordination.

6.2 Inter-Sector Interactions (interaction between two sectors)

The following items describe the overall experiences and observations related to inter-sector interactions:

1. The DSR R-side displays for sectors 49 and 50 are physically adjacent to one another. As such, the two R controllers routinely observed each other's displays to obtain information about the traffic in each other's sectors. It was noted that this would not have occurred if the controller workstations were not physically adjacent.
2. As usual, there was verbal coordination for point outs, hand-offs, and aircraft's assigned speed. Exchange of aircraft's assigned speeds is important particularly for metering.
3. Occasionally, the R controller requested early hand-offs from the adjacent sector to ensure the metering times were met.

6.3 Individual Tool Specific Considerations

The following items describe the overall experiences and observations related to individual interactions with URET and TMA:

1. As pointed out above, not having flight strips with the current version of URET added some communication tasks between R and D controllers for speed/heading changes and point outs. This problem should be mitigated with URET CCLD Build 2.
2. Some participants indicated that it might be useful to identify Expected Future Clearance in the meter list for aircraft that are being held.
3. Some participants experienced difficulties in entering commands to swap aircraft in the meter list or re-sequence the order of the meter list. This may have been a simulation equipment

artifact. Perhaps message content analysis needs to be done to ensure that such re-sequencing or swapping can be performed more efficiently.

4. Participants indicated that having both the computer ID and aircraft ID on the meter list would be useful.
5. Participants also indicated that the R controller does not have access to URET entries. This will be addressed in URET CCLD Build 2.
6. Some participants suggested that TMA should be a distance based tool rather than a time based tool. The philosophical argument related to distance or time based metering was beyond the scope of this study and was not addressed further.

6.4 Operational Considerations

The following items describe experiences and observations related to operational consideration:

1. The participants indicated that it is beneficial to have a pad for writing their own notes related to frequency changes (or hand-offs) and speed/heading assignments.
2. One collocation related consideration was the meter list sequence (i.e., arrival list). The list sequence on TMA was different than the list sequence on URET. It was mentioned that URET CCLD Build 2 will have drag and drop capability that will allow controllers to reorganize the aircraft list.
3. Some participants indicated that it would be beneficial if TMA provided planned metering information to sector controllers.
4. Participants noted that it would be desirable to display the meter arc on the DSR display. This would provide them with a visual clue for meeting the times.
5. Some participants felt the meter fix crossing times and delay estimates were not always accurate. This may have been an artifact of early CTAS adaptation for ZTL. Further enhancements in adaptation might resolve this problem.

7 CONCLUSIONS AND RECOMMENDATIONS

Based on the traffic and sector configuration examined in this study, the participant consensus was that URET and TMA are quite independent tools and their collocation had no negative impact on safety or the interaction of the R and D controllers (both intra and inter sector). There was also no negative impact on individual controller operation. Although not related to the collocation issue, a few participants were not completely comfortable with the time-based metering concept. Perhaps more training and familiarization would help controllers overcome any initial bias towards this concept. The participants also identified individual tool specific considerations. It was determined that most are planned to be addressed in future versions of the tools. There were no procedural issues identified in this study. This study also provided an opportunity for all participants to gain familiarization with the tools. It was especially beneficial for the participants from ZTL. If a follow-on study is to be conducted, it should focus on high altitude sectors with more over flights. Such a study would complement this study which focused on arrivals.

May 9, 2001

Appendix A

ATLANTA COLLOCATION STUDY
PARTICIPANT CONSENT FORM

I, _____________________________, understand that the Federal Aviation Administration sponsors and Vincent Lasewicz-Jr direct this study, entitled *Atlanta Collocation Study*.

Nature and Purpose:
I will volunteer as a participant in the project above. I understand the purpose of Phase I is to evaluate controller interactions associated with the concurrent use of User Request Evaluation Tool (URET) and Traffic Management Advisor (TMA) in Atlanta airspace. Under the conditions simulated, the specific objectives are to:

- Gain understanding of the operational impacts of URET and TMA co-location;
- Evaluate the operational interaction between the R-side and D-side controllers; and
- Evaluate the operational interaction between sectors, if appropriate.

One group of six participants (consisting of either CPC's, staff, or supervisors) will be selected for the simulation. These participants can be selected from ZTL, ZME, ZID, ZFW or ZMP. This group will participate for a one-time period of up to 9 days (including travel) with the weekend off.

Experimental Procedures:
Two participants will have URET experience. These participants will be selected from ZME or ZID. These participants will work as D-side controllers for sectors 49 and 50. Two participants will have TMA experience. These participants will be selected from ZFW or ZMP. These participants will work as R-side controllers for sectors 49 and 50.

Two participants will be from ZTL and act as Expert Observers (EO). These participants must be familiar with ZTL traffic operations and have specific knowledge of sectors 49 and 50. During the simulation runs, these participants will observe the operation of sectors 49 and 50 and provide subjective feedback through several forms and questionnaires.

Discomforts and Risks:
There are no expected discomforts or risks associated with this experiment.

Benefits:
I understand that the only direct benefit to me is to participate in research. The benefit for participants derived from the results of this study may include the examination of the impact of concurrent operation of URET and TMA.

Participant Responsibilities:
During the experiment it will be my responsibility to control air traffic and regard the simulated air traffic as if it were live traffic. I will answer any questions asked during the experiment to the best of my abilities. I will not discuss the content of the experiment with anyone until the completion of the experiment. I will complete a background questionnaire, a post run

questionnaire at the end of each scenario, and a post-simulation questionnaire at the end of simulation.

Participant's Assurances:
I understand that my participation in this study is completely voluntary. Vincent Lasewicz-Jr has adequately answered any and all questions I have about this study, my participation, and the procedures involved. I understand that Vincent Lasewicz-Jr. will be available to answer any questions concerning procedures throughout this study. I understand that if new findings develop during the course of this research that may relate to my decision to continue to participation, I will be informed.

I have not given up any of my legal rights or released any individual or institution from liability for negligence.

I understand that records of this study are strictly confidential, and that I will not be identifiable by name or description in any reports or publications about this study. Photographs and audio recordings are for use within the William J. Hughes FAA Technical Center (WJHTC) only. Any of the materials that may identify me as a participant cannot be used for purposes other than internal to the WJHTC without my written permission.

I understand that I can withdraw from the study at any time without penalty or loss of benefits to which I may be entitled. I also understand that the researcher of this study may terminate my participation if she feels this to be in my best interest.

If I have questions about this study or need to report any adverse effects from the research procedures I will contact Vincent Lasewicz-Jr at (609) 485-6805.

I have read this consent document. I understand its contents, and I freely consent to participate in this study under the conditions described. I have received a copy of this consent form.

Research Participant: __________________________Date: ____________

Research Director: ____________________________Date: ____________

Witness: ____________________________________Date: ____________

Appendix B

Atlanta Collocation Study
ATC Background Questionnaire

Participant ID: **Role (circle one):** **Observer Controller**

Sector: 49 50 **Position (only for controllers)** R D

1. Circle the facility were you currently work? ZTL ZME ZID ZFW ZMP Other ___
2. How long you worked at your current facility? ____________
3. What is your total experience as an air traffic controller? _____________
4. How many years have you worked as an *en route* air traffic controller? _______
5. List the facilities at which you have worked as an *en route* air traffic controller:

   ____

6. Are you trained on URET? YES NO

   6.1. If YES, how many years have you been using URET? ______________

   6.2. How often do you use URET in a week? ____________hours

7. Are you trained on TMA? YES NO

   7.1. If YES, how many years have you been using TMA? ______________

   7.2. How often do you use TMA in a week? ____________hours

Appendix C

Atlanta Collocation Study
Observer During-the-Run Form

Observer ID#:_________ Controller IDs, R-Side:_________ D-Side:_________

Scenario: ___________ Run #: ___________ Sector: _________

Please record the time of the interesting events as and when you notice (record the time of the event, aircraft ID, and put a check mark in the appropriate column)

Simulation Time	Aircraft ID	Event/Item of Interest

As and when appropriate, please record your observations regarding the following:

1. Use of URET

2. Use of TMA

3. Coordination between R-side and D-side controllers

4. Coordination with other sectors

5. Phraseology

6. Difficulty with simulation environment, equipment, voice system, etc.

7. Other relevant information

Appendix D

Atlanta Collocation Study
Participant Post-Run Questionnaire

Controller ID#:_____ Position: R-Side or D-Side (*circle one*)
Scenario:_____
Run#:_____ Sector:_____
Date:______/______/______

The term ***overall situation awareness*** refers to what is commonly known as the controller's "picture" and involves processing the relevant air traffic information to develop a thorough understanding of the current situation that facilitates appropriate air traffic actions in a timely manner.

1. Rate your level of ***overall situation awareness*** during this run.

1	2	3	4	5
Very Low		Moderate		Very High

Comments.

____

____

____

2. Did you use URET? YES NO
If YES, please explain how you used URET. If your answer is NO, please explain why you did not use URET?

____

____

____

____

3. What URET information did you communicate/share with R-side controller (for D-side controllers only)?

4. What URET information did you communicate/share with D-side controller (for R-side controllers only)?

5. Did you use TMA? YES NO

If YES, please explain how you used TMA. If your answer is NO, please explain why you did not use TMA?

6. What TMA information did you communicate/share with D-side controller (for R-side controllers only)?

7. What TMA information did you communicate/share with R-side controller (for D-side controllers only)?

8. Do you think any new procedures are necessary to adopt concurrent operation of URET and TMA (circle one)? YES NO
If your answer is YES, please explain the procedural issues.

9. Please provide any additional comments, concerns, or suggestions you may have about this run.

Appendix E

Atlanta Collocation Study
Participant and Observer Post-Simulation Questionnaire

Controller ID#:_____ Position: R-Side or D-Side (*circle one*)
Scenario:_____
Run#:_____ Sector:_____

Date:______/______/______

1. What additional procedures would you suggest to facilitate the concurrent operation of URET and TMA?

____

____

____

____

2. Describe the benefits of concurrent operations of URET and TMA to controllers?

____

____

____

____

3. Rate the realism of the simulated flight crew responses compared to your field experience.

1	2	3	4	5
Very Unrealistic		Moderate		Very Realistic

Comments.

____

____

4. Rate the overall realism of the simulation compared to your field experience.

1	2	3	4	5
Very Unrealistic		Moderate		Very Realistic

Comments.

5. Rate the adequacy of the simulation training.

1	2	3	4	5
Inadequate		Moderate		Adequate

Comments.

6. Were you anytime confused due to conflicting or inconsistent information from URET and TMA? YES NO If Yes, please explain

7. What can be done to improve simulation fidelity? If we were to conduct similar research, what improvements in scenario, traffic, phraseology, and simulation would you suggest?

8. Please provide your general comments or suggestions about simulation or any related factors.