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MITRE TECHNICAL REPORT

Analysis for Enabling Benefits at User Request Evaluation Tool (URET) Field Sites

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Center for Advanced Aviation System Development
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CAASD

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Abstract

In 1998, the Federal Aviation Administration (FAA) established the Free Flight Phase 1 (FFP1) program to provide new decision-support systems to a limited number of facilities in a relatively short time (by the end of 2002), with the goal of providing increased user benefits while maintaining levels of safety.

The User Request Evaluation Tool (URET) was one of the systems selected for inclusion in FFP1. The MITRE Corporation's Center for Advanced Aviation System Development (CAASD), in conjunction with the FAA, developed URET as an operational prototype, deploying the system at the Indianapolis and Memphis Air Route Traffic Control Centers (ARTCCs) in the 1996-97 timeframe. Under the FFP1 program, URET was implemented as a production system and became operational at six ARTCCs between December 2001 and April 2002.

URET assists air traffic controllers with the detection and resolution of aircraft-to-aircraft and aircraft-to-airspace separation problems. The key URET capabilities include trajectory modeling, aircraft and airspace conflict detection, trial planning to support conflict resolution of user or controller requests, and electronic flight data management.

The system was designed to provide benefits in the areas of safety, FAA productivity, and NAS user cost savings. In addition, URET has a significant role in the achievement of benefits through interaction with other systems and procedures in the future NAS. The benefits of URET are achieved when the controllers understand the system capabilities and use them effectively. Therefore, it is important to understand how controllers are using the system and to determine what FAA actions can make it more useable.

During the first half of 2003, CAASD personnel visited the six URET FFP1 ARTCCs to assess how controllers are using URET to provide benefits and where additional actions could enable further benefits. During the spring and summer of 2004, CAASD personnel visited the new URET FFP2 sites and revisited two of the FFP1 sites. This paper presents the major findings on the usage of the system and the changes in usage between the initial deployment at six sites and the more recent deployment at the additional FFP2 sites. Based on the findings, it makes suggestions on how URET can be used in the future to increase its utility and expand the benefits it provides.

KEYWORDS: URET, CAASD, FFP1, FFP2, Benefits, Recommendations

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Section 1

Introduction

1.1 Background

In 1998 the Federal Aviation Administration (FAA) established the Free Flight Phase 1 (FFP1) program to provide new decision-support systems to a limited number of facilities in a relatively short time (by the end of 2002), with the goal of providing increased user benefits while maintaining levels of safety. The FAA selected systems that were anticipated to meet those goals and had demonstrated support within the air traffic community.

The User Request Evaluation Tool (URET) was one of the systems selected for inclusion in FFP1. The MITRE Corporation's Center for Advanced Aviation System Development (CAASD), in conjunction with the FAA, developed URET as an operational prototype, deploying the system at the Indianapolis (ZID) and Memphis (ZME) Air Route Traffic Control Centers (ARTCCs) in the 1996-97 timeframe. Under the FFP1 program, URET was implemented as a production system and became operational at six ARTCCs between December 2001 and April 2002. It has since been deployed at four additional ARTCCs within the continental United States, under the Free Flight Phase 2 (FFP2) program. The current plans are to deploy the system to the remaining Centers within the continental United States in the 2005 – 2006 timeframe (see Figure 1-1).

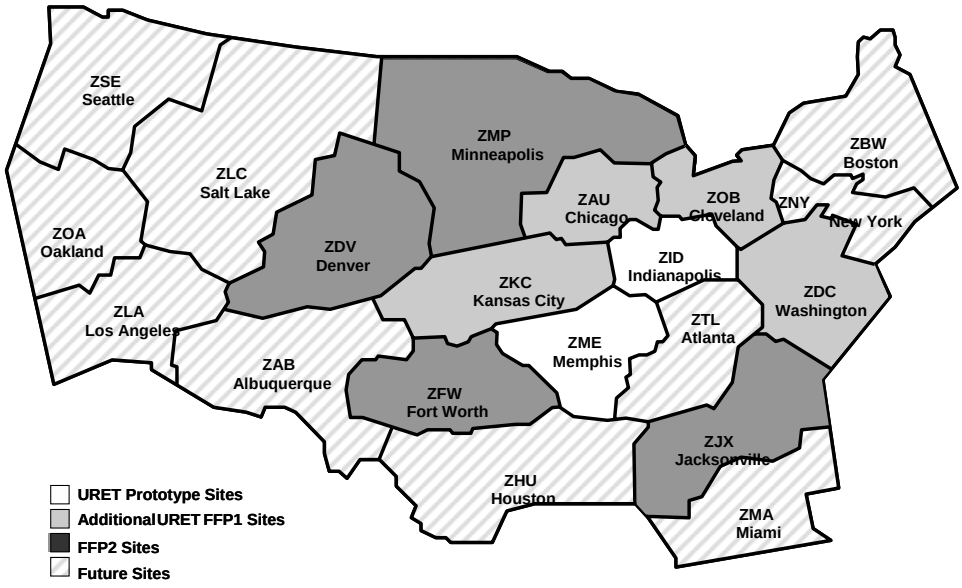

Figure 1-1. URET Prototype, FFP1, FFP2 Sites

1.2 URET Capabilities

URET is a conflict probe tool that predicts aircraft-to-aircraft and aircraft-to-airspace separation problems. The key URET capabilities include:

- Trajectory modeling
- Aircraft and airspace conflict detection
- Trial planning to support conflict resolution of user or controller requests
- Electronic fight data management

URET processes real-time flight plan and track data from the Host Computer System (HCS). These data are combined with site adaptation, aircraft performance characteristics, and winds and temperatures from the National Weather Service in order to build four-dimensional flight profiles, or trajectories, for all flights within or inbound to the Center. URET also provides a "reconformance" function that adapts each trajectory to the observed speed, climb rate, and descent rate of the modeled flight. For each flight, incoming track data are continually monitored and compared to the trajectory in order to keep it within acceptable tolerances. URET systems in neighboring facilities exchange flight data, position

and reconformance data, and status information in order to model accurate trajectories for all flights up to 20 minutes into the future.

URET maintains "current plan" trajectories (i.e., those that represent the current set of flight plans in the system) and uses them to continuously check for aircraft and airspace conflicts. When a conflict is detected, URET notifies the appropriate sector up to 20 minutes prior to the start of that conflict. Trial planning allows a controller to check a desired flight plan amendment for potential conflicts before a clearance is issued. The controller can then send the Trial Plan to the HCS, as a flight plan amendment. For more details about URET capabilities, benefits, and operational concepts see [Walker, 2002a].

1.3 Benefits Overview

The utilization of the URET prototype at ZID and ZME provided an opportunity to evaluate the capabilities of URET and identify user benefits prior to the implementation of the system at the six FFP1 sites. The prototype provided an understanding of URET's operational impact and a basis for a FFP1 benefits process. URET also helped define and collect meaningful benefits metrics while enabling benefits to airspace users. Over the period of time that the URET prototype was deployed, operational personnel implemented practices and procedures increasing benefits to National Airspace System (NAS) users, as documented in [Walker, 2002b].

Figure 1-2 plots the daily average distance saved, on a monthly basis, by all lateral amendments from May 1999 until January 2002 when the prototype was replaced at ZID and ZME with the FFP1 system. Lateral flight plan amendments are defined as those that change the direction of an aircraft, not the altitude or speed. They include increases in distance (e.g., turns away from the destination to avoid conflicts or heavy weather areas) as well as decreases.

Data includes all lateral amendments input to the HCS during the ten busiest hours at ZID and the eight busiest hours at ZME on the two most heavily trafficked days of the week (Wednesday and Thursday), not only those entered via URET. Distance saved is from the point of the amendment to the destination airport. The savings increased from approximately 1000 nautical miles (nmi) average daily savings (May and June 1999) to approximately 10,000 nmi average daily savings in January 2002.

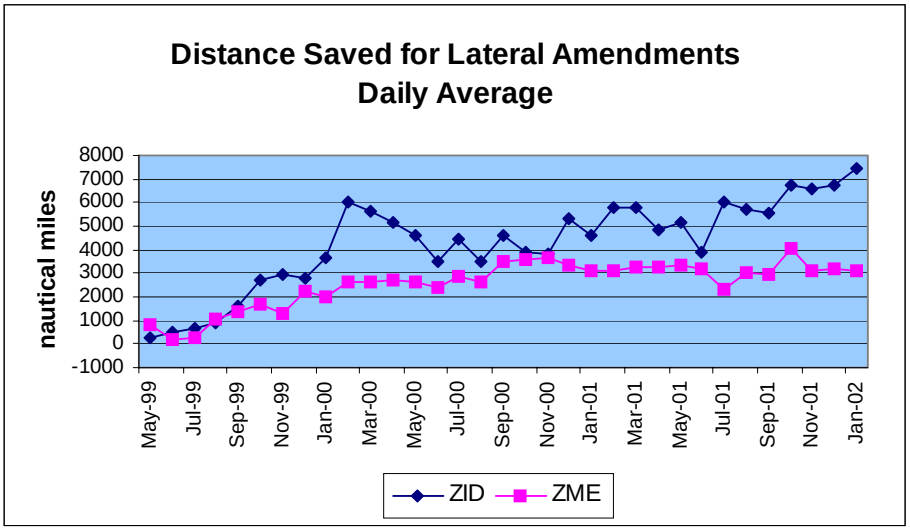

Figure 1-2. Distance Saved by Lateral Amendments – Indianapolis (ZID) and Memphis (ZME) Prototypes

In the first six months of 2003, CAASD personnel visited all of the FFP1 sites to review the use of URET from a benefits perspective [Walker, 2003]. Operational personnel found the URET FFP1 system to be operationally acceptable and beneficial. Controllers using the system provided measurable benefits to users of the NAS.

Figure 1-3 shows the average daily distance savings from lateral amendments at the URET FFP1 sites, calculated from the effective Initial Daily Use (IDU) date. The chart compares the savings at the newer FFP1 sites with the distance saved in the early months of usage at the prototype sites. The data include all lateral amendments entered into the HCS for all the time that URET was operational (24 hours daily, 7 days a week). Lateral savings at the prototype sites were extrapolated to 24 hours, 7 days a week for a valid comparison with the newer sites using the method described in Section 2.3.

The chart illustrates the progress that the four FFP1 sites made with URET, in comparison with the early months for the prototype sites. The data shows a similar increase in distance saved at the four additional URET sites, indicating that the trend of increasing distance savings has continued since the deployment of URET FFPl.

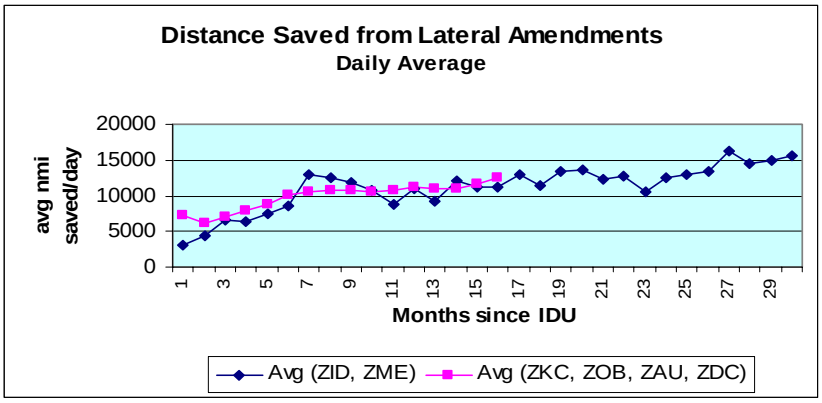

Figure 1-3. Total Distance Saved from lateral Amendments URET FFP1 Sites

URET was deployed at the FFP2 sites, Jacksonville (ZJX), Ft. Worth (ZFW), Minneapolis (ZMP) and Denver (ZDV), between August 2003 and February 2004. The Air Traffic Organization (ATO) estimate of user savings from the increase in the issuance of lateral amendments with URET at the ten sites at which URET is currently deployed amounts to 60,000 nmi daily, which amounts to over 21.6 million nmi saved annually [Air Traffic Organization, 2004].

In [Walker, 2002b] CAASD estimated that the ten sites at which URET is currently deployed the savings would be 13.1 million nmi (see Table 1-1). This is 7.4 million nmi less than the current ATO estimate. Using the ATO value for the current ten sites and the CAASD estimate for the next ten sites, which would appear to be a conservative estimate of 11.1 million nmi, the total URET savings would be 32.7 million nmi. Assuming a typical Airline Direct Operating Cost (ADOC) of $7.00 per nautical mile [Hoffer, 1998], the annual savings to users of the NAS that will accrue from national usage of URET will be approximately $230 million.

Table 1-1. Annual Distance Saved with URET in Millions of NMI

Deployment Sites	CAASD Estimate Distance Savings	CAASD Estimate Percent	ATO Estimate Distance Savings
ZID and ZME	2.7	11%	6.8
ZKC, ZAU, ZOB, ZDC:	6	25%	9.7
ZFW, ZJX, ZDV, ZMP:	4.4	18%	5
Future URET Sites	11.1	46%	

1.4 Scope of Document

URET benefits in the areas of safety, controller efficiency and benefits to users of the NAS depend upon the effective use of URET by the controller workforce. During the spring and summer of 2004, CAASD personnel visited the operational FFP2 sites and two FFP1 sites to review the use of URET from a benefits perspective.

Section 2 of this report describes the benefits that URET enables in the areas of safety, controller productivity and airspace user cost savings. It also identifies future potential savings that URET can enable.

Section 3 provides an analysis of the observations made during the visits to the FFP2 URET sites, with the focus on the operational use of URET to achieve benefits.

Section 4 discusses the future use of URET, after full-scale deployment, for increased benefits. Based on the review and analysis of field operations and URET functionality, this section makes recommendations for improved training, modified procedures, reduction in airspace constraints and the further integration of URET capabilities into an integrated sector operation.

Section 5 provides a summary of benefits, observations, and recommendations.

Section 2

URET Benefits

Benefits from effective use of the URET capabilities are broadly categorized in three areas: safety, FAA productivity, and user cost savings. A brief description of the benefits mechanisms follows. For details see [Walker, 2003].

2.1 Safety

URET can increase safety by providing the controller with earlier awareness of prospective conflicts and support in resolving them. URET reduces controller workload; it gives advance notification of potential conflicts; and it supports the controller in strategically resolving problems. The URET capabilities can increase controller situational awareness.

According to a 2003 report [Office of Inspector General, 2003], almost 90 percent of operational errors are attributed to human factors issues rather than procedural or equipment deficiencies. A report on operational errors in Atlanta airspace [Rodgers, M. D., et al, 1998] states that in 73% of the cases the controllers were not aware of the developing error.

The URET conflict probe function alerts controllers up to 20 minutes in advance of potential problems. During the time that the URET prototype system was operational at ZID and ZME, 37 operational errors at these sites were analyzed. The analysis showed that in those instances in which the HCS provided reliable data, URET provided an average warning time of seven minutes versus approximately two minutes for Conflict Alert.

The FAA monitors the effects of URET and other Free Flight tools to ensure that the highest standards of safety are maintained. The Free Flight System Safety Workgroup and the FAA System Safety Work Group participate together in assessing the impact of URET and other Free Flight Program Office (FFPO) tools on the NAS and the controller workforce and “whether these tools have a relationship to operational errors” [FAA, 2003].

The FFPO, in conjunction with Air Traffic Investigations and Evaluations Staff, reviews all operational errors and deviations occurring in the en route environment to ensure that Free Flight tools were not contributing factors to the events. Their conclusion is that “to date, none of the Free Flight tools have been identified as the main causative factor for any operational error or deviation” [FAA, 2003].

Rather, there is an increasing belief within the FAA that URET and the other FFPO tools (i.e., Traffic Management Advisor and Controller-Pilot Datalink Communications) enhance the safety of the system. Specifically, URET increases situational awareness and alerts controllers to potential conflicts, which should reduce operational errors [FAA, 2003].

2.2 Productivity

FAA productivity is accomplished by being able to safely handle increasing number of aircraft operations in a higher-complexity environment. URET capabilities increase controller productivity through:

- Reduction in use of paper flight strips
- Increased ease of evaluating potential conflicts and resolving them
- Easier formulation and entry of amendments
- Reduction in verbal communication requirements
- Increased data accuracy and currency

National Order 7110.65, Section 13-1-5, states that "The ACL (Aircraft List) shall be used as the sector team's primary source of flight data" and that " When URET is operational, sector teams shall post flight progress strips for any non-radar flights" and for other causes "that are deemed necessary for safe or efficient operations."

A significant controller workload reduction results from the use of the URET Aircraft List as the sector team's main source of flight data. Management of paper flight progress strips requires the controller to post and mark the strips and keep them current. When new aircraft enter the sector, the controller adds the new strips to the strip bay and physically reshuffles the strips. URET manages flight data and keeps it current and accurate automatically with system changes. URET provides the controller with earlier, more accurate information for making better decisions, potentially reducing conflicts and controller workload in downstream sectors.

URET provides a pull-down menu for the controller to enter route, altitude and speed amendments. The URET route amendment capabilities are most frequently used by controllers and provide the greatest increase in productivity from the entry of amendments. Before the deployment of URET, controllers would enter a route amendment by typing it into the system. This method is prone to errors, either through entering a wrong fix name or mistyping characters. The controller would then have to correct the entry. With URET, the controller easily creates the amendment message using the URET point-and-click interface. A recent upgrade to the system provides the controller with the capability of placing an aircraft on an ATC Preferred Route (APR) via the URET route menu. The URET route menu (Figure 2-1) provides the controller with multiple options. The controller can:

- Select a downstream fix on the route of flight (e.g., MAMEE)
- Select an ATC Preferred Route
- Type a route modification into the displayed route string.

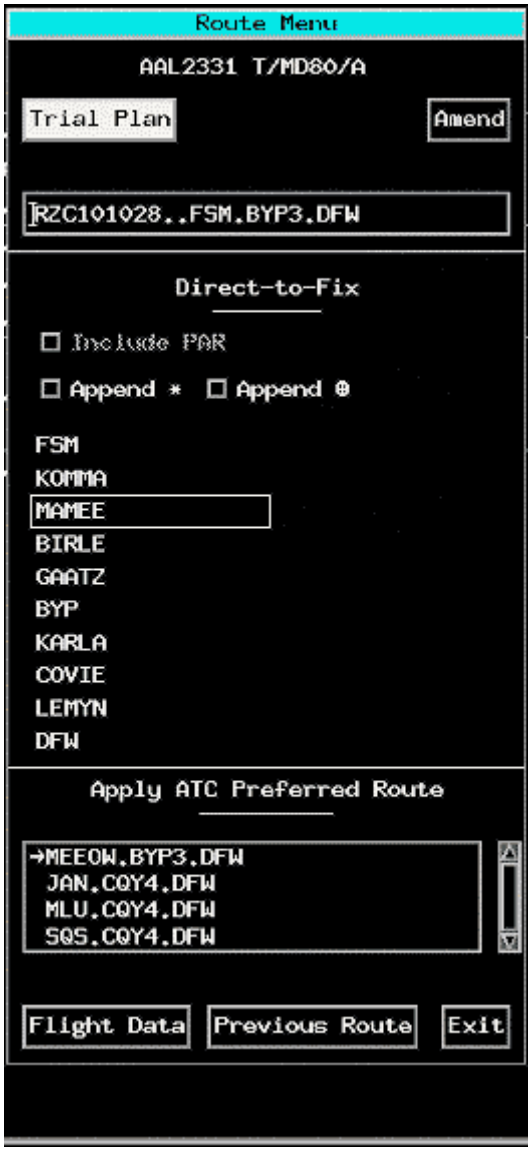

Figure 2-1. URET Route Menu

URET automatically formats the flight plan amendment message for the HCS when the controller designates that it be sent.

URET has the potential to reduce controller verbal coordination between sectors and for those Centers with interfacility capability between Centers. Controllers in the sending sectors can see if a plan is problem-free before implementing it. Verbal coordination is not required. With interfacility, controllers can identify potential problems across center

boundaries. Controllers in the receiving sectors have accurate information of incoming traffic and can more easily plan their work without verbal coordination. In our discussions with several controllers at ZJX, they said that the interfacility capability with ZDC reduced verbal coordination and saved time.

URET was designed as a sector tool, primarily for use in a two-person sector operation. Optimally, the radar associate carries out the strategic planning tasks that increase safety and achieve user benefits [Celio et al, 2000]. The radar controller's focus is primarily on tactical management of traffic within the sector boundaries. The reduction in sector workload that URET provides was recognized as critical for the effective use of URET by the sector team.

Based on field observations and reports, the increase in controller productivity has resulted in an increased amount of time that sectors are staffed with one person, which is an unexpected effect of URET. Some of the issues with use of URET in a one-person sector are listed below.

- The radar controller's prime responsibility is managing traffic within sector boundaries, while URET is a strategic tool that provides advance information of incoming traffic and predicted problems. The URET timeframe for conflict notification (an average of 12 minutes before the predicted conflict) may be longer than the tactical responsibility of the radar controller.
- The controller in a one-person sector may have difficulty locating the alert data on the Aircraft List when concentrating on the radar display and primary duties.
- URET has a separate keyboard, track ball and display, increasing the effort required to use the different URET capabilities effectively.
- The number of URET alerts (red, yellow, muted red, muted yellow, blue) may provide more warning information than the radar controller can address.

2.3 Airspace User Cost Savings

Benefits to users of the NAS from URET derive primarily from the fact that controllers issue more direct-to-fix amendments with URET; i.e., lateral amendments that reduce distance from the point of the amendment to the arrival airport. The number of directs has continued to increase at all URET sites. This section describes user benefits from the increase in direct amendments, as well as other initiatives to reduce route structure and increase user benefits that have been proposed and evaluated in the past. A summary of airspace user cost savings is provided in Section 1-3.

Issuance of Amendments

To calculate the URET benefit to users of the NAS, it is necessary to compare the distance and dollar savings from URET with the baseline case; i.e., the distance saved before URET was deployed. Data collection began in August 2002, which was after IDU at the

FFP1 sites. According to the automated data collection, the distance saved per amendment has remained relatively constant since August 2002 when data collection began at the FFP1 sites, approximately 4.5 nmi per amendment. The pattern appears to be the same at the FFP2 sites (see Figure 2-2).

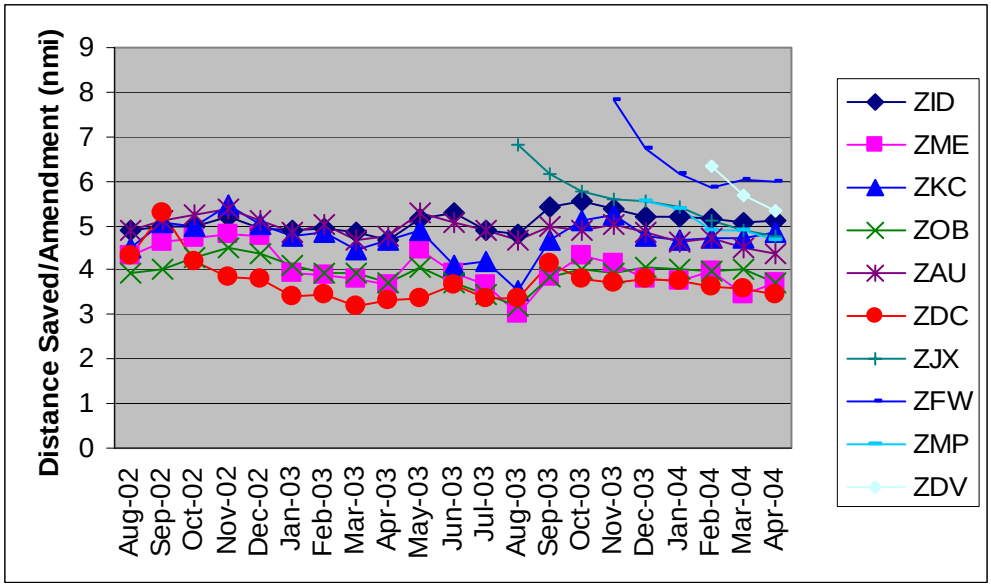

Figure 2-2. Distance Saved Per Amendment

Using the Enhanced Traffic Management System (ETMS) data, the Air Traffic Organization estimated the increase in the number of amendments after deployment of URET at each of the URET sites by comparing the average of the most recent (post-URET) month to the average level for the year prior to URET deployment [Air Traffic Organization, 2004] (see Table 2-1).

The increase in distance saved from the baseline to June 2004 was determined by multiplying the increase in number of amendments by 4.5 nmi saved per amendment for a total of over 60,000 nmi saved per day or $13 million saved per month, assuming a typical Airline Direct Operating Cost (ADOC) of $7.00 per nautical mile [Hoffer, 1998].

Table 2-1. Increase in Number of Amendments from Baseline (ETMS Data)

ARTCC	Baseline (Amendments/Day)	Increase with URET June 2004 (Amendment/Day)	Distance Saved (nmi/day)
ZID	3,648	2,786	12,538
ZME	2,273	1,489	6,699
ZKC	2,426	1,236	5,564
ZOB	3,886	1,007	4,533
ZAU	3,315	1,537	6,917
ZDC	2,935	2,197	9,887
ZJX	2,832	1,281	5,767
ZFW	2,227	603	2,712
ZMP	1,917	612	2,756
ZDV	2,266	607	2,732

Route Structure

As stated in [Walker, 2003] URET has the potential to reduce the route structure and altitude constraints in the NAS. It provides advance notification of incoming traffic and potential problems, allowing the controller to separate aircraft from aircraft rather than provide structure that separates aircraft from airspace.

Initiatives have been undertaken to evaluate the use of URET to reduce structure in the NAS. But they have not been established as policies across the URET facilities. Potentially they could be more effective, resulting in increasing benefits to NAS users.

The initiatives include:

- When the prototype was operational at ZID and ZME, the sites were issued 60-day waivers allowing controllers to send aircraft Incorrect Altitude for Direction (IADOF) without first verbally coordinating with the receiving controller, if the IAFDOF would not cause a downstream problem [Air Traffic Planning and Procedures, 2001a, 2001b]. The waivers were not extended. However, a similar waiver was granted to

ZKC in September 2003 [Air Traffic Planning and Procedures, 2003]. That waiver has been extended indefinitely, valid only during the midnight shift operational hours and only within ZKC airspace.

- URET tests and evaluations of static altitude restrictions at ZID resulted in the lifting and modification of a number of intrafacility static altitude restrictions. Aircraft could stay at higher altitude levels longer, reducing fuel burn. Savings to NAS users from the ZID evaluations and modifications amounted to approximately $950,000 annually [Walker, 2002c]. The static altitude restrictions have not been re-imposed. Evaluations for the removal of additional restrictions are not currently in process.
- There was an effort to modify the structure of the ATC Preferred Routes (APRs) that must be flown by users between certain airports, or flying through certain airspace. Operational personnel at ZID, using the interfacility look-ahead URET capabilities, proposed modifying APRs to allow aircraft to fly more direct routes further downstream; e.g., one proposed modified APR from Memphis to Detroit allowed the aircraft to avoid the Rosewood fix, reducing the distance from origin to destination by approximately 12 nmi [Walker, 2003]. There are many issues and much interfacility coordination required before the initiative to modify APRs across Center boundaries can be tested and evaluated.

Section 3

Operational Usage – Summary of Findings

CAASD staff visited the new FFP2 sites and revisited two of the FFP1 sites to understand how the capabilities of URET are integrated by site personnel in their daily work and how site personnel are using the system.

CAASD staff met with site personnel associated with URET training and deployment, and with the local URET National Air Traffic Controllers Association (NATCA) representative at the sites to get an overall sense of the acceptance of the system within the facility, as well as any site-specific issues. Most of the visit at each site was spent in observing the usage of URET on the control room floor.

This section describes some general observations on operational usage followed by the summary of findings at the sites. For further observations from the FFP1 sites see [Walker, 2003].

3.1 General Observations on Operational Usage

Operational personnel at all the FFP2 Centers looked forward to the deployment of URET and accepted it enthusiastically. There are many reasons for the more rapid acceptance of URET at the FFP2 Centers.

- Training was modified and greatly improved at the FFP2 sites. As a result, controllers were more comfortable with their ability to carry out their responsibilities using URET.
- The system was more robust. Many problems experienced in the initial deployment had been fixed before deployment at the new sites. One particularly aggravating problem, the fact that the Aircraft List frequently disappeared or 'jumped' for a second or two, when a new flight was added, was fixed in an upgrade to the system (Release 3.0B), deployed at both the FFP1 and new FFP2 sites by the end of 2003.
- Operational personnel at the FFP2 sites knew that they were part of an ongoing deployment cycle. They were not the first ones; they were not, in some sense, initial testers; i.e., the system had previously been accepted. Many of them were looking forward to the new capabilities and the workload reduction that URET provides.
- Operational personnel knew that they were required to use URET as their primary source of flight data management once the sector team was trained [FAA, Order 7110.65, 2001]. The expectation that all controllers would use the system once trained made acceptance easier. At some of the FFP1 sites, usage was voluntary.

The FFP2 ARTCCs reached 100% utilization of URET very rapidly in comparison with the FFP1 Centers (see Figure 3-1). ZMP has not yet reached 100% utilization as they have some sectors responsible for non-radar airspace. Those sectors continue to use paper flight strips.

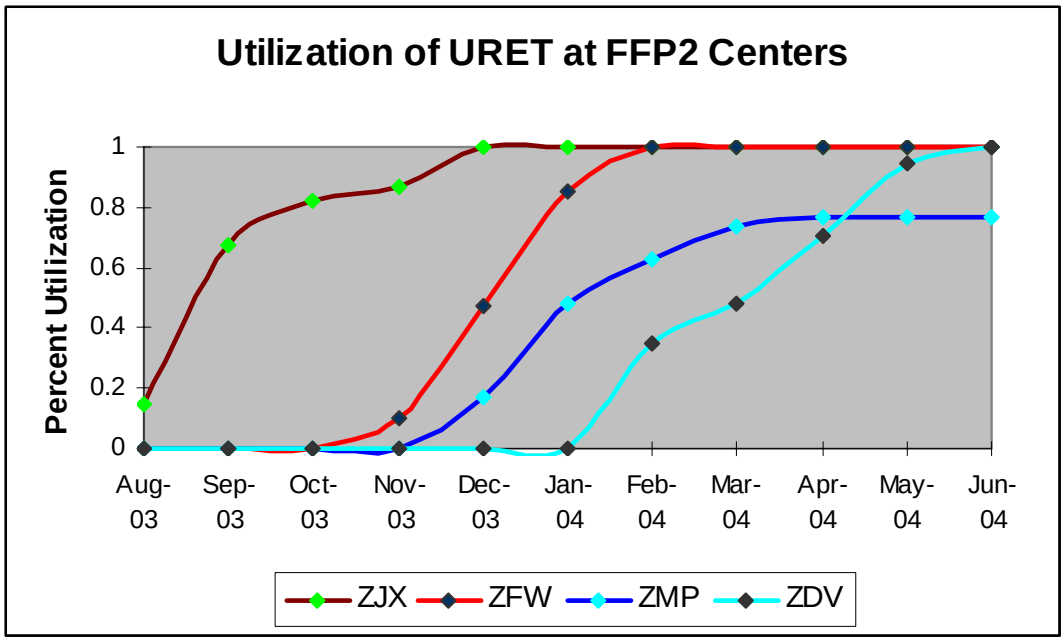

Figure 3-1. URET Utilization at FFP2 Sites

Table 3-1 shows the timeframe from IDU to 100% utilization of URET at the FFP1 sites in comparison with the FFP2 sites. URET was deployed at the prototype sites (ZID and ZME) in the 1996-97 timeframe; usage reached 100% when a system upgrade provided the capability to send amendments to the HCS via URET in July 1999. The URET system was deployed at ZDC in April 2002, but usage was intermittent because of system problems until August 2002. Due to airspace complexities, URET is not used at seven sectors in ZAU. ZAU has submitted a NAS Change Proposal (NCP) for a HCS modification that will address their concerns. The change is scheduled for deployment by the end of August 2004. When it is implemented, ZAU will use URET at all sectors. ZMP is waiting for the capability to use URET in non-radar airspace.

Table 3-1. Initial Daily Use of URET and Current Utilization

	Center		IDU	100% Utilization of URET	Elapsed Time
Prototype Sites	Indianapolis	ZID	1997	July-99	24 months
	Memphis	ZME	1997	July-99	24 months
FFP1 Sites	Kansas City	ZKC	Dec-01	Aug-02	9 months
	Cleveland	ZOB	Jan-02	Aug-02	8 months
	Chicago	ZAU	Feb-02	Jan-04 85% Util.	23 months
	Washington	ZDC	Apr-02	Aug-03	16 months
FFP2 Sites	Jacksonville	ZJX	Aug-03	Dec-03	5 months
	Ft. Worth	ZFW	Nov-03	Feb-04	4 months
	Minneapolis	ZMP	Dec-03	Apr-04 76% Util.	5 months
	Denver	ZDV	Feb-04	Jun-04	5-months

3.2 Summary of Findings

The summary of findings is based on the recent visits of CAASD staff to the FFP2 sites and two of the FFP1 sites (ZME and ZDC) to understand how the capabilities of URET are integrated by site personnel in their daily work and how controllers are using the system.

3.2.1 Training

Training for FFP2 sites was much better than FFP1 URET training. There was a substantial reduction in Computer-Based Instruction (CBI) and a greater emphasis on use of URET to identify and resolve potential conflicts. Operational personnel, in general, were very positive about the training.

FFP1-trained controllers had complained that the CBI training was tedious and boring and that the training period of five days was too long. The FFP2 training more effectively interspersed CBI with active group participation in working URET problems. FFP2-trained controllers did not complain of the length of training time.

The URET FFP1 training did not emphasize ‘best practices’ in the use of conflict probe and trial planning. Controllers were presented with the conflict probe and trial planning

capabilities, but training in how to use URET when a conflict is predicted to occur was not emphasized. Many FFP1-trained controllers, when they started using URET on the control room floor, did not initially use the conflict probe capability. By the time they were ready to look at prospective conflicts, display them on the GPD, and create trial plans, they said that they had frequently forgotten how to use these features.

FFP2 training placed more emphasis on the use of URET to identify and resolve conflicts. Training emphasized the use of URET to evaluate situations earlier and the use of trial planning to determine resolutions for conflicts and look for beneficial routes and altitudes. FFP2-trained controllers were better prepared to use the conflict notification features of URET effectively.

In the training segment on "Effective Use of URET" there are six diagrams that display conflicts on the Graphic Plan Display (GPD). Questions on how to resolve the conflict accompany each diagram. The questions accompanying the first diagram (Figure 3-2) are listed below:

- You are working Sector 1.
- You see a red alert for COA96 on the ACL (Aircraft List).
- A check of the alert is displayed on the GPD. Note the conflict with AAL78.
- What are some options that you have?

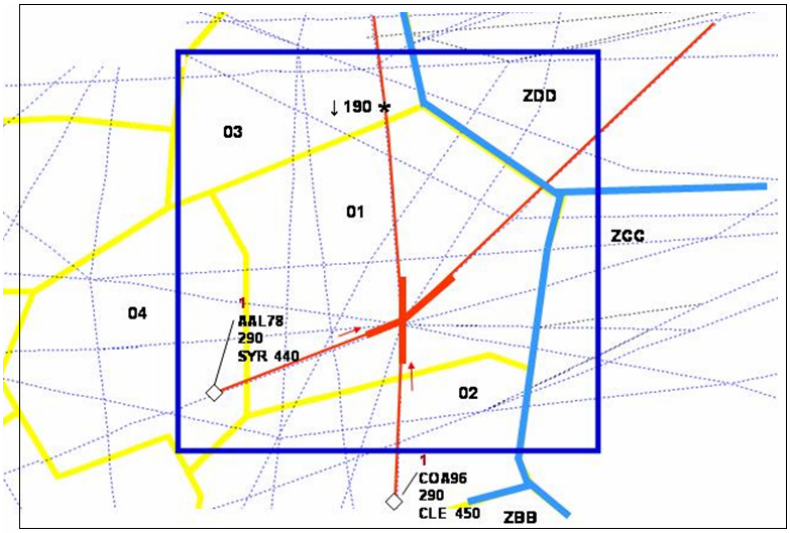

Figure 3-2. Example from FFP2 Training Package

However, some of the messages that were conveyed in the training focus too much on the radar associate controller as an adjunct to the radar controller, rather than as a member of the sector team who analyzes URET conflict information and strategically resolves problems. Some examples are given below [National Air Traffic Training Program, 2004]:

- URET's Trial Planning capability should not take attention away from the Radar Associate controller's primary responsibility of helping the Radar controller.
- "The controller should not get carried away with Trial Planning every solution for every traffic situation possible."
- "Do not neglect the Radar controller while attempting to resolve conflicts using the Trial Plan feature."

The positive results of the training are apparent in the rapidity with which controllers at the new URET Centers achieved 100% usage at all sectors, except for ZMP, which has nine non-radar sectors for which paper flight strips are mandated (See Table 3-1). The need for increased focus on the strategic role of the radar associate is also apparent in the inconsistent use by controllers of the conflict detection and trial planning features.

3.2.2 Flight Data Management

Controllers at all the sites appreciate URET flight data management features, and they consider the replacement of paper strips by URET one of its best features. The Aircraft List, the flight data display, is the standard URET display (see Figure 3-3). At most sectors at the

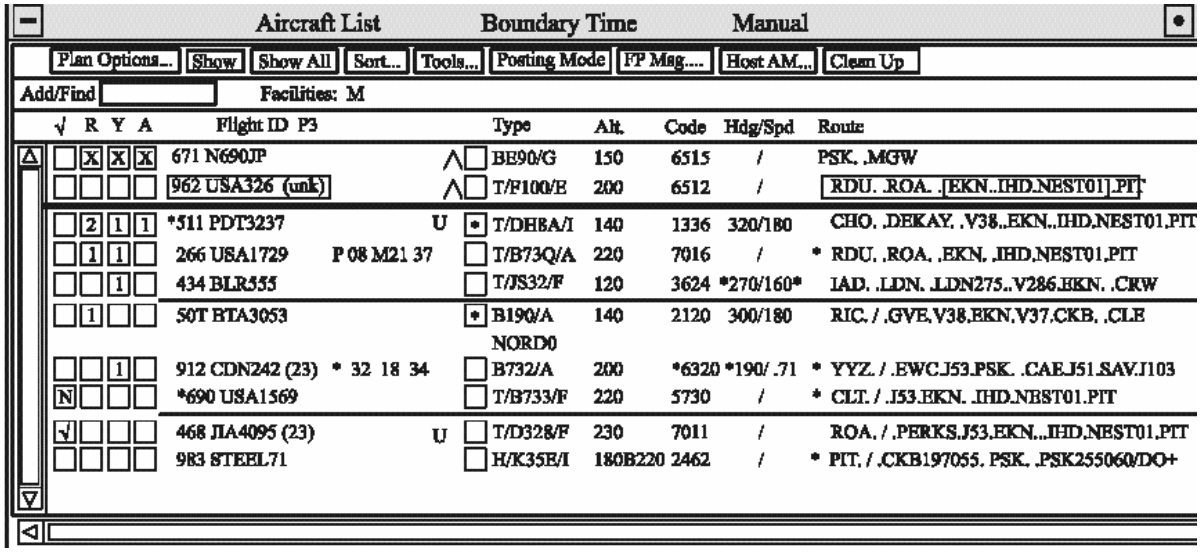

Figure 3-3. Aircraft List Display

four new URET sites controllers keep the Aircraft List up full screen and bring up the other windows as needed.

The Aircraft List provides controllers with many of the options of paper strips. For example, controllers can sort the Aircraft List entries by various criteria; they can record control information such as speed and heading; and they can add free-text to any entry.

Additional flight data management features deployed in the April-May 2003 timeframe provide functionality requested by operational personnel, e.g., the entry of point-outs and transfer of heading and speed between sectors and between the Radar and Radar Associate displays. Other new features include separator lines between every three entries on the Aircraft List to assist controllers in reading across a list entry as well as additional sort options for the Aircraft List that make for easier identification of a specific aircraft on the display and increased flexibility in arranging flight data for operational conditions and procedures.

Controllers agree that the Aircraft List provides accurate data and maintains currency. It updates itself. All of the amendments are automatic, and there is no need for any manual handling. At ZJX, operational personnel commented that they get a lot of convective weather requiring reroutes in the summer months, which causes lots of re-routings and amendments. Too many paper strips were being generated to reflect the changes. At ZDV, they noted that URET creates a quieter and cleaner atmosphere in the radar control room than in the past.

Controllers use the GPD to identify the route of flight, especially when they encounter an unfamiliar fix on the route string. A controller at ZFW said that he uses the GPD to determine the proposed path of the aircraft and see what Centers or sectors might need a point out.

The management of flight data via URET does not provide a one-to-one correspondence with management of flight data with paper strips. There was a reduction in the use of paper flight strips to manage traffic at some centers prior to the deployment of URET. ZID operational personnel had also reduced the marking of paper strips before URET was deployed. Controllers need to interact with URET in a different way than they did with paper flight strips to manage flight data effectively.

Uses of Flight Data Notation

The posting and marking of the paper flight strips supported the controller by providing:

- A recordkeeping function for important information
- A reminder to the controller of significant issues in a relief briefing
- A means of non-verbal communication between the radar associate controller and the radar controller.

With paper flight strips, at most ARTCCs the radar associate controller posted and marked the strips and could point out any necessary actions to the radar controller without verbal coordination. The symbols used to mark paper strips were mandated nationally, with some local additions.

URET provides the capability for controllers to enter special notations that they formerly entered on strips in a free text area associated with each item on the Aircraft List. But the use of the Aircraft List for notations has been inconsistent. There are multiple reasons:

- Procedures for use of the free text area were not mandated with URET (for more details see [Walker, 2003]).
- Controllers who are not very comfortable with automation find it more difficult to enter the text in URET. They have to find the entry and click on the small square and then type.

Inconsistent and limited use of the free text area by controllers results in some controllers not making useful notations that would be helpful for recordkeeping, places an added communication burden on operational personnel to ensure that the relieving controller understands the notation, and can increase intra-sector verbal coordination [see Walker, 2003]. Operational personnel cited specific instances in which they needed a standardized model of notation in URET; e.g., at ZAU, the recording of the teletype message issued for international flights. Work to standardize notations should include:

- National specification of required symbols and usage of the free text area, with some local variations for particular conditions
- More focus in training on use of the free text area to increase controller proficiency.

Route Amendments

Before URET, the printing of a new paper strip notified the controller that the route had changed. With URET, modifications to a route for an incoming aircraft might not be noticed by the receiving controller. URET updates the route automatically. Controllers are only required to coordinate route changes if they are within five minutes of the boundary. This can result in traffic flow problems as the controller makes plans based on the earlier route and do not notice that the route has changed until it is too late. Controllers using URET have to look at the Aircraft List for changes, not be cued by a new paper flight strip. Reinforcement of training can address this concern.

Display of Coordination Fix and Time at a Fix

URET does not display the coordination fix or time at a fix on the Aircraft List. With URET, the controller can do a flight plan readout by clicking on the route string to show the coordination fix and time at the fix, as well as any other notations that were on the paper flight strip. Controllers find this feature useful in predicting when an aircraft would reach a

specified point. With paper flight strips the data is immediately displayed; with URET display of coordination fix and time at fix requires an extra action (:point and click). This concern can be addressed by training.

3.2.3 Conflict Notification and Trial Planning

The attention that controllers pay to the URET conflict notification is not uniform across Centers or even within a Center. Conflict information and trial planning provide controllers with conflict information up to 20 minutes before the conflict is predicted to occur. URET provides an alert on the Aircraft List with a warning time that depends on the likelihood of a conflict. The average warning time is about 12 minutes. Notification of a predicted conflict goes to the sector where the start of the conflict is predicted to occur.

Controller response to URET notification of a conflict is mixed across facilities and operations. Some controllers use trial planning as intended to assess the impact of a proposed amendment before rerouting the aircraft. Some controllers set up their screen so that both the Aircraft List and the Graphic Plan Display are visible most of the time (see Figure 3-4). The controller can identify a prospective conflict on the Aircraft List and show the results of a Trial Plan immediately on the GPD.

In some instances, if the controller determines that no action is required or the controller has determined what action to take, the alert suppression function is invoked. Controllers find this feature especially useful for muted alerts when they do not intend to take action.

Many controllers do not pay attention to the conflict information displayed on the Aircraft List on a systematic basis. Some reasons include:

- The timeframe of notification is too long (up to 20 minutes before the predicted conflict).
- The display of muted alerts for aircraft not yet cleared on the route (e.g., to meet an altitude restriction) is an unnecessary distraction
- The fact that the Aircraft List does not display the other aircraft in the conflict makes the notification less useful. The controller does not know from the Aircraft List which of the aircraft is in conflict with each other.
- In many instances, when the sector is staffed by a single controller, the controller pays less attention to URET than in a two-person sector. The radar controller glances at URET for flight data information, but does not find it convenient to use the conflict notification and trial planning capabilities. The same controller might use these features more when staffing the radar associate position.
- Controllers were trained to manage their sector operations. They take pride in their total awareness and control of their sector and don't think that URET conflict notification is needed. If the controller looks at a prospective conflict and knows how

to solve it using a traditional solution, the controller will frequently just implement the solution.

- Some radar associate controllers use URET primarily as a paper flight strip replacement. They focus primarily on supporting the radar controller, spending most of their time with their eyes on the radar glass and ignoring URET except for flight data management.

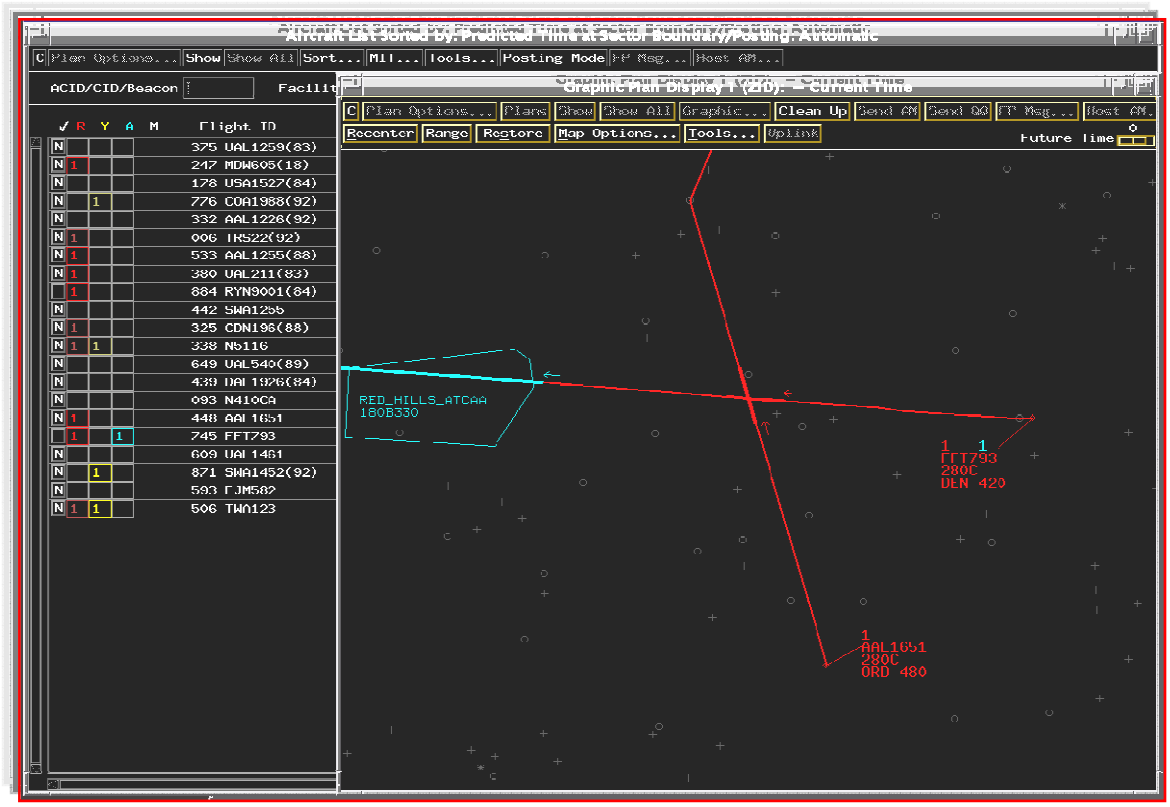

Figure 3-4. Aircraft List and Graphic Plan Display Configuration

3.2.4 Amendment Generation

Controllers like the support of URET in entering amendments, especially route amendments. They particularly like the ability to send an aircraft "direct;" this feature increases controller productivity and provides user benefits.

The ease with which route amendments can be generated and submitted to the HCS has resulted in an increase in the number of direct-to-fix route amendments entered that reduce

the distance flown. The system also has better information on aircraft intent making the trajectory model and conflict information more accurate.

3.2.5 Standardized Route Selection

Standardized routes are specified for arrivals into busy airports. These routes have been applied over the years as a means of providing structure to aid the controller to handle growing levels of air traffic. These routes include Preferential Arrival Routes (PARs) and ATC Preferred Routes (APRs).

PARs are required routes of flight in en route airspace to specified airports. They are part of HCS adaptation and are automatically applied by the HCS to the current flight plan. They may start 100 or 200 nmi from the arrival airport. PARs provide structure in the NAS on arrival routes into busy airports and they identify the handoff point from en route airspace to the TRACON. Controllers issue clearances to ensure flights follow the PAR.

The interaction of the HCS PAR adaptation and the URET adaptation results in some incompatibilities; e.g.

- If the controller modifies the route after the start of the PAR, the HCS sometimes reapplies the PAR.
- When the controller amends the flight plan of an aircraft on a PAR, the aircraft might not get the right handoff to the TRACON.

URET displays the PARs inserted by the HCS on the Aircraft List by putting a blue box around the route display. The blue box remains until a controller issues the PAR to the pilot and then clicks the route menu, removing the blue box from the controller's display and future sector displays.

APRs specify the routes that users must fly between certain airports or flying through certain airspace. They are published and approved routes. They are applied by controllers and are not part of the HCS adaptation. An upgraded version of URET deployed in 2003 provided controllers with the ability to use the URET route menu to put aircraft on APRs (see Figure 2-1 for an arrival into Dallas-Ft. Worth airport).

With the APR capability of URET, facilities are re-considering the best approach to assigning mandatory routing to flights. Operational personnel at the URET Centers have found many instances in which APR processing in URET is more accurate and less time consuming than the PAR application used in the HCS. As Centers become 100% URET users at all sectors, they are converting their PARs into APRs. APRs have multiple advantages.

- They are easier to use with URET. Controllers select the appropriate route, issue the clearance to the pilot, and send the amendment directly to the HCS. This feature has further reduced controller workload.

- They provide the controller with more flexibility, making it easier to amend the route.
- They are published and available to users.
- The replacement of PARs with APRs reduces the work of maintaining the PARs in the HCS.

3.2.6 Coordination

With the longer effective warning time that URET provides, solving conflicts can be accomplished earlier resulting in fewer situations where time-critical maneuvers are required to maintain separation, better workload balancing across sectors, and more efficient conflict resolution maneuvers. However, controllers do not generally coordinate the resolution of conflicts with upstream controllers. There are several reasons for lack of back-coordination:

- Over time, ATC has become a much more tactical operation. Managing and controlling traffic within the sector boundaries is taught and trained to emphasize this operation. Back-coordinating is done but in a tactical time-frame.
- Back-coordinating is more workload than accepting the handoff and solving conflicts in the sector. To coordinate a lateral maneuver can be complicated and prone to communication errors.
- Controllers don't know the workload of the upstream controller. With this uncertainty, there is a reluctance to possibly over-burden the upstream controller.
- Sectors in many western ARTCCs, such as ZMP, are quite large and with such a large amount of airspace there is plenty of time to maneuver aircraft.
- URET training emphasized that controllers were to do their job in the same way as before URET, and that did not include more frequent back-coordination.

Controllers infrequently coordinate a maneuver with an upstream sector controller because of these factors. They may coordinate for an early handoff, but not a maneuver. More often, they are waiting for handoff to solve a problem or to identify the situation to the radar controller for resolution. These techniques are what the controllers have done previous to getting the new URET capabilities. URET training and operational usage has not shown the controllers how coordinating an early maneuver will improve their effectiveness or provide user benefits.

3.2.7 Standardization of Usage

Experience with standardizing the use of URET varies. Examples of areas of standardization of URET usage include the establishment of procedures for use of the Free Text area, the establishment of symbols for entry into the Free Text area, the specification for

use of the check box; e.g., for noting when the aircraft is on frequency, and specification of the set-up of URET displays.

ZDV specifically decided to limit facility procedures and requirements for the use of URET. One of their lessons learned states "Don't over-proceduralize." ZDV personnel said that some FFP1 sites instituted too many local procedures and it became too cumbersome. However, limited standardization puts more responsibility on the controller going off duty to make sure that the new controller knows how the system is configured. ZDV did specify procedures for use of the free text area.

At ZFW, operational personnel said that the major flaw with URET was that there is no standard way to use the system. Controllers are free to use it however they want. This results in reduced teamwork because one controller doesn't know what to expect from the other. It also made staff changes difficult, as the new controller does not know how URET was set up and spends time changing the URET arrangement.

Observations indicate that increased standardization would be helpful. However, standardization of usage has not been specified by the Air Traffic Organization and most ARTCCs have not imposed standardized usage.

3.2.8 Wind Display

URET provides a wind display that shows, by altitude, the direction and velocity of the wind. Controllers frequently check this display, when they first sign on to a sector. Controllers said that the accurate wind data assists them in determining the direction to turn the aircraft, when clearing vectors or making route changes (see Figure 3-5).

Figure 3-5. Wind Grid Display

3.2.9 Traffic Management Unit (TMU) Interaction with URET

At most URET sites, the TMU uses URET to look at the wind display and to enter activation and de-activation of restricted airspace. However, at ZJX, the traffic management coordinator (TMC) uses URET to amend the route of flight of an aircraft if the aircraft has not yet departed. If the aircraft is airborne, the TMC checks the route and calls the supervisor to instruct a controller to issue a route amendment.

The use of URET directly by the TMC to issue amendments for aircraft that are still on the ground reduces coordination and saves time. For airborne aircraft, the TMC gets accurate information via URET of position and trajectory of the aircraft.

Section 4

Enabling Increased Benefits

For URET to enable future benefits beyond an extension of those described (i.e., reduction in controller workload and reduction in distance flown), controllers have to use URET capabilities more effectively to increase situational awareness, to identify and resolve predicted conflicts early, and to support reduction in airspace constraints.

This section provides recommendations for enabling increased benefits in the future with URET through modifications in training, procedures, airspace structure and enhanced URET capabilities.

4.1 More Effective Training

As stated in Section 3.2.1, the training for FFP2 was substantially improved over the initial training package, emphasizing conflict notification and resolution much more. FFP2-trained controllers are now using URET operationally.

However, many controllers do not use conflict notification and trial planning to effectively identify and resolve potential conflicts strategically. The FFP2 training package should be evaluated and modified as needed to help controllers use URET strategically to resolve conflicts early, increase safety, more effectively manage work flow, and support new airspace initiatives that decrease structure. This section discusses areas where URET training should be modified.

Strategic Tool

While the training effectively demonstrates *how* to use URET's planning tools, it needs to emphasize the overall operational concept of the role of the radar associate as part of the sector team, using URET to strategically identify and resolve predicted future problems. Strategic use of URET includes:

- Taking early action to analyze predicted conflicts and develop resolutions, using the trial planning function
- Coordinating resolutions with upstream sectors
- Ensuring separation of aircraft prior to their entry into the sector.

These practices can smooth the sector workload, increase safety, and perturb the route of the aircraft less making for greater predictability for the user of the NAS.

Increased Safety

Training should focus more directly on the use of URET to increase safety. If the controller uses URET capabilities to take early action to prevent conflict situations and resolve potential conflicts, URET can assist in the reduction in operational errors and deviations.

Use of URET in Single-Staffed Sector

URET training focuses on the use of URET when both a radar and a radar associate controller are working the sector. Anecdotally and from site observations it is apparent that sectors are more frequently single-staffed with the deployment of URET than formerly. Training should provide instruction and examples of how URET can be used effectively when the sector is single-staffed.

Refresher Training

Training has improved substantially since URET was deployed at the FFP1 sites. The FFP1 site personnel should undergo refresher training, particularly in the areas of conflict probe and trial planning. Some of the materials developed for the new sites could be used to focus on "best practices" in the use of URET.

Training of Developmentals

As stated in [Walker, 2003] more emphasis should be placed on the training of new controllers in the use of URET. FAA Order 3120 prescribes instructions, standards and guidance for the administration of Air Traffic technical training [FAA, 1998]. The performance criteria for the developmental to satisfactorily pass the radar associate On-the-Job Training do not specifically include competence in the use of URET. Evaluation of developmentals should incorporate evaluation of proficiency with the capabilities of URET.

Training for developmentals should emphasize the use of URET to maintain situational awareness. Operational personnel, at some sites, expressed concern that controllers trained primarily on URET rather than on paper flight strips do not have as good a mental image of the route of flight of the aircraft when radar associate training is completed. URET provides automated capabilities that eliminate the need for the controller to mentally extrapolate potential conflicts based on flight data analyses. The controller, using URET, should be able to more accurately predict problems than he could with paper flight strips.

4.2 Procedure Standardization

National standards have not been mandated with URET for the management of flight data. Examples of areas in which standardization would be helpful include the specification of the display setup (e.g., see Figure 3-4) , when to use the GPD to display predicted

problems, the establishment of procedures and symbols for the use of the Free Text area, and procedures for how the check box should be used.

ATO should work with the ARTCCs to take an inventory of the procedures that were mandated with paper strips, determine which ones are appropriate with URET, decide when standardization should be national and when local, and produce procedures at the national and local levels. Increased standardization will result in more consistent use of URET by controllers and more consistent information within and across facilities.

4.3 Airspace Structure Modification

This section describes ways in which URET capabilities support modification of the airspace structure, which can further increase user benefits. The section first presents modifications directly related to URET. It then describes other planned airspace changes that URET will accommodate. Appropriate use of URET is key in both areas.

Extension of Current Efforts

The URET look-ahead capability allows controllers to see the traffic and separate aircraft from each other rather than putting them on fixed routes to separate the aircraft from airspace. Section 2.1.3, Airspace User Cost Savings, describes some of the trial efforts undertaken as a result of URET deployment to reduce airspace structure. These include a reduction in static altitude restrictions - saving fuel, the ability to send aircraft incorrect altitude for direction without prior approval - accommodating users, a proposal to extend APRs beyond center boundaries - allowing aircraft to fly on user preferred routes for a longer period.

The URET facilities are not currently evaluating altitude restrictions for possible relaxation or removal due, in part, to lack of backfill overtime to compensate controllers for the extra training. FAA Order 7210.3S states that "facilities shall create a plan and conduct ongoing evaluations on the need to relax or remove restrictions not warranted during URET CCLD (Core Capability Limited Deployment (FFP1)) operations" [FAA, 2002]. The process that calls for an inventory, evaluation and, where possible, relaxation or removal of static altitude restrictions, including interfacility restrictions, should be re-established. Experience at ZID demonstrated user benefits in reduction in fuel burn.

The waiver that was granted to ZKC in September 2003 [Air Traffic Planning and Procedures, 2003] to allow aircraft to fly Incorrect Altitude for Direction (IAFDOF) in the midnight shift has been very successful (see Section 2.3). IAFDOF rules will change in January 2005 when Domestic Reduced Vertical Separation Minima (DRVSM) becomes effective nationwide at FL290 and above. Subsequent to the implementation of DRVSM, IAFDOF requirements for approval by the receiving controller should be reviewed and implemented as appropriate. The benefit would be a user benefit of greater flexibility as the

controller would be more likely to grant IAFDOF if approval coordination with downstream controllers were not required.

As specified in Section 3.2.4, URET sites are working to replace PARs with APRs. The potential exists to modify APRs across facility boundaries with adjacent ARTCCs, when both facilities have URET, allowing aircraft to fly more direct paths, and saving substantial distance; e.g., an extended APR form Memphis to Detroit, avoiding Rosewood would save 12 nmi (see Figure 4-1).

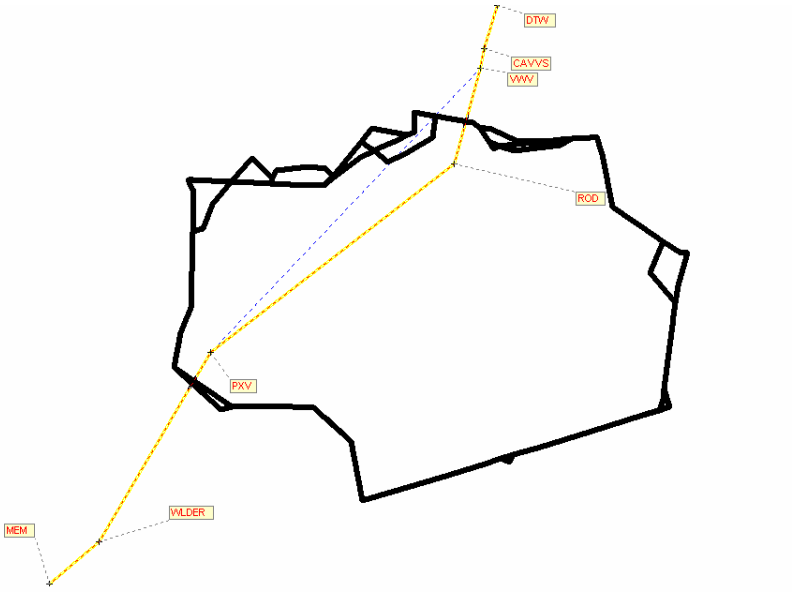

Figure 4-1. Notional Extended ATC Preferred Route: Memphis to Detroit

Planned Airspace Redesign Initiatives

Other airspace redesign initiatives and air traffic procedure initiatives will increase the capacity of the NAS and reduce the route structure, decreasing the constraints on properly equipped aircraft. Use of these initiatives operationally will require new procedures, modifications to URET processing, and operational acceptance and effective use [CAASD, 2003]. These initiatives include:

- The planned expansion of the National Route Program (NRP) will allow more users of the NAS to file and fly their preferred route. The NRP allows aircraft to fly great circle routes or wind-preferred routes in en route airspace. For NRP flights, controllers have to separate the aircraft from each other rather than maintain separation by structured routes

- Expanded use of the Area Navigation (RNAV) capability where aircraft are able to navigate between two specific points without requiring an aircraft to fly over a NAVAID. With the advent of multi-sensor Global Positioning Systems and advanced Flight Management Systems, more aircraft are eligible to fly RNAV routes thereby taking advantage of RNAV route procedures [FAA, 2002].
- Non-Restrictive Routing (NRR) airspace provides free routing in the defined airspace. It is planned to start with airspace above FL390 in the northwest United States and slowly expand.

URET can support these changes by making it easier for controllers to manage traffic in unstructured airspace. Conflict detection operates equally effectively in a structured and non-structured routing environment, giving the controllers early warning. Conflicts with SUAs can be detected and resolved well in advance, and reroutes can take advantage of the random navigation capabilities of modern aircraft. In addition, the increased efficiency that URET provides gives controllers more time to consider any potential problems and resolve them.

4.4 Extension of URET Capabilities

To enable future benefits from URET, it must be better integrated into the entire sector operation. An Integrated Concept of Use is being researched and evaluated. This Concept takes into account all that has been learned through the operational use of URET to-date and continuous research activities of CAASD and others in the aviation industry. Implementation of an Integrated Concept of Use will:

- Make it easier for the radar controller to make effective use of URET-predicted conflict data, especially when the sector is single-staffed.
- Simplify and prioritize alert information presented to controllers:
  - Alerts on uncleared sections of the trajectory (muted alerts)
  - Alerts with long warning times
  - Alerts with very short warning times

Current research and development call for the display of a conflict indicator on the data block of the radar display when URET determines that a conflict should be displayed. Pull-down Trial Plan altitude, direct-to-fix, and speed menus will inform the radar controller if a prospective amendment is conflict-free (see Figure 4-2). Red and yellow alert indicators in URET will be redefined to better support the tactical role of the radar controller and the strategic role of the radar associate. New conflict filters will be implemented to improve conflict notification under very tactical conditions. Algorithm and parameter modifications

currently under review can reduce the total number of alerts by approximately 20 percent [CAASD, 2003].

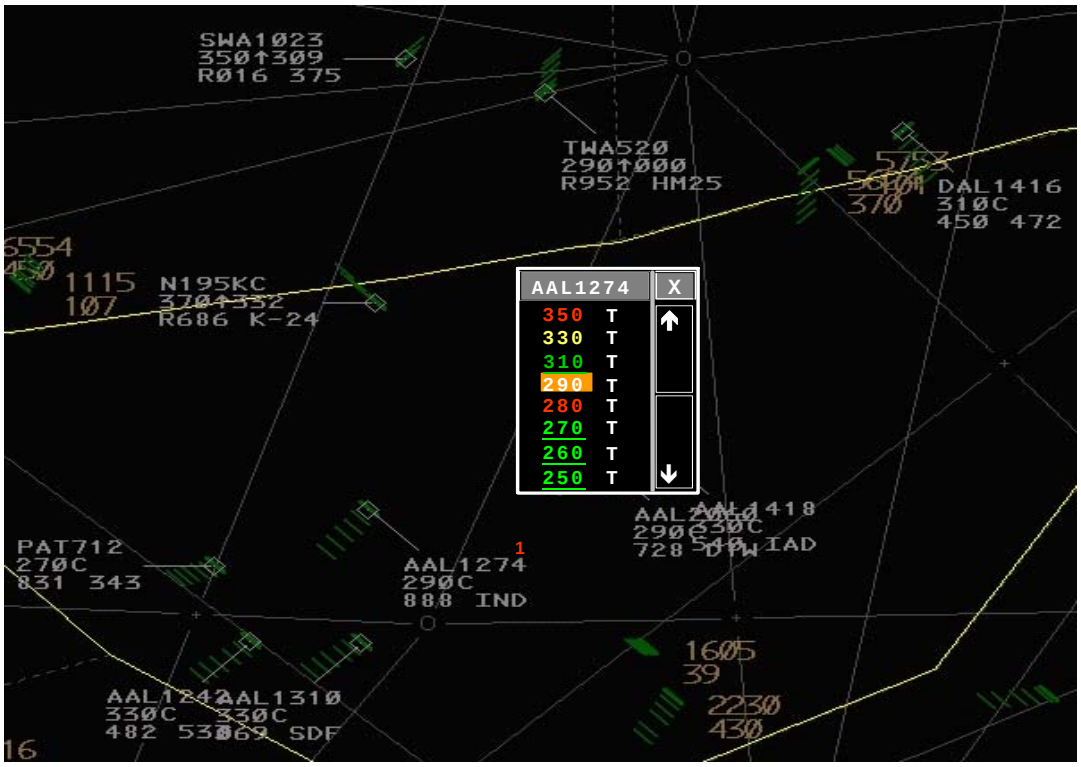

Figure 4-2. Notional Integrated Sector Operation Display

An Integrated Concept of Use will provide increased flexibility in the allocation of resources. The radar controller will have more problem-solving tools available and be able to make effective use of conflict data in single-staffing situations. Implementation would require field evaluations for determining the alert parameter settings, proper procedures and training program. Technology transfer and integration with the en route architecture as well as appropriate training would then be developed for eventual national deployment.

Section 5

Summary

URET has demonstrated its utility as a decision-support tool. It benefits users of the NAS by enabling controllers to issue more clearances that send flights direct to downstream fixes, reducing distance flown and saving money for users of the NAS. These benefits will continue and be extended when URET is deployed at the other ten ARTCCs within the continental United States. The anticipated dollar savings from the increase in number of lateral amendments due to URET when it is deployed nation-wide is currently estimated to be $230 million annually.

Site observations confirm reports that many controllers do not use the conflict probe and resolution capabilities of URET effectively. Reasons include:

- Emphasis on traditional tactical control operations
- Insufficient focus in training on strategic use of URET
- Timing and prioritization of alert notifications
- Difficulty in using URET when the sector is staffed with one person

Additional benefits, above the substantial user cost savings already seen by using URET, can be enabled with a few additional improvements that include:

- Increased standardization for more effective and consistent use of URET
- More effective training in the use of URET as a strategic tool that predicts problems early and provides the opportunity to formulate less drastic resolutions. Particular emphasis on remedial training at FFP1 sites.
- Modification to the timing of alerts, so that they better complement controller duties and responsibilities
- Better integration of URET into sector operations, to make it more accessible in sectors that are single-staffed.

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Glossary

ADOC	Airline Direct Operating Costs
APRs	ATC Preferred Routes
ARTCC	Air Route Traffic Control Centers
ATC	Air Traffic Control
ATO	Air Traffic Organization
CAASD	Center for Advanced Aviation System Development
CBI	Computer Based Instruction
CCLD	Core Capability Limited Deployment
DFW	Dallas Ft. Worth
DRVSM	Domestic Reduced Vertical Separation Minima
ETMS	Enhanced Traffic Management System
FAA	Federal Aviation Administration
FFP1	Free Flight Phase 1
FFP2	Free Flight Phase 2
FFPO	Free Flight Program Office
GPD	Graphic Plan Display
HCS	HOST Computer System
IADOF	Incorrect Altitude for Direction
IDU	Initial Daily Use
NAS	National Airspace System
NATCA	National Air Traffic Controllers Association
NCP	NAS Change Proposal
NMI	Nautical Miles
NRP	National Route Program
NRR	Non-Restrictive Routing
PAR	Preferential Arrival Route
RNAV	Area Navigation
SUA	Special Use Airspace

TMC Traffic Management Coordinator
TMU Traffic Management Unit

URET User Request Evaluation Tool

ZAU Chicago ARTCC
ZDC Washington ARTCC
ZDV Denver ARTCC
ZFW Ft. Worth ARTCC
ZID Indianapolis ARTCC
ZJX Jacksonville ARTCC
ZKC Kansas City ARTCC
ZME Memphis ARTCC
ZMN Minneapolis ARTCC
ZOB Cleveland ARTCC