

Summary of CAASD FY01 CRCT Technology Transfer Activities

September 2001

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McLean, Virginia

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Abstract

For Fiscal Year 2001, the Federal Aviation Administration asked The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) to facilitate incorporating the Collaborative Routing Coordination Tools (CRCT) functions into the Traffic Flow Management Infrastructure. The challenge of this technology transfer task was in integrating these functions into the Enhanced Traffic Management System, an existing infrastructure.

This document summarizes this year's accomplishments, dividing them into five different types of activities (see Table 1). It also describes technology transfer plans for FY02.

Table 1. FY01 Technology Transfer Activities

Activity Types	Activity Definitions
Plans	Described what will, should, or can be done such as evaluation plans or concepts of use
Evaluations	Conducted evaluations in the field and in the CAASD laboratory
Intellectual Property (IP) Transfers	Provided algorithms, software, and a complete CRCT system to Volpe National Transportation Systems Center (VNTSC)
Meetings	Participated in VNTSC Technical Interchange Meetings (TIMs) and Program Management Reviews, and hosted TIMs
Reports	Described results, something completed, such as an evaluation, an analysis, a description of capabilities, a comment on a reviewed VNTSC product

KEYWORDS: Technology Transfer, CRCT, ETMS, TFM, TFM-I, VNTSC, Volpe

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Section 1

Introduction

1.1 Background

In Fiscal Year 2001 (FY01), the Federal Aviation Administration (FAA) asked The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) to facilitate incorporating the Collaborative Routing Coordination Tools (CRCT) functions into the Traffic Flow Management (TFM) Infrastructure (TFM-I). This technology transfer task was carried out differently from the more traditional method of moving an existing research system from the concept development research stage to the prototype development production stage. Instead of providing a contractor with a completed system ready to be hardened and supported, CAASD was asked to transfer CRCT functions deemed operationally mature by the FAA to the TFM-I contractor, Volpe National Transportation Systems Center (VNTSC), for incorporation into the Enhanced Traffic Management System (ETMS). Therefore, the challenge is integrating these functions into an existing infrastructure.

To enable the implementation of CRCT capabilities into the TFM-I, a set of mature functions needed to be identified and described in detail for VNTSC. There are four types of maturity that the FAA must consider in implementation planning:

- operational maturity and suitability, based on the field perception of the function and the function's use for evaluation during the test period
- technical maturity, based on how clearly the Human Computer Interface (HCI) and algorithmic requirements are defined
- procedural maturity, based on the extent to which the function's operational use is defined
- developmental maturity, based on the extent to which the means for building it into the operational system are defined

CAASD's evaluation and assessment focused primarily on operational maturity (for example, see section 2.2.1 Field Evaluations), also considering technical maturity (for example, see section 2.5.2 Predictability Analysis). CAASD assisted also in partial assessment of procedural maturity of the Flow Constrained Area (FCA) functionality (see section 2.2.2 Integrated Evaluation); but developmental maturity was outside the scope of CAASD's assessment.

CRCT functions were implemented first in the CRCT Concept Demonstration and Evaluation Platform (CDEP) for evaluation in three field sites: the Air Traffic Control

System Command Center [ATCSCC], Kansas City Air Route Traffic Control Center [ZKC ARTCC], and Indianapolis ARTCC [ZID]. This year's evaluations resulted in two lists of functions: one of mature functions ready for transfer, and another of functions requiring further research (see Section 2.5.8 Evaluation Results).

1.2 Scope

This document summarizes this year's technology transfer accomplishments, dividing 18 activities into five groupings.

- *Plans*: CAASD wrote plans describing what will, should, or can be done. In FY01 CAASD wrote an evaluation plan, maturity assessment guidelines, and a reroute concept of use.
- *Evaluations*: CAASD conducted evaluations of CRCT functions and operational procedures in the field and in the laboratory.
- *Intellectual Property (IP) transfer*: CAASD directly transferred CAASD IP, such as algorithms, software, and a complete CRCT CDEP, to VNTSC.
- *Meetings*: CAASD participated in VNTSC Technical Interchange Meetings (TIMs) and Program Management Reviews (PMRs), and hosted TIMs.
- *Reports*: CAASD wrote reports describing completed activities, for example, evaluation results, analyses, a description of CRCT capabilities, or comments on other products. These reports included both deliverables and supplemental products.

1.3 Document Organization

Section 2 describes each of the 18 technology transfer activities completed in FY01. Each activity is grouped by activity type and includes the following information:

- Name and date of the activity
- Description of what it was, or what was done
- Description of why it was done, the value of this particular activity or product

Section 3 discusses next steps in the technology transfer plans for FY02.

Section 2

Summary of FY01 Activities

A short description of each technology transfer activity follows, organized by activity type: plans, evaluations, IP transfers, meetings, and reports.

2.1 Plans

Plans describe what will, should, or can be done, such as evaluation plans, guidelines, and concepts of use.

2.1.1 Operational Evaluation Plan

In December 2000, CAASD delivered the following document to the FAA:
Hollenberg, Joseph M., G. J. Jacobs, Dr. A. J. Masalonis, E. M. Simons,
K. H. Thompson, *Collaborative Routing Coordination Tools (CRCT) FY01 Operational Evaluation Plan*, MP 00W0000302.

This document describes the plan for conducting the FY01 operational evaluations using the CRCT CDEP at ZKC, ZID, and the ATCSCC (see section 2.2.1 Field Evaluations). Goals and objectives are included, as are the planned schedule and site configurations, roles and responsibilities, functions to be evaluated, and pre-evaluation and evaluation activities (for example, training and questionnaires).

The evaluations were designed to determine which of the CRCT functions designed to assist flow managers in managing National Airspace System (NAS) congestion were operationally mature enough to be incorporated into the TFM-I. These evaluations provide a basis for validating the requirements guiding the incorporation of CRCT reroute what-if capabilities into the TFM-I.

2.1.2 Maturity Assessment Guidelines

In August 2001, CAASD delivered the following document to the FAA:
Sud, Ved, *Research and Development Maturity Assessment Guide with Examples from Traffic Flow Management*, MP 01W0000154.

This paper discusses two models for managing research and development activities. It discusses the relationship of the models to one another, and provides guidance for the transition decisions necessary when moving from phase to phase or level to level within the research and development process. The first model is the four-phase Concept Exploration/Concept Development/Prototype Development/Full System Development model traditionally used in the TFM domain. The second model is the newer Readiness Levels model being considered by the FAA's Free Flight Program Office, based on the Technical Readiness

Levels used by the National Aeronautics and Space Administration for managing research activities.

These guidelines were written at the request of the FAA to guide the TFM Integrated Product Team in decision-making involving the maturity of TFM research capabilities, especially those related to CRCT. The maturity decision is important to explicitly enable the transition of capabilities from the research phase to the fielding phase in an incremental manner as envisioned in evolutionary systems development. The FAA's goal was to initiate a process for transferring operationally mature TFM research capabilities to the TFM-I, currently embodied in ETMS.

2.1.3 Reroute Concept of Use

In August 2001, CAASD delivered the following document to the FAA:
Hermes, Michael A., P. A. Nussman, and N. J. Taber, *A Strawman Concept of Use for Reroute Capabilities in the Traffic Flow Management Infrastructure*, WN 01W0000134.

This document identifies entities (such as airplanes, controllers, and airline personnel) affected by aircraft rerouting and the possible actions that each may take when rerouting may be needed, describing the necessary collaboration among them. Some of the actions involve steps that are supported by the automation capabilities already explored with the CRCT CDEP and that are being implemented currently in ETMS, though the concept is not limited to those capabilities.

This document is a strawman concept intended to provide a starting point for in-depth discussion among FAA traffic managers and the NAS user community on what collaboration is necessary for efficiently rerouting aircraft. This work's objective is to provide an operational context for implementing CRCT capabilities. The long-term goal is to develop procedures to use those capabilities collaboratively. It is expected that concepts described in the document will provide an initial starting point for more extensive discussion and development of a detailed concept of operations and procedures for rerouting. This future work needs to explore the extensive interactions necessary within a facility for accomplishing the steps described and to identify additional information transfer or automation necessary to accomplish collaborative rerouting effectively.

2.2 Evaluations

Evaluations of CRCT functions and operational procedures were conducted in the field and in the CAASD laboratory.

2.2.1 Field Evaluations

Evaluations were conducted at the three field sites (ATCSCC, ZKC, and ZID) during May and June 2001, and interviews with the June evaluation participants were conducted in July.

In May, on-site training was conducted at each site in a laboratory area near the user's normal work location. The structured training was conducted with a CRCT CDEP system running recorded data. Thirty-four participants received one-on-one, hands-on training provided by CAASD personnel. Each participant received a three-part training package: a Training Workbook (see Section 2.5.7), the CRCT Reference Manual (see Section 2.5.4), and a small Quick Reference Guide (see Section 2.5.3). The training was immediately followed by laboratory evaluations also using recorded data.

During the entire month of June, real-time evaluations were conducted at all three sites using live data in each participant's regular work location. Twenty-four personnel who had participated in the May training and laboratory evaluation were assigned on specific days to staff an additional Traffic Management Unit or Severe Weather position to analyze live traffic situations using the CRCT CDEP functions learned in May.

During the second week of July, interviews were conducted individually with each real-time evaluation participant regarding their perception of CRCT functions, including the importance and usefulness of each set of functions, and how each function could be improved if implemented in ETMS. The interview ratings and comments were analyzed along with information from observed usage as captured by a metrics collection capability (see Section 2.5.6 Enhancements Summary), and user log entries made during the real-time evaluation period.

These evaluations were designed to identify the maturity of the CRCT functionality for implementation in ETMS. Investigation concentrated on determining the operational suitability of the rerouting what-if capability, as well as other functions for assessing projected demand on an airspace sector or center, volume of airspace, or other NAS element. In addition to determining the operational suitability of the functions, recommended refinements were identified by CAASD for the CRCT Core Team (See Section 2.4.3 CRCT Core Team Meeting/TIM). The CRCT CDEP was available during this period to analyze actual situations as they developed, although it was not used as the sole source for decision making during the real-time evaluation period. Therefore, these conclusions can be considered fairly reflective of what would occur if the capabilities were implemented in the ETMS system (see Section 2.5.8 Evaluation Results).

2.2.2 Integrated Evaluation

In August 2001 Integrated Evaluation exercises were conducted in the CAASD laboratories. FAA representatives from ZKC, ZID, and the ATCSCC attended, as did

representatives from three airlines and the Air Transport Association (ATA). The evaluation minutes [Simons, 2001] were delivered to the FAA in September 2001.

The Integrated Evaluation was requested by the CRCT Core Team for two reasons. The primary reason was to evaluate the draft Notice *Flow Evaluation Area (FEA) and Flow Constrained Area (FCA) Procedures* issued by the FAA's Air Traffic Tactical Operations organization (ATT-1). The secondary reason, also important, was to demonstrate how the collaboration would be effected between the ARTCCs, the ATCSCC, and the airlines. The exercises were held at CAASD because at the time, the CRCT CDEP was the only system that had all the functionality needed to test the procedures. FCAs were created and applied, and results were shared using the new CRCT CDEP web-sharing capability.

The exercises were actually conducted in two parts, following a meeting held earlier in the month with a representative of the ATA and the CRCT Core Team leads to determine scenarios that could be used to validate the draft FEA/FCA procedures. The first part was a dry run, held with FAA representatives for one day. The second part was the full five-scenario exercise, run with all participants over two days in the following week. After reviewing the draft FEA/FCA procedures, several major procedural points were discussed and revisions to the procedures were proposed.

The evaluation exercises successfully documented numerous issues and enabled the planning of the next step, which will be a live field test. These exercises were critical to the technology transfer process and were the beginning of the end of that process for the first of the CRCT functions to be implemented in ETMS, the FCA function.

2.3 IP Transfer

CAASD Intellectual Property such as algorithms and software were transferred to VNTSC.

2.3.1 Discussions

Over the course of FY01 CAASD participated in a number of discussions with the FAA and VNTSC regarding the transfer of software, algorithms, and other aspects of CRCT functionality from the CDEP to ETMS. Additionally, roles and responsibilities related to IP transfer were also discussed. In addition to the formal meetings described here, numerous telephone conversations took place.

One of these discussions, a teleconference in November 2000 at the request of the FAA, was held to discuss the possibility of transferring the CAASD Altitude and Speed Restriction Database, which is based on ARTCC Letters of Agreement (LOAs) and Standard Operating Procedures (SOPs). Although there are some advantages to including restrictions (see Section 2.5.2 Predictability Analysis), after discussing CAASD's experience with using and maintaining the database, VNTSC decided not to implement it at this time.

A meeting was held in August 2001 to discuss current and future plans for technology transfer cooperation, exchange of information and products, and roles and responsibilities for technology transfer in FY02. VNTSC saw the value of receiving other pieces of the CRCT CDEP and arrangements were made to expedite this transfer (see 2.3.2 CRCT CDEP). Another meeting is planned for September 2001 to discuss specifics of incorporating the NAS Monitor, Sector Count Monitor, and Time-in-Sector graph software in ETMS.

2.3.2 CRCT CDEP

In October 2000, CAASD provided CRCT CDEP algorithms and code to VNTSC. (In February 2001, a letter documenting this transfer was delivered to the FAA.) In August 2001, additional software and an entire system were delivered to VNTSC.

The algorithms and code delivered in October 2000 were the FCA intersection algorithms. This software receives an FCA definition from the user interface of the CRCT CDEP, including the geometric parameters of the FCA, start and end time, its speed and direction, and aircraft filters specified by the user. The FCA definition is then applied to the CRCT CDEP aircraft trajectory database to derive the list of aircraft that are predicted to penetrate the FCA during the specified time and according to the specified filters.

The software delivered in August was the specific code for displaying the NAS Monitor, the Sector Count Monitor, and the Time in Sector graph. These functions are used in the CRCT CDEP to depict sector loading throughout the continental United States. The flight counts displayed are calculated by the intersection algorithms provided earlier.

In addition to the software code mentioned above, an entire CRCT CDEP was loaned to VNTSC in August. This included the hardware (a Sun Ultra TM60 workstation) and all the CRCT CDEP software pre-installed to run off recorded data. CAASD set up and configured the system for use by VNTSC personnel and is providing general technical support via telephone and email.

Providing a system and specific code to the VNTSC enhances the technology transfer of CRCT functions. The system enables VNTSC personnel to practice using the functions, greatly increasing their understanding of how they work, thereby enhancing VNTSC understanding of CRCT functional requirements. By sharing specific code, functions can be incorporated more easily into ETMS because VNTSC can reduce the amount of new software needed.

2.4 Meetings

Technical Interchange Meetings were participated in and hosted.

2.4.1 ETMS TIM/PMR

In November 2000, and in January, March, July, and August 2001, CAASD participated in ETMS TIM/PMR meetings conducted at ATCSCC or VNTSC. CAASD plans to continue attending these regularly scheduled meetings during the entire technology transfer process.

Among other topics at these meetings, the status of the CRCT technology transfer was discussed. Specific topics included the CRCT capabilities assigned to each ETMS release, the schedules of those releases, and the status of release software development efforts.

Attendance at these TIM/PMRs increased CAASD's understanding of the issues involved in transferring CRCT functions to ETMS, and provided an opportunity for CAASD to answer questions regarding CRCT functions and capabilities. These meetings helped promote understanding among all participants about CRCT and ETMS.

2.4.2 CRCT TIM

In March 2001, CAASD hosted a CRCT Technology Transfer TIM. The TIM was attended by the FAA (including the ATCSCC, ZKC, and ZID field site personnel) and VNTSC.

The three main topics of discussion at the CRCT TIM were: (1) Status and scheduling of ETMS releases incorporating CRCT functions; (2) CRCT FCA functions and the Future Traffic Display (FTD); and (3) CRCT rerouting functions (including playbook and enhancements not yet evaluated). Demonstrations were given of the FCA, the FTD, and the new and already fielded rerouting what-if capabilities. Additionally, the preliminary results of the CRCT Predictability Analysis (see Section 2.5.2) as well as a briefing about usage metrics for benefits assessment were also presented. Although the primary focus of the TIM was designed to center on rerouting, most of the questions and discussions focused on FCAs and the FTD.

TIMs are valuable in helping VNTSC gain an understanding, from an operational and engineering perspective, of the functions as they currently exist within CRCT. For example, it is helpful for VNTSC to hear directly from the field regarding desirable functionality, applications, and potential improvements. This meeting was an important step in initiating a process for transferring mature CRCT capabilities to ETMS. Because VNTSC was in the process of developing the FCA capability in ETMS, the increased understanding of FCAs gained from this TIM was very beneficial to them.

2.4.3 CRCT Core Team Meeting/TIM

From July 30 through August 1, 2001, CAASD hosted a CRCT Core Team Meeting/Technology Transfer TIM attended by FAA, VNTSC and airline representatives.

The Core Team met at CAASD to complete action on two major items: (1) to determine which CRCT functions are operationally mature and ready for transfer to ETMS (based on the CRCT evaluations—see Section 2.2.1 Field Evaluations), and (2) to discuss the draft *Notice Flow Evaluation Area (FEA) and Flow Constrained Area (FCA) Procedures*.

A CAASD representative presented the results of the 2001 CRCT field evaluations describing those functions considered operationally mature and those functions requiring additional research (see Section 2.5.8 Evaluation Results), and also recommending functional refinements. The Core Team accepted the recommendations with minor modifications and additions (see [Houde, 2001]). The Core Team then scheduled another meeting in September 2001 at VNTSC to discuss VNTSC proposed implementation schedules for incorporating these CRCT capabilities into the next several versions of ETMS.

There was also much discussion about the proposed FAA Notice, particularly from the airline perspective. At this meeting, CAASD was asked to validate the Notice procedures (see Section 2.2.2 Integrated Evaluation). Further research of the FEA/FCA collaboration issues would be a secondary benefit of procedure validation.

The primary value of this TIM was in presenting the reroute what-if functions that the evaluations suggested were operationally mature, and beginning discussion on the difficulty and priority of implementing the functions in ETMS. In addition, this TIM was valuable in helping VNTSC further increase their understanding of the operational issues associated with FCAs, and in helping the FAA and airlines increase their understanding as well. At this meeting, it was clarified that a software capability is only as useful as the operational procedures implemented for its use.

2.5 Reports

Reports describe something that was completed, such as analysis or evaluation results, a description of capabilities, or comment on a reviewed VNTSC product.

2.5.1 Functional Description

In March 2001, CAASD delivered the following document to the FAA:
Rhodes, Laurel S., L. R. Rhodes, and E. K. Beaton, *CRCT Capabilities Detailed Functional Description*, MTR 00W0000302.

This report provides a baseline of TFM operational capabilities resident in the CRCT CDEP as of FY01. The capabilities are organized according to four major functional areas: Traffic Display, Flow Constrained Area, Rerouting, and Data Sharing. Also included is an overview of the CDEP Decision Support System (DSS) software functions and data inputs. The overview describes the functional design of the CDEP DSS and the relationship between CRCT user functionality and the DSS software.

The CRCT CDEP is a key aspect of the conceptualization and development of CRCT capabilities. This report was intended to provide design and engineering guidance to VNTSC as they implement CRCT capabilities into ETMS. It is also a useful reference for operational subject matter experts engaged in CRCT operational evaluation activities.

2.5.2 Predictability Analysis

In March 2001, CAASD delivered the following document to the FAA:
Masalonis, Anthony J., C. R. Wanke, D. P. Greenbaum, C. K. Jackson, E. K. Beaton, S. M. Mahmassani, D. Chaloux, E. A. Cherniavsky, and J. Forren, *Preliminary Analysis of CRCT Traffic Prediction Performance*, MP 01W0000062.

This report documents intermediate results of the CRCT CDEP predictability assessment. Specific CRCT CDEP modeling features were analyzed to identify those thought to improve traffic prediction, and to better understand the circumstances under which predictions are improved. Three features were analyzed in this study. First was the application of altitude and speed restrictions, incorporated into the CDEP by developing a database derived from ARTCC LOAs and SOPs. Second was the inclusion of Host Computer System data in the CDEP, including flight plans, radar track reports, and the current sector map of open and closed sectors. Third was the use of adaptive departure modeling, algorithms that estimate in real time the current departure delays at all NAS airports.

Understanding which modeling features improve prediction performance is important in making recommendations to VNTSC on whether or not to incorporate those features into ETMS flight modeling. Restrictions are used in the CDEP's modeling under the rationale that if they are not modeled, flights may be predicted to enter sectors that they would not normally enter. Radar track reports and the current sector map affect how predictions are made and presented. The estimated departure delay is used to predict delays for flights that have not yet departed, in order to improve overall prediction of departure times. Additional research is needed to confirm and extend these results before drawing conclusions about incorporating them into ETMS flight modeling functions; however, preliminary results suggest improvements could be made. The analysts found that the modeling of speed and altitude restrictions improves predictions in certain sectors; that adaptive modeling of departures times, using real-time delay data, improves predictions at look-ahead times of up to 45-60 minutes; and that the currently-active sector map improves the usefulness of the data presentation.

2.5.3 Quick Reference Guide

In April 2001, CAASD delivered the following document to the FAA as part of the training package (see Section 2.2.1 Field Evaluations):

Kapoor, Pauline K., L. R. Rhodes, A. J. Masalonis, D.L Berry, *Collaborative Routing Coordination Tools (CRCT) Quick Reference Guide, Rev. 3*, MP 01W0000174.

This Quick Reference Guide contains reminders about how to activate the basic CRCT functions including FCAs, reroute what-ifs, and volume analysis tools. This revision also contains directions for using Playbook functions, and a guide to color coding and symbology used for routes on the Traffic Display.

The Reference Guide is part of the training package used for on-site structured training conducted during May, 2001 (see Sections 2.2.1 Field Evaluations and 2.5.7 Training Workbook). It served as a quick reminder for trainees as they learned the CRCT functions and used them during real-time evaluations in June 2001.

2.5.4 Reference Manual

In April 2001, CAASD delivered the following document to the FAA:
Kapoor, Pauline K., L.R. Rhodes, L.S. Rhodes, *Collaborative Routing Coordination Tools (CRCT) Reference Manual*, MP 01W0000066.

This manual describes the features and operation of the CRCT CDEP HCI. The document is organized into four key areas: CRCT Basics, Demand Analysis Tools, Aircraft Rerouting Tools, and Reroute Evaluation Tools. It is designed to assist users in employing the CDEP for investigating aircraft demand on any airspace volume or NAS resource such as an airport, and for assessing the impact of traffic management reroutes before they are placed into effect.

The manual serves as a supplemental reference for CDEP users, including FAA traffic flow management personnel, airspace planners, and analysts who are using the CDEP for operational analysis. Because the manual describes how to use the CDEP to evaluate the impact of reroutes, including pre-defined reroutes such as the National Playbook reroutes, airspace and traffic flow analysts are better able to assess the impact of these reroutes on the NAS. This reference is a guide, assisting specialists and analysts in making full use of the various CRCT features available for their assessments. The reference is useful to VNTSC because an understanding of the functions and details of how CRCT works is important for their own implementation of the CRCT functions.

2.5.5 Requirements Review

In June 2001, CAASD provided review comments to VNTSC regarding the following document:

ETMS System Requirements, Flow Constrained Area Functions, Version 1.4, dated May 17, 2001.

CAASD reviewed the above document at the request of VNTSC and sent compiled comments directly to them. The new or modified requirements for version 1.4 described in this document reflected significant improvements to the operational capabilities of the ETMS, most notably the additions proposed for the FCA filters.

As VNTSC personnel have gained experience working with CAASD over FY01, they have increased requests for interaction and help with the technology transfer. FCAs were planned to be implemented in ETMS in two phases. The first phase was implemented in June 2001 in ETMS version 7.2. The second phase is planned to be implemented in ETMS version 7.3 in the fall of 2001. In this case, VNTSC completed writing the requirements for finalizing FCAs in this second phase, and requested this review of those requirements by CAASD. Reviews such as this one are valuable in supporting VNTSC's understanding and eventual implementation of the requirements.

2.5.6 Enhancements Summary

In August 2001, CAASD delivered the following document to the FAA:
Beaton, Emily K., S. M. Mahmassani, T. B. Stewart, *Summary of Major CRCT Enhancements and Results of System Testing*, MP 01W0000170.

During FY01, CAASD provided system maintenance and upgrades needed to sustain CRCT daily use operations at ATCSCC, ZKC, and ZID. This document describes how CAASD determined which enhancements and upgrades were needed, which upgrades were completed this year, and how CAASD tested those upgrades for operational suitability. In addition to several infrastructure enhancements implemented to assure continued compatibility of the CDEP with other operational systems (for example, the Weather and Radar Processor), in FY01 CAASD added three specific sets of enhancements. A new testing process was also implemented.

Maintaining and enhancing the CRCT CDEP was necessary to support operational evaluations of CRCT functions in preparation for the transfer of those functions to the TFM-I. The enhancements were designed to improve the operational capabilities of the CDEP, thereby improving the value of our research evaluations. The first major enhancement was a metrics collection capability to enhance our ability to evaluate usage. Second was a reroute-FCA/Playbook capability to enhance our ability to evaluate reroute requirements and maturity. The third enhancement was a web-sharing capability to enhance our ability to evaluate collaborative decision-making requirements. The test process was developed to increase the reliability of the evaluation platform, enabling CRCT CDEP developers to balance rapid innovation with robustness.

The enhancement process is the first step in transferring CRCT technology to the TFM-I. The enhanced CDEP is used in evaluations to determine functions ready for transfer and to validate the requirements for that transfer. Documents such as this one provide VNTSC the opportunity to plan ahead for possible future functions that may need to be incorporated into ETMS. VNTSC can then investigate any possible architectural, data and software design implications.

2.5.7 Training Workbook

In August 2001, CAASD delivered the following document to the FAA:
Collaborative Routing Coordination Tools (CRCT) Training Outline and Workbook, F045-B-041.

This Training Workbook contains the lessons used during the May 2001 training sessions prior to the evaluations that were conducted in May, June, and July (see Section 2.2.1 Field Evaluations). Lesson 1 presents an overview of CRCT and of the training and evaluation protocol. Lesson 2 discusses features, functions and the HCI, and provides several hands-on activities to practice using the features. Lesson 3 describes operational situations and demonstrates the techniques for applying CRCT functions to each operational situation.

The *CRCT Training Outline and Workbook* was used to train 34 Traffic Management Coordinators (TMCs) and specialists at the three field sites (ZID, ZKC, and ATCSCC). It served as a guide for the trainers and as a tutorial for the TMCs and specialists. The course prepared the trainees to participate in lab and floor evaluations using CRCT functions to analyze operational situations. The evaluations were used to determine the maturity of the CRCT functions and their readiness for implementation in ETMS. The *CRCT Training Outline and Workbook* was also provided to VNTSC; the exercises were considered especially useful to increase their understanding of how the TMCs would use FCAs operationally.

2.5.8 Evaluation Results

In September 2001, CAASD delivered the following document to the FAA:
Masalonis, Dr. Anthony J., K. A. Connolly, R. A. Hunt, S. M. Edmondson, G. J. Jacobs, D. L. Berry, E. M. Simons, P. K. Kapoor, P. S. Hawkins, *Operational Evaluation Report (ZKC, ZID, ATCSCC)*, MP 01W0000181.

The preliminary, abbreviated results were briefed to the CRCT Core Team [*FY01 CRCT Training and Evaluations*, F045-B-005] at the end of July (see Section 2.4.3) by Dr. Anthony J. Masalonis, K. A. Connolly, and the TFM Evaluation and Analysis Project Team.

This document describes the training and evaluations performed in FY01, and more importantly, the results of those evaluations. The final results are reported in terms of field usage as well as field perceptions of the CRCT functions, with emphasis on evaluating the reroute what-if capabilities. These results are a compilation of all the data collected during the evaluations. These data include the automatic usage metrics and the interviews for both the canned scenario evaluations held in May (after the training was conducted) and the live usage evaluations held in June and July.

The information compiled served as a catalyst for decisions regarding which functions prototyped on the CRCT CDEP are ready for implementation in ETMS. Functions identified

as ready for technology transfer immediately (from an operational perspective) were listed. VNTSC could then determine the software level of effort required for implementation. Functions requiring more research were also listed for prioritization by the FAA.

Section 3

Next Steps

Several initiatives are planned for FY02 that will continue to enhance the technology transfer of CRCT functions.

First, CAASD will play a larger role in the System Requirements Definition process. VNTSC has requested that we draft or help draft the initial set of System Requirements for the reroute capabilities. As part of this effort, CAASD will review paper mockups of the planned reroute capabilities. Also, CAASD will be given a prototype version of the planned ETMS releases to critique VNTSC's design and help validate operational requirements. A new ETMS line may need to be installed to support this.

Second, CAASD will be included in the development and review of the reroute software design requirements, representing a new level of CAASD involvement. In addition to participating in VNTSC's software design discussions, CAASD software design staff will have technical exchange meetings with VNTSC to share the CRCT CDEP design history and experiences. This should help VNTSC better focus their efforts and obtain lessons learned from prior concept-development activities.

Third, CAASD will continue to support the CRCT CDEP system in two ways. First, CAASD will continue to support the CDEP that was provided to VNTSC in FY01 to run with recorded data. As VNTSC becomes more familiar with the CRCT functions and how they can be applied, they should be better able to incorporate those features into the TFM-I. Second, CAASD will continue to enhance the CDEP to support future research. New CRCT dialogue boxes will be built to look more like the ETMS Traffic Situation Display dialogue boxes. This should also make it easier to transfer the features to the TFM-I.

Finally, CAASD will work with VNTSC and the ATA to get access to the ETMS development string, which includes airline data. This would give CAASD laboratories access to the full data feed being used by VNTSC. In addition to increasing our understanding of the TFM-I, this will give us a better method for testing and evaluating new CRCT CDEP features prior to evaluating them in the field.

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Glossary

ARTCC	Air Route Traffic Control Center
ATA	Air Transport Association
ATCSCC	Air Traffic Control System Command Center
ATT-1	Air Traffic Tactical Operations
CAASD	Center for Advanced Aviation System Development
CDEP	Concept Demonstration and Evaluation Platform
CRCT	Collaborative Routing Coordination Tools
DSS	Decision Support System
ETMS	Enhanced Traffic Management System
FAA	Federal Aviation Administration
FCA	Flow Constrained Area
FEA	Flow Evaluation Area
FTD	Future Traffic Display
FY	Fiscal Year
HCI	Human Computer Interface
IP	Intellectual Property
LOA	Letter of Agreement
NAS	National Airspace System
PMR	Program Management Review
SOP	Standard Operating Procedure
TFM	Traffic Flow Management
TFM-I	Traffic Flow Management Infrastructure
TIM	Technical Interchange Meeting
TMC	Traffic Management Coordinator
VNTSC	Volpe National Transportation Systems Center
ZID	Indianapolis ARTCC
ZKC	Kansas City ARTCC

