

ERAM

En Route Automation Modernization



NextGen

Overview

- Introduction to ERAM
- What is ERAM
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 - The FAA's comments on why ERAM is important
- Original Timeline for ERAM
- The Contractors
- ERAM Capabilities
- Problems with ERAM
- The FAA response to the ERAM problems
- ERAM Today

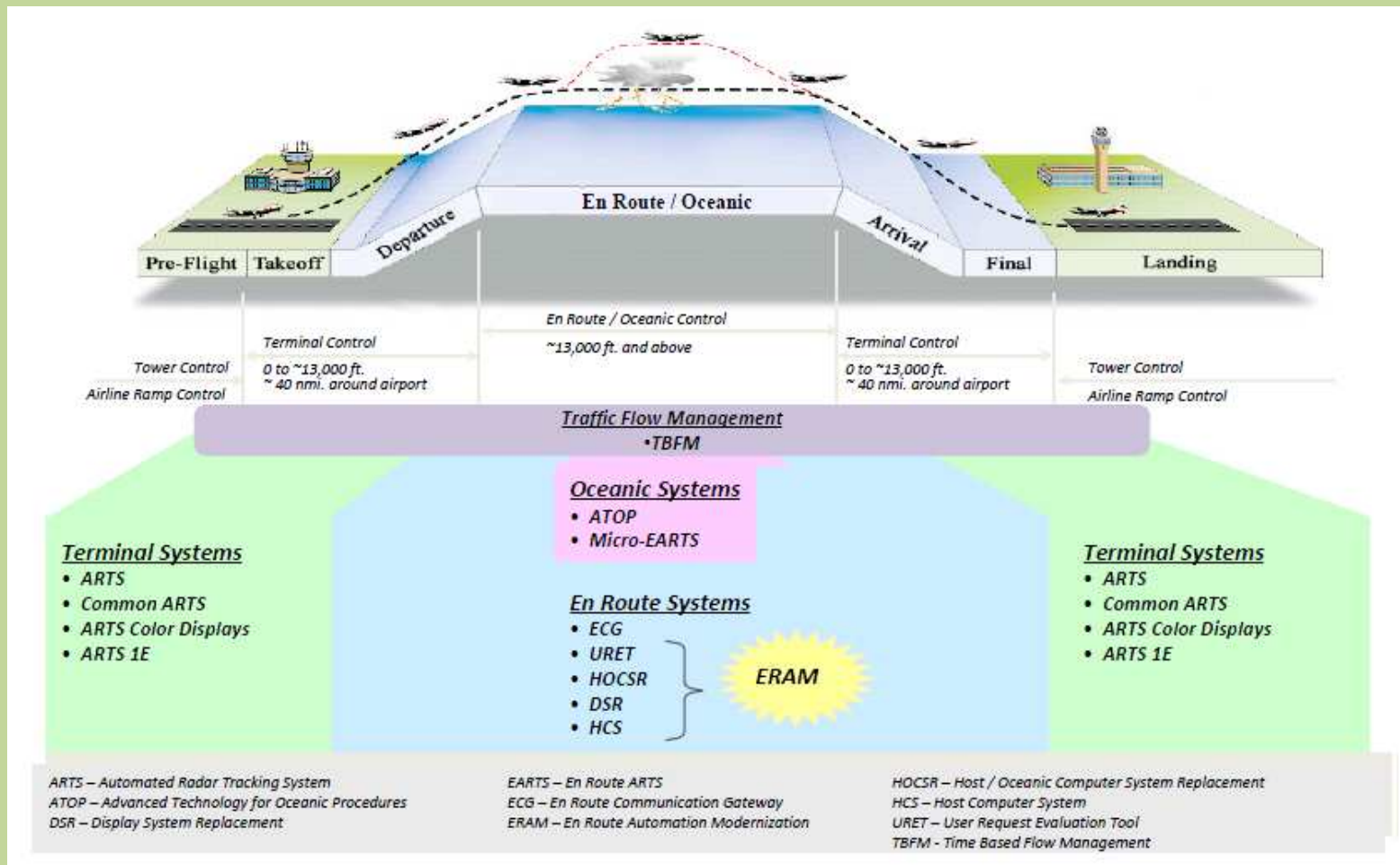
The Goals of NextGEN

- Increase **capacity and reliability**
- Improve **safety and security**
- Minimize the **environmental impact of aviation**

Needs of National Aerospace System per Sid McGuirk

- Improve **aircraft separations**
- Increase weather forecast accuracy
- Build more runways

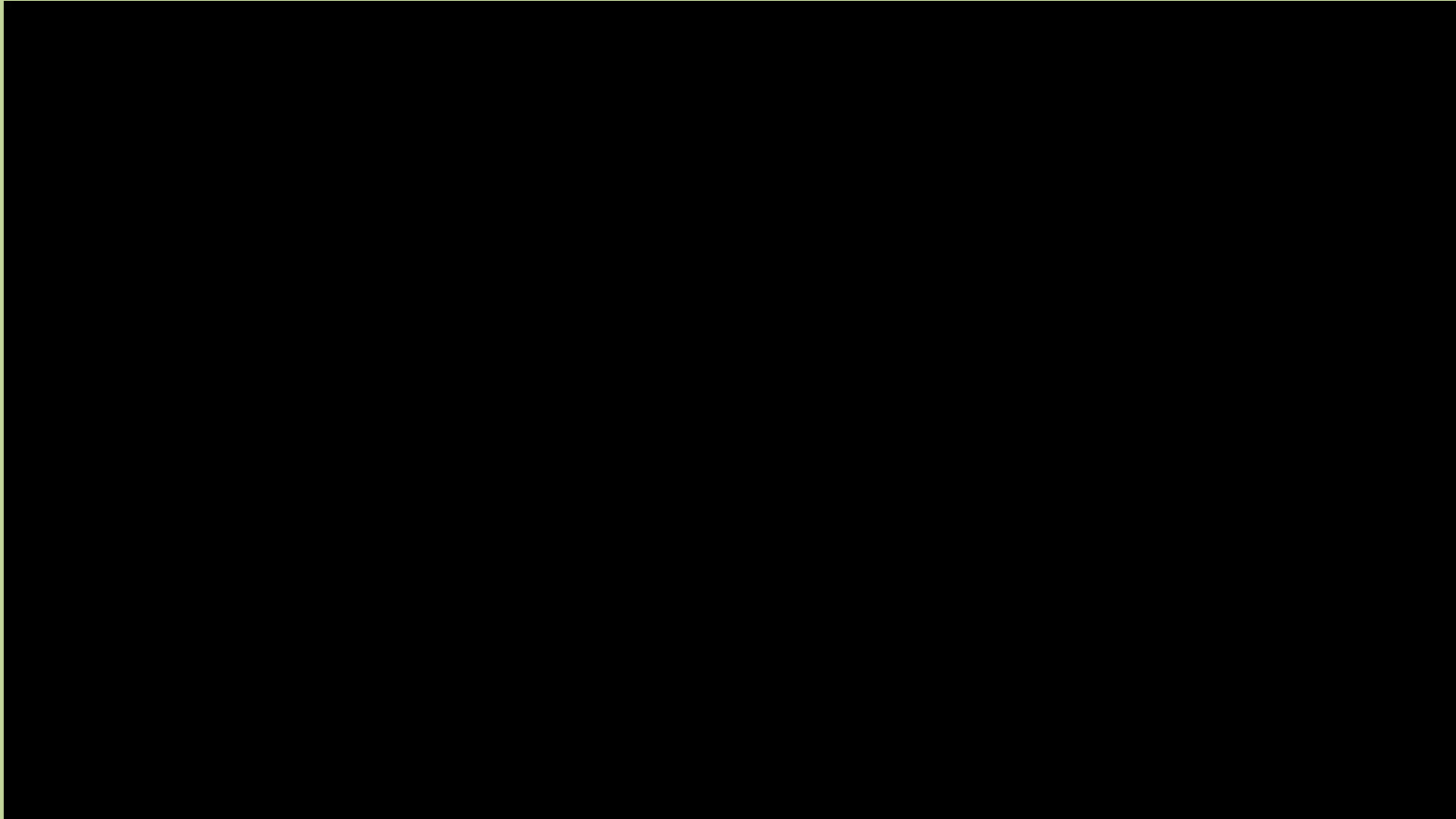
ERAM at a Glance



ERAM At A Glance

- ERAM is a \$2.1 billion system for processing flight data was launched in 2003 to replace FAA's 30-year old Host system.
- ERAM is to be used at 20 FAA Air Route Traffic Control Centers in the United States to control aircraft flying at altitudes above 10,000 feet.
- ERAM will also support other NextGen cornerstone programs
 - Automatic Dependent Surveillance Broadcast (ADS-B)
 - Data Communications.
- ERAM was originally scheduled to be completed in 2010, but software-related problems have pushed it back to 2014.
- The prime contractor responsible for ERAM is Lockheed Martin

A Look at ERAM and NextGen



What is ERAM & What is its Purpose

- “The Platform for NextGen Air Traffic Control Initiatives”
- ERAM is a foundational NextGen system key for achieving NextGen’s primary goals, such as increasing air capacity and reducing flight delays.
- ERAM is at the core of everything that happens with air traffic in this country. As the backbone of national airspace system, ERAM processes satellite data, radar data, communications, flight information and displays tracks for aircraft.
- ERAM replaces 20 Air Route Traffic Control Center (ARTCC) legacy Host computer processing systems
 - Host was developed in 1960s
 - Host was implemented in 1970s
- The Host is a tremendously complex system, therefore ERAM replacement project is one of the largest efforts undertaken by the FAA.

What is ERAM & What is its Purpose

- ERAM is a FAA program designed to allow faster processing of route requests and in flight route changes.
- ERAM is a hardware and software upgrade to the current air traffic control computer system.
 - Switch from 20 individual server systems to one centralized network.
- Salt Lake City and Seattle chosen as the first two ERAM test sites.
 - Planned 1st operational use: Salt Lake ARTCC in October 2008
 - Last to transition: Miami ARTCC in November 2009
- Designed to
 - Improve efficiency
 - Reduce emissions
 - Save Fuel
 - Decrease workloads
 - Improve cooperation
 - Decrease stress

Host vs. ERAM

- ERAM will process flight radar data, provide communications support and generate display data for air traffic controllers, allowing controllers to track 1,900 aircraft at a time, instead of the current 1,100, under the current Host system.
- ERAM shall be capable of processing both satellite & radar data, unlike Host.
- ERAM is designed to process data from 64 radars instead of the current 24.
- Lockheed Martin stated the last Host system will be required until 2014 although the systems will be decommissioned as each site reaches Operational Readiness Demonstration, starting in 2012.
- HOST:
 - Flight plan checked for route constraints only within the area of the local departure facility.
 - A controller is able to access information to respond to pilot requests by opening and closing multiple views.
 - Information on the flight is only available to controllers within the same facility, hampering efficient coordination.
- ERAM:
 - Flight plan checked for route constraints for the entire flight.
 - A controller is able to access information to respond to pilot requests by simultaneously reading multiple views arranged more efficiently.
 - Information on the flight is available to all controllers regardless of facility location, helping coordination.



Why is this important to the FAA?

- En Route Automation Modernization (ERAM)
 - Replaces EnRoute Host Computer System (HCS) and backup
- ERAM provides all of today's current functionality and:
 - Capabilities that enable National Airspace System evolution
 - Improved information security and streamlined traffic flow at our international borders
 - Additional flight radar data processing, communications support, and controller display data
 - A fully functional backup system, precluding the need to restrict operations as a result of a primary system failure
 - The backup system provides the National Transportation Safety Board (NTSB) recommended safety alerts, altitude warnings, and conflict alerts.
 - Improved surveillance processing performance using a greater number/variety of surveillance sources (e.g. ADS-B)
 - Stand-alone Testing and Training capability



Why is this important to the FAA?

- ERAM also:
 - Detects and alerts air traffic controllers when aircraft are flying too close together for both safety and long term planning.
 - Simultaneously supports many operating modes and complex airspace configurations, driven by thousands of users who want to use the airspace differently.
 - Allows more radars and flights than the old Host Computer System which ERAM replaces
 - Enables the use of future capabilities to efficiently handle traffic growth due to the system's open architecture
 - *Ensures a more stable and supportable system.*

Contractors

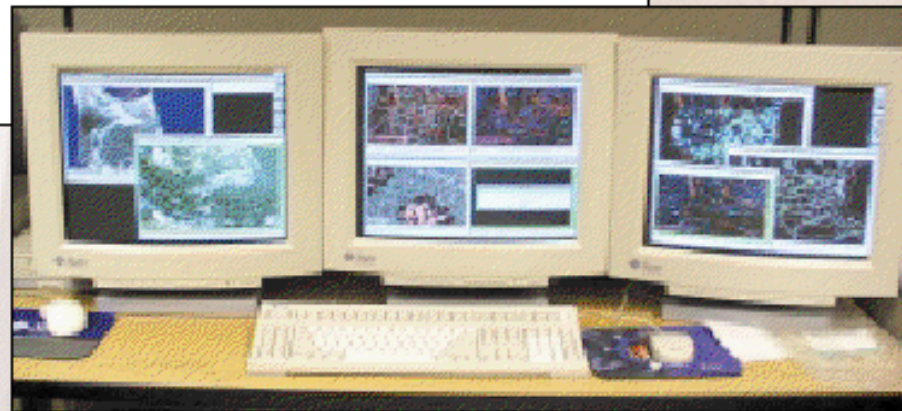
- Lockheed Martin – Primary Contractor
- Boeing
 - Development of advanced airspace modeling tools
- Northrop Grumman
 - Adaptation of Air Traffic Control systems
- Harris Corp
 - Development of systems for communications and weather
 - Weather and Radar Processor (WARP)
- Computer Sciences Corp
 - Development of subsystem applications for
 - Flight Data Processing
 - Data Reduction and Analysis
 - Information Security
- Raytheon
 - Development of flight and surveillance data processing systems
 - Raytheon originally protested award of the primary contract to Lockheed. As a result, a deal was negotiated in which Raytheon would subcontract from Lockheed Martin on the ERAM project, and Lockheed Martin would subcontract on a Raytheon project.

What is WARP

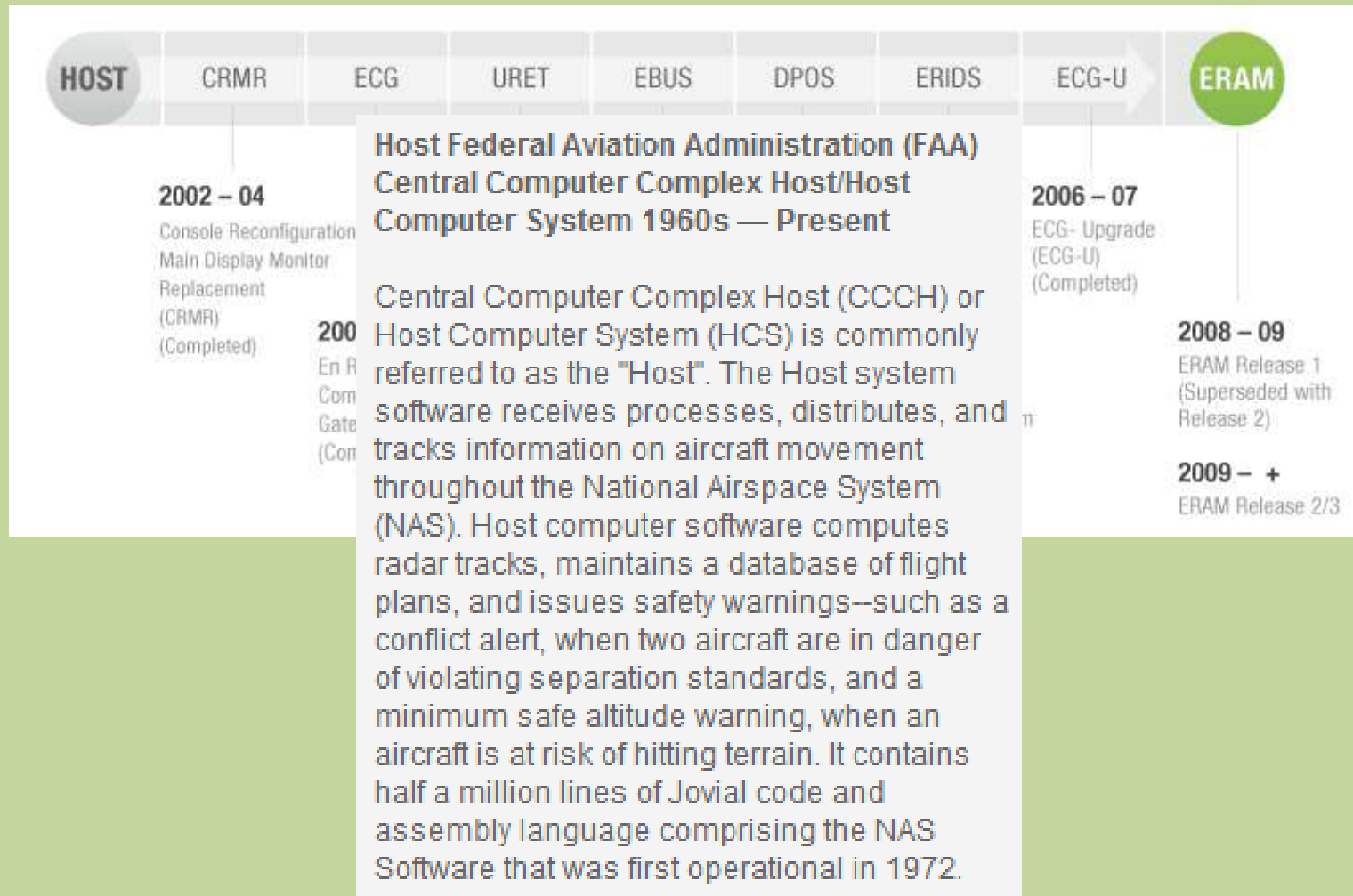
WARP Locations and Associated NEXRADs



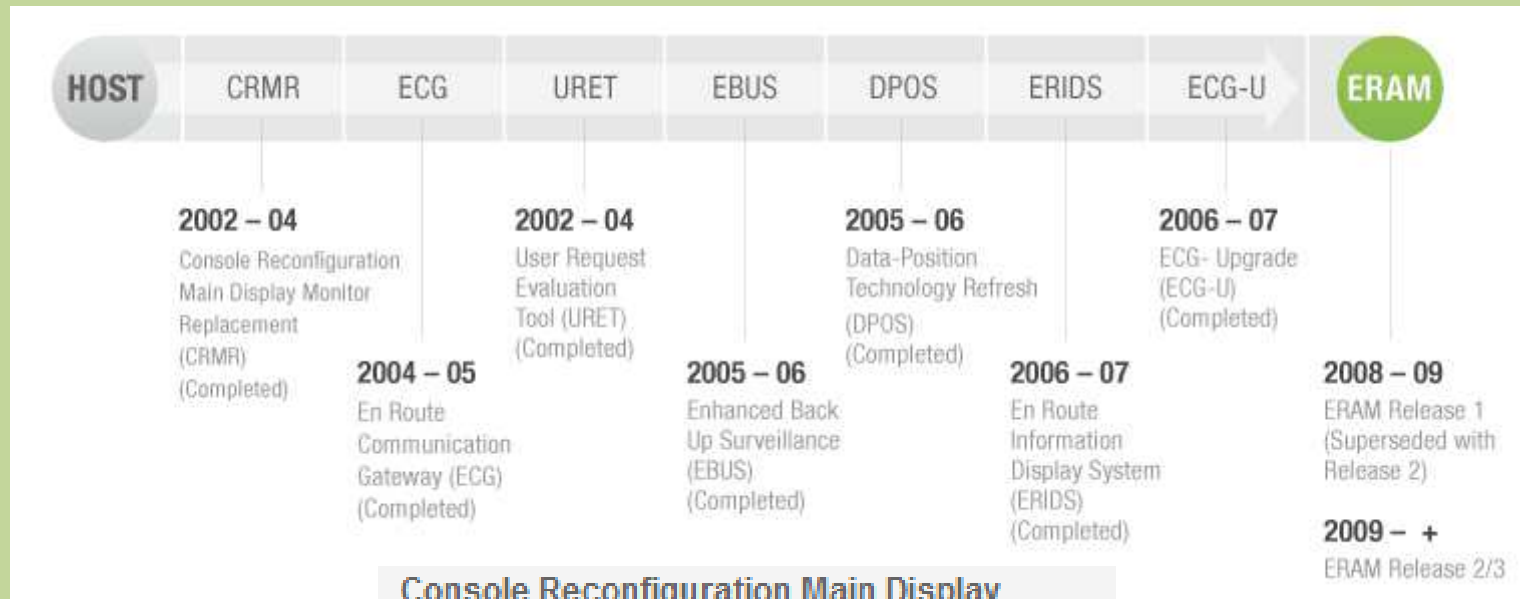
The Weather and Radar Processor (WARP) system is an enroute weather system that provides Mosaiced Next Generation Weather Radar (NexRAD) information to air traffic controllers



ERAM Timeline



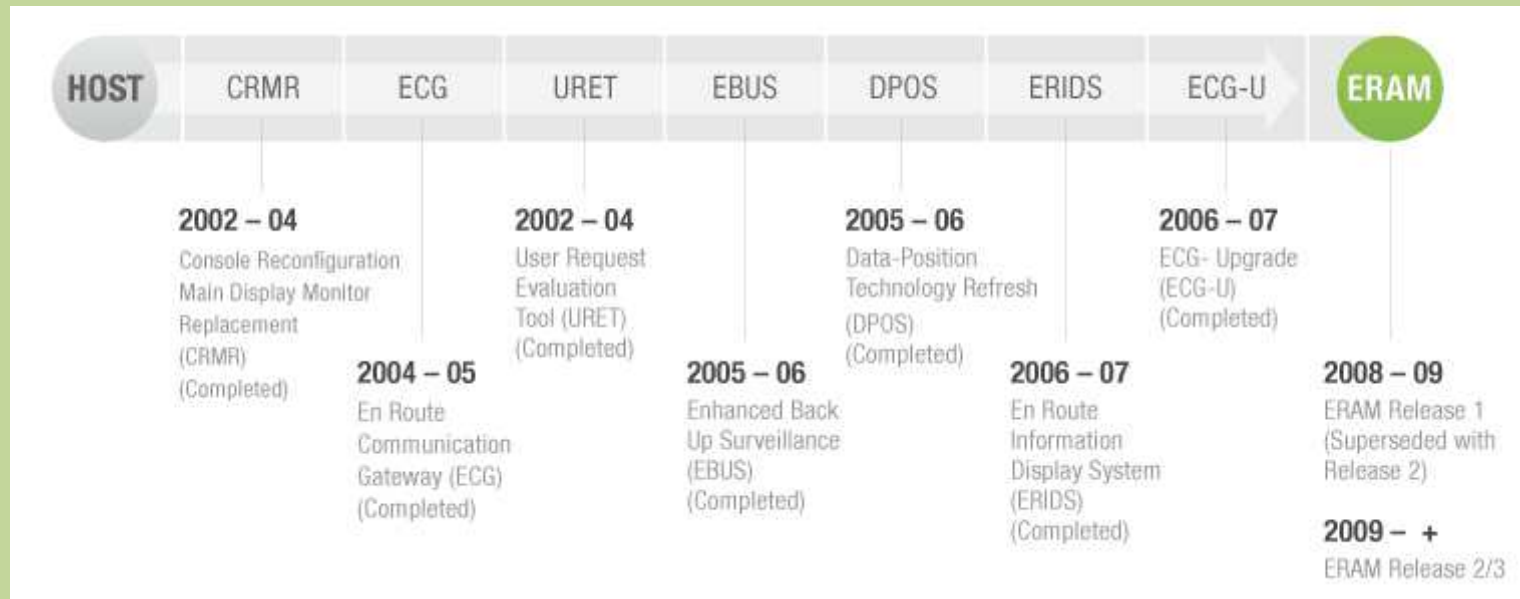
ERAM Timeline



Console Reconfiguration Main Display Monitor [MDM] Replacement (CRMR) 2002-2004

The FAA mechanically reconfigured both the radar (R) and data (D) positions to house the replacement of the old MDMs with a new flat screen monitor. New articulating arms were bolted to each position, for each monitor to strengthen and hold the flat screen monitor in place.

ERAM Timeline

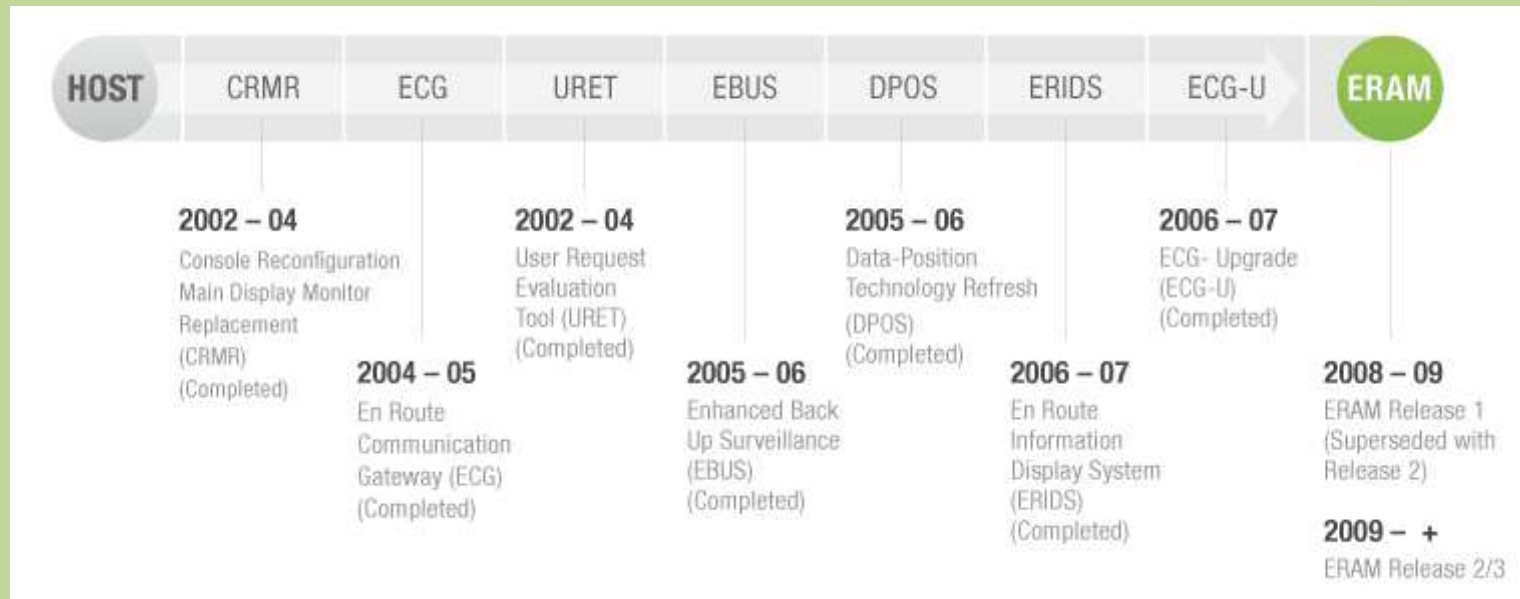


En Route Communication Gateway (ECG) 2004-2005

The En Route Communications Gateway (ECG) is the portal via which surveillance and flight data, critical to providing air traffic services, enters/exits the FAA Air Route Traffic Control Centers.

The En Route Communications Gateway (ECG) is a mission-critical interface for surveillance and flight data. It provides the portal for the transfer of aircraft flight plan and surveillance data to other En Route systems – both legacy systems and critical Next Generation Air Transportation System (NextGen) technology, such as the En Route Automation Modernization (ERAM) program and Automatic Dependent Surveillance - Broadcast (ADS-B), while providing added network communications. The ECG system is modular in design, and system capacity can be incrementally increased as air transportation demands change.

ERAM Timeline

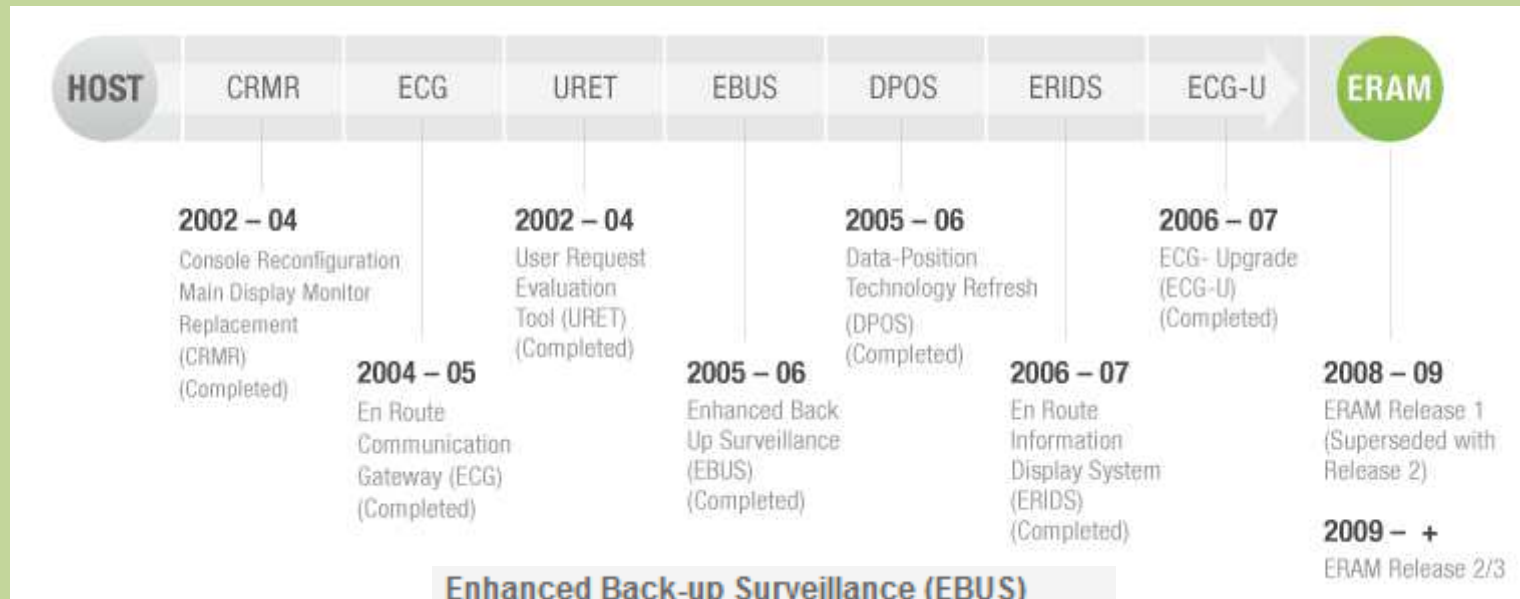


User Request Evaluation Tool (URET) 2002-2004

This tool is a radar assistant-side data side enhancement tool for conflict prediction and flight data management intended for strategic flight plan management.

MITRE's Center for Advanced Aviation System Development (CAASD) developed the User Request Evaluation Tool or URET to help air traffic controllers to detect and resolve potential conflicts between aircraft and between aircraft and airspace. The goal of URET is to help air traffic controllers to support a greater number of user-preferred flight profiles, increase user flexibility, and increase system capacity.

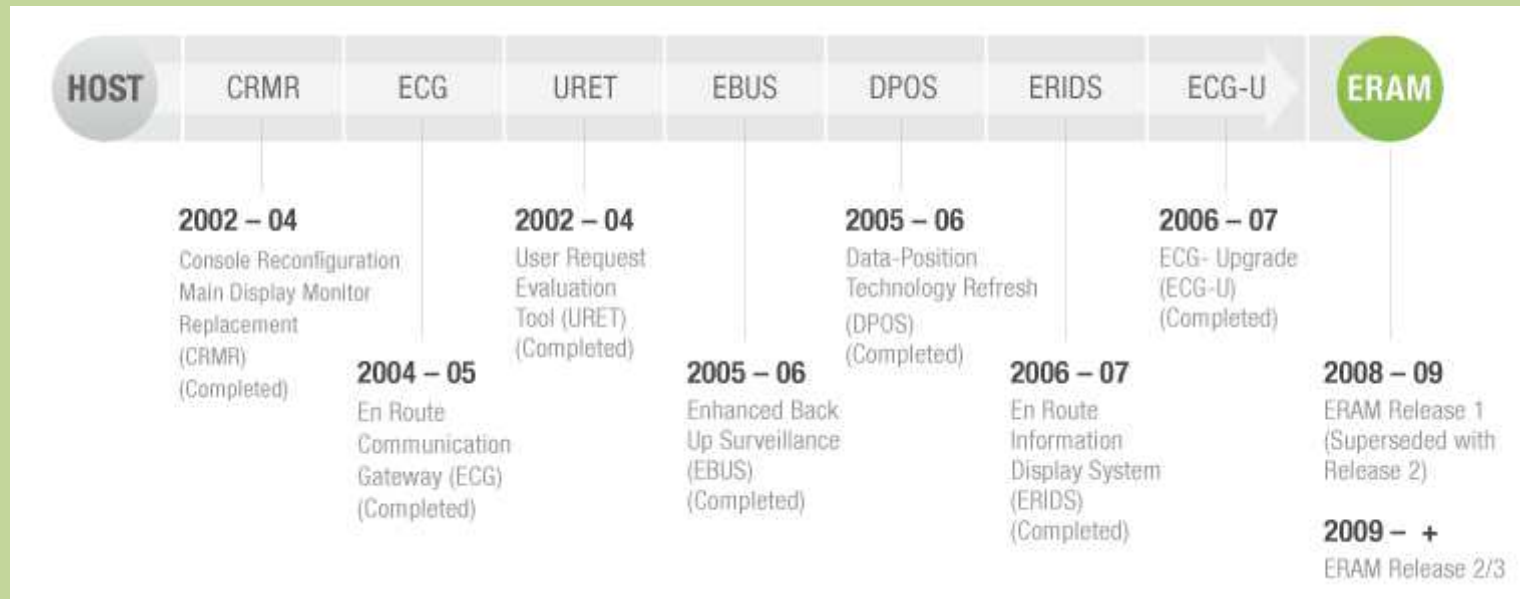
ERAM Timeline



Enhanced Back-up Surveillance (EBUS) 2005-2006

The EBUS program replaced the Direct-Access Radar Channel (DARC) hardware and software system that provides back-up radar data processing services in the United States en route environment. EBUS is used in the event of a primary system failure in HOST or when the primary system is taken down for maintenance.

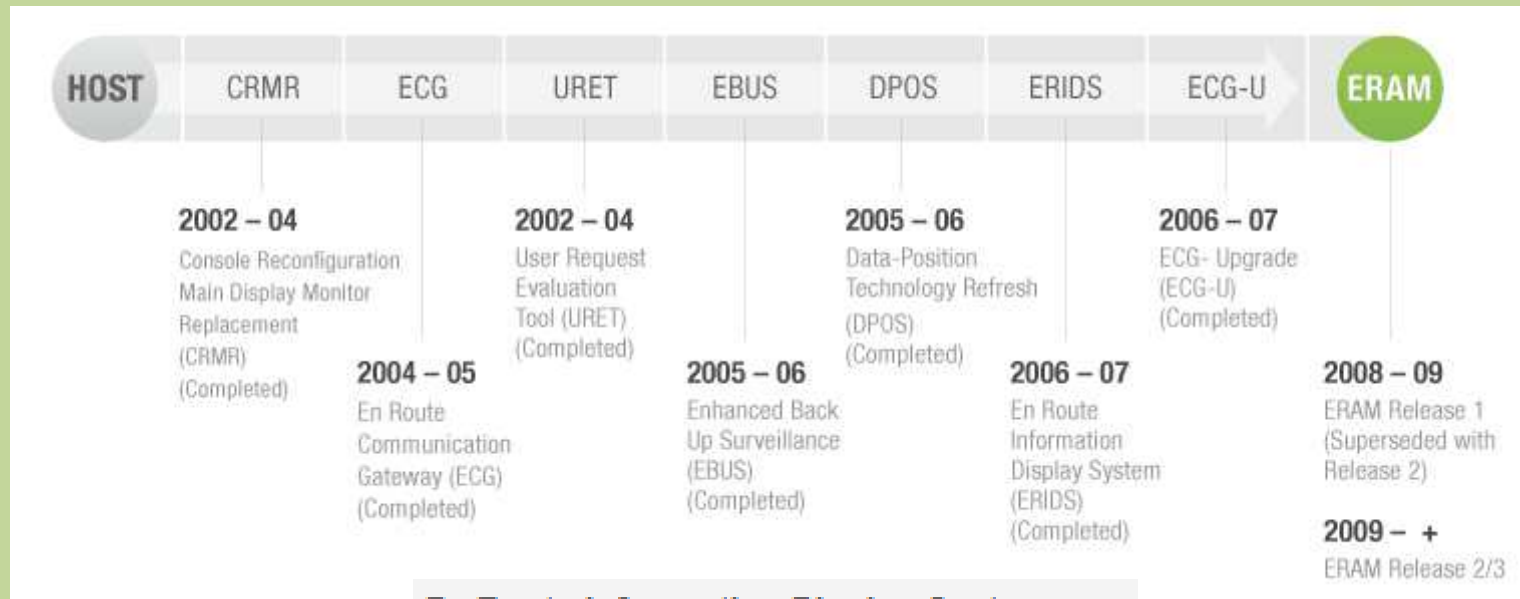
ERAM Timeline



Data Position Replacement (DPOS) 2003-2006

The FAA replaced the computer processing unit on the Data Position side of the controller position at a sector. This was the 1st step in making way for ERAM dual redundancy in processing capability.

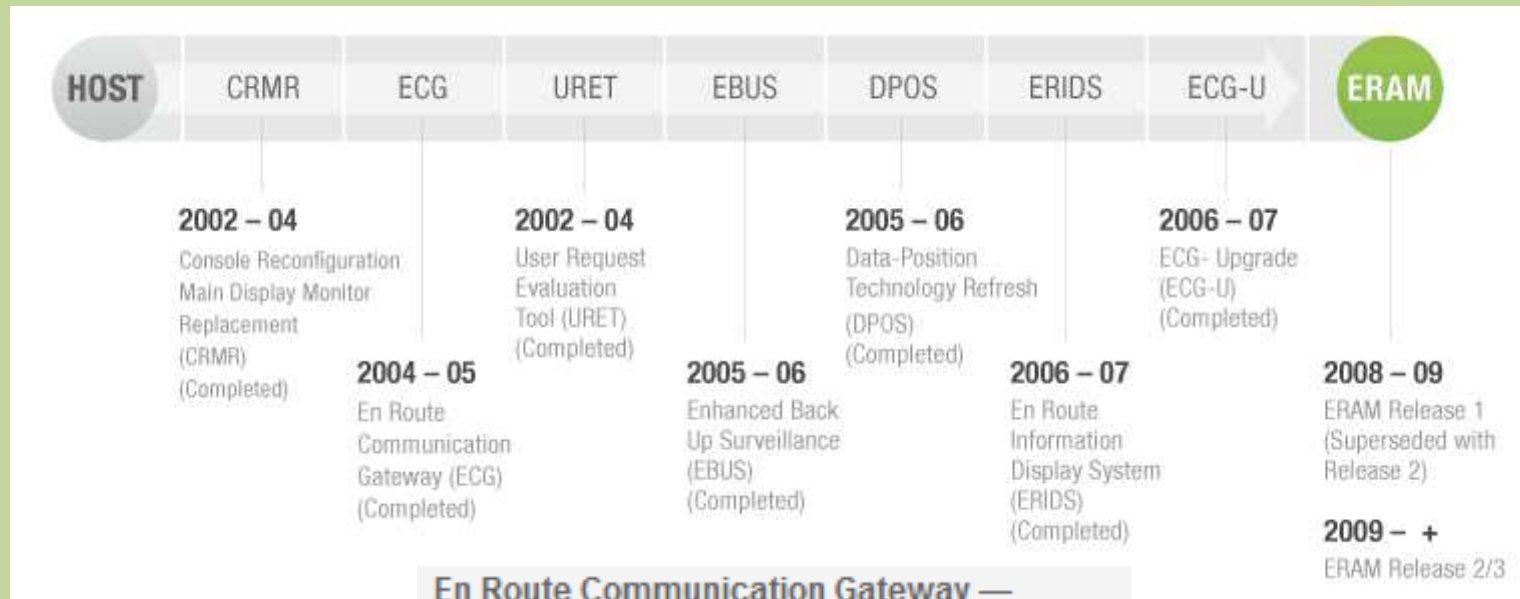
ERAM Timeline



En Route Information Display System (ERIDS) 2005-2007

Provides a browser-based automated information display system that provides electronic access to facility and NAS-wide information for use by controllers at the sector. This is installed with an articulating arm on the data side of the console.

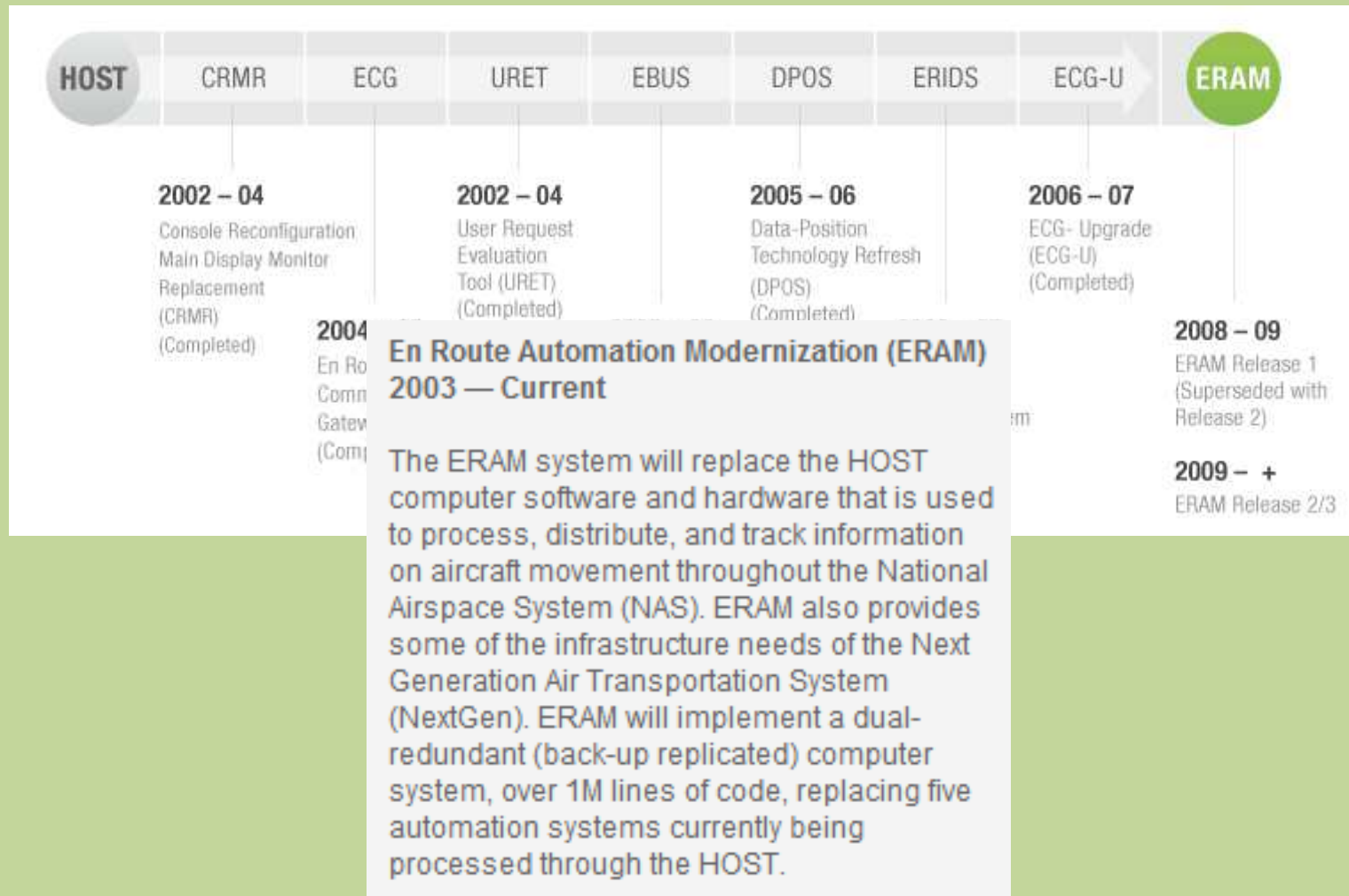
ERAM Timeline



En Route Communication Gateway — Upgrade (ECG-U) 2006-2007

The upgrade to the portal for surveillance and flight data flow was an improvement in consistency of the data in the Primary Interface Processor (PIP) and the Back-up Interface Processor (BIP). When ECG was originally deployed the data in the PIP wasn't always replicated in the BIP. The upgrade corrected that process.

ERAM Timeline



ERAM Capabilities per Lockheed Martin

- **ERAM Provides Enhanced Surveillance Data Processing**
 - Processes new types of surveillance data, including radars, Automatic Dependent Surveillance - Broadcast (ADS-B) and Wide Area Multilateration (WAM) data in CD-2 format
 - Multi-sensor tracking with Kalman filters (aka linear quadratic estimations)
 - Advanced safety functions provide aircraft-to-aircraft and aircraft-to-terrain alerts
- **Flight Data Processing Enhancements Provide Capacity And Efficiency Improvements**
 - Provides full International Civil Aviation Organization (ICAO) flight plan processing, with net-centric flight object access
 - Provides flexible airspace management and route processing, improved interfacility coordination capabilities, and end-to-end route conversion for airspace users
 - Supports legacy and new external interfaces with interface proxy architecture
- **ERAM Provides Enhanced Weather Data Processing**
 - Processes weather grids containing wind, temperature, and pressure data for use by flight data processing trajectory modeling and for display at the controller positions
 - Formats Mosaiced Next Generation Weather Radar (NEXRAD) products for graphical display of precipitation data at the controller positions
 - Processes and distributes text-based meteorological information
- **Conflict Probe Capability Provides Strategic Planning**
 - Conflict Probe and Alert Notification
 - 20 minute look ahead for aircraft/aircraft and aircraft/airspace conflicts
 - Trial Planning – Model and Probe Potential Flight Plan Amendments

@Lockheed Martin

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New Enhancements & Advanced Capabilities

- **Route Tracking in 4-D**
 - An end-to-end 4-dimensional trajectory model that predicts the path of each aircraft in time and space.
 - Switching from ground-based radar to satellite-based GPS
- **Weather data integration**
 - Controllers using information from weather systems will better help pilots route away from storms and turbulence.
- **Conflict resolution**
 - Automated tools will help detect potential conflicts.
 - ERAM will allow for controllers to see the bigger picture to better choose the safest and most efficient resolution
- **Cockpit communication**
 - Data links will allow controllers and pilots to share flight information
 - Allow controllers to see from the cockpit perspective
 - Ultimate goal is share the 4-D trajectory between cockpit and ground automation systems



New Enhancements & Advanced Capabilities

- Information Sharing
 - A System Wide Information Management (SWIM) system will allow the various FAA systems to share information with each other and other users of the airspace
- Airspace Flexibility
 - Will allow airspace boundaries to be adjusted so workload is better balanced between controllers.
- Strategic Flow Management
 - Data sharing will enable a better overall view of air traffic flow nationwide
 - Controllers will be able to re-route aircraft whether in flight or on the ground for optimum efficiency and airport capacity.

Problems with ERAM

- Software problems that have impacted the system's ability to safely manage and separate aircraft.
 - Ada
 - C++



- Projected to be 4 years behind schedule

Problems with ERAM

- **FAA Program Management Weaknesses**
 - Unrealistic Schedule
 - Allowing ERAM to pass Government Acceptance levels even though testing was limited and could not replicate actual field conditions
 - Ignoring of early warning signs of trouble such as high number of problem reports
 - Lack of attention to identify, communicate, and fix ERAM problems
 - Management culture was slow to acknowledge the extent of ERAM's problems and communicate the problems to senior FAA management
- **Weakness in Contract**
 - Poor structured and administrated
 - Sole source contract with Lockheed Martin
 - Hybrid of multiple contract types – fixed-price incentive, cost-plus-fixed-fee, cost-plus-incentive-fee, and time-and materials.
 - Government shouldered much of program's cost risk
 - Failure to fully finalize costs for 16 out of 57 contract tasks
 - Over \$150 million awarded in cost incentives despite cost overruns, delays, and software problems.

Problems with ERAM

- “ERAM testing has yielded more than 40,000 problem reports, over 100 of which are considered to be Initial Operating Capability (IOC) critical, meaning they must be resolved prior to deploying the system for use with live traffic.”

Patrick Forrey, President of NATCA, (May, 2009)

- “official on the ERAM team disclosed that ERAM had yet to remain stable and functional for a full 24 hours of continuous operational testing”

Forrey, (2009)

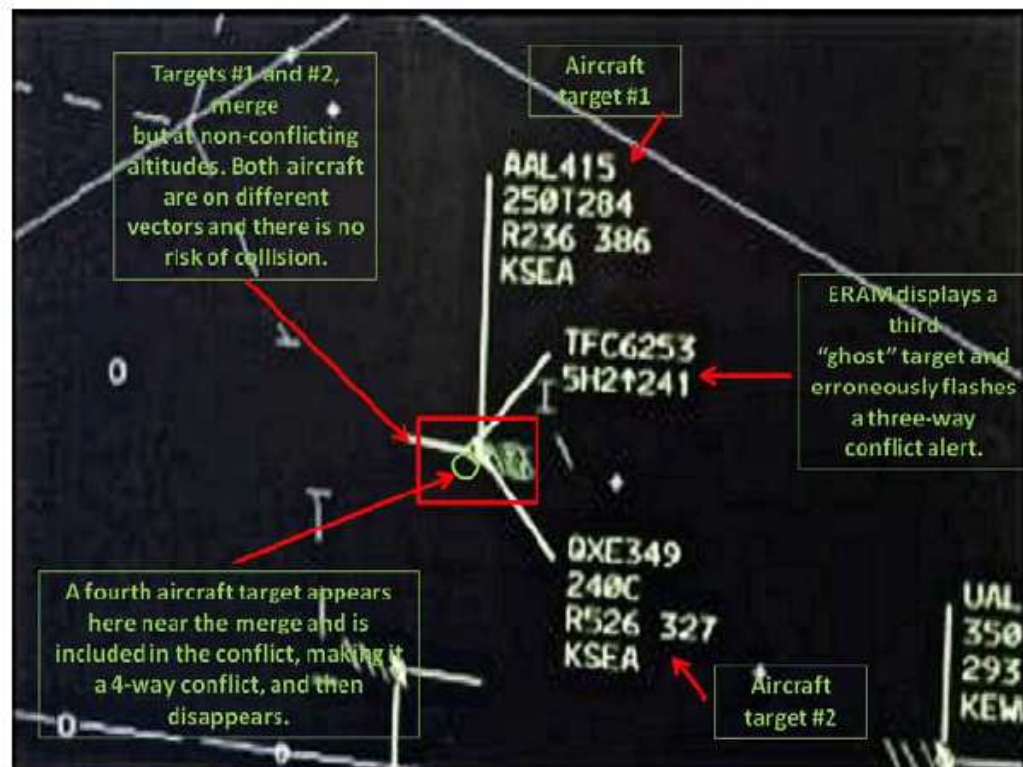
- “many controllers still have serious concerns with the stability of the system...Safety concerns demand that ERAM not be implemented until it meets and exceeds the standards of reliability and stability of the system it replaces. Therefore, we respectfully request that you further examine the implementation of the ERAM system and delay implementation until an acceptable level of reliability and stability is maintained and verified.”

From letters written by Senators Hatch and Bennett & Congressmen Matheson and Chaffetz to the FAA (June, 2009)

- “while NATCA supports ERAM as a good concept and necessary for the future of air traffic control, the FAA has proceeded thus far with out NATCA involvement and, thus, has encountered problems and NATCA confidence is low in the product in its current state”

Forrey as cited by Church (2009)

Problems with ERAM



Source: FAA (textboxes added by OIG)

Event Description: Two aircraft (tagged as AAL415 & QXE349) merge on the screen at different altitudes and vectors. ERAM then produces a “ghost” target TFC6253 (a false target). This series of non-conflicting events activates a conflict alert for the controller’s attention.

Controller’s Concern: There is no reason for ERAM to cause an active conflict alert in any one of these scenarios; consequently, this is a significant distraction to the controller.

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"Phew! I narrowly avoided a near miss."

Problems with ERAM

- In 2010, The FAA was forced to take down the system five days after turning it on at its first site, Salt Lake City.
 - Flight information sometimes failed to accompany aircraft targets displayed on radar scopes or would be paired with the wrong planes.
- In 2010, ERAM had to be taken down after being activated in Seattle.
 - A 27-second outage during caused controllers to rely on radios and memories for plane locations.



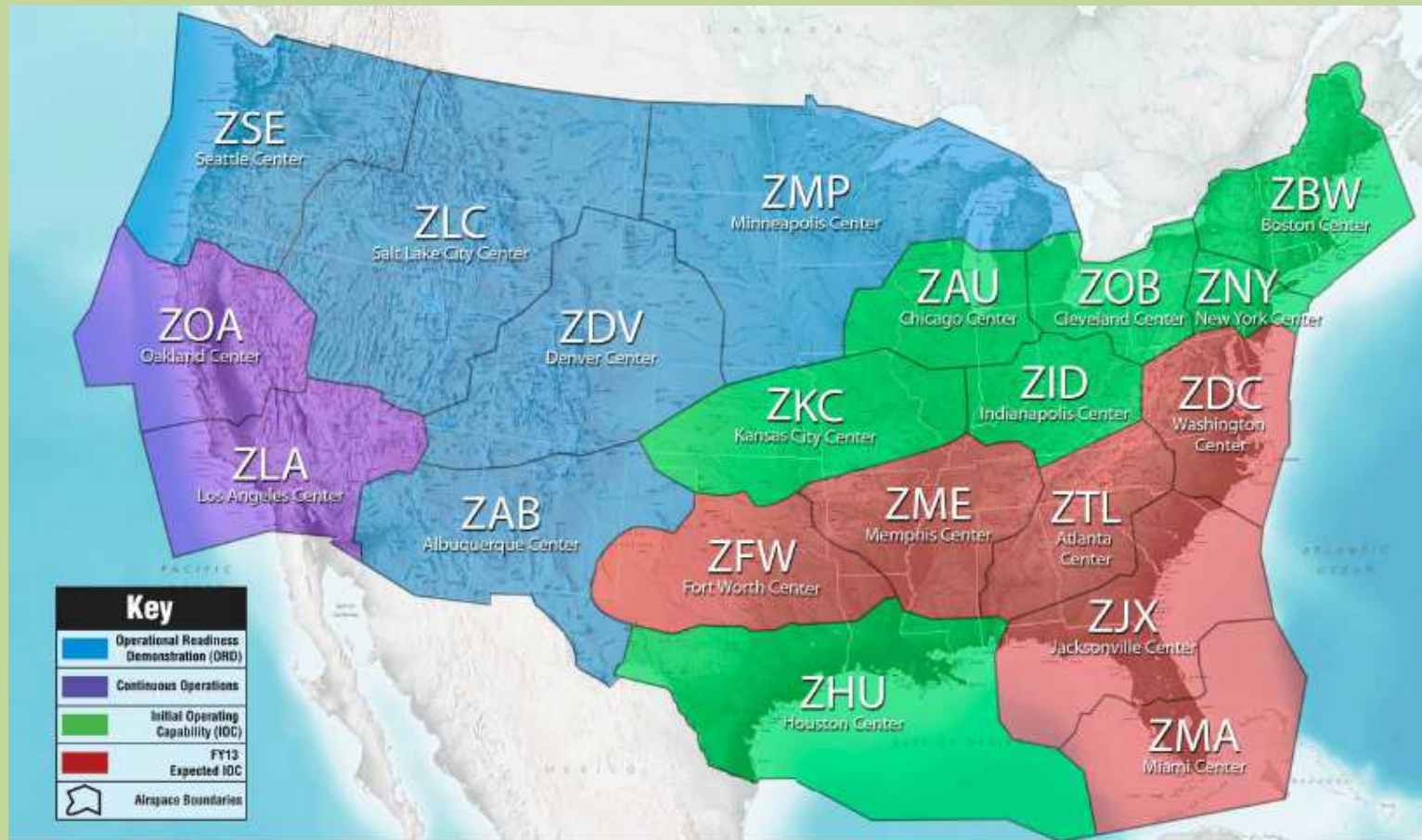
Responses to Problems

The FAA has undertaken a series of management initiatives that are helping to get ERAM back on track:

- In 2011, ERAM program was restructured with a \$330 million variance in funding and a 3-year, 8-month variance in schedule.
- FAA appointed a new management team within the ERAM program who improved relationships with the National Air Traffic Controller's Association (NATCA) and Professional Aviation Safety Specialists (PASS) unions, and creating collaborative work groups.
- New program governance/oversight was put in place in early 2011 which included the labor unions, a steering committee and regular program management reviews.
- FAA and union working group standardized procedures resolved technical and training challenges and prioritized necessary fixes to the system.
- Improvements were implemented to enhance how software is released, tested, and deployed – reducing the number of problems with software code.
- 14 of 20 ERAM sites are now operational, with 7 in continuous operations and over 45,000 hours of operational run-time nationwide on ERAM since December 2011.

ERAM Today

Blue, purple, and green areas represent active ERAM operations, with red areas planned for operations no later than September 30, 2013.





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Questions



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