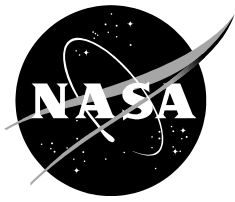
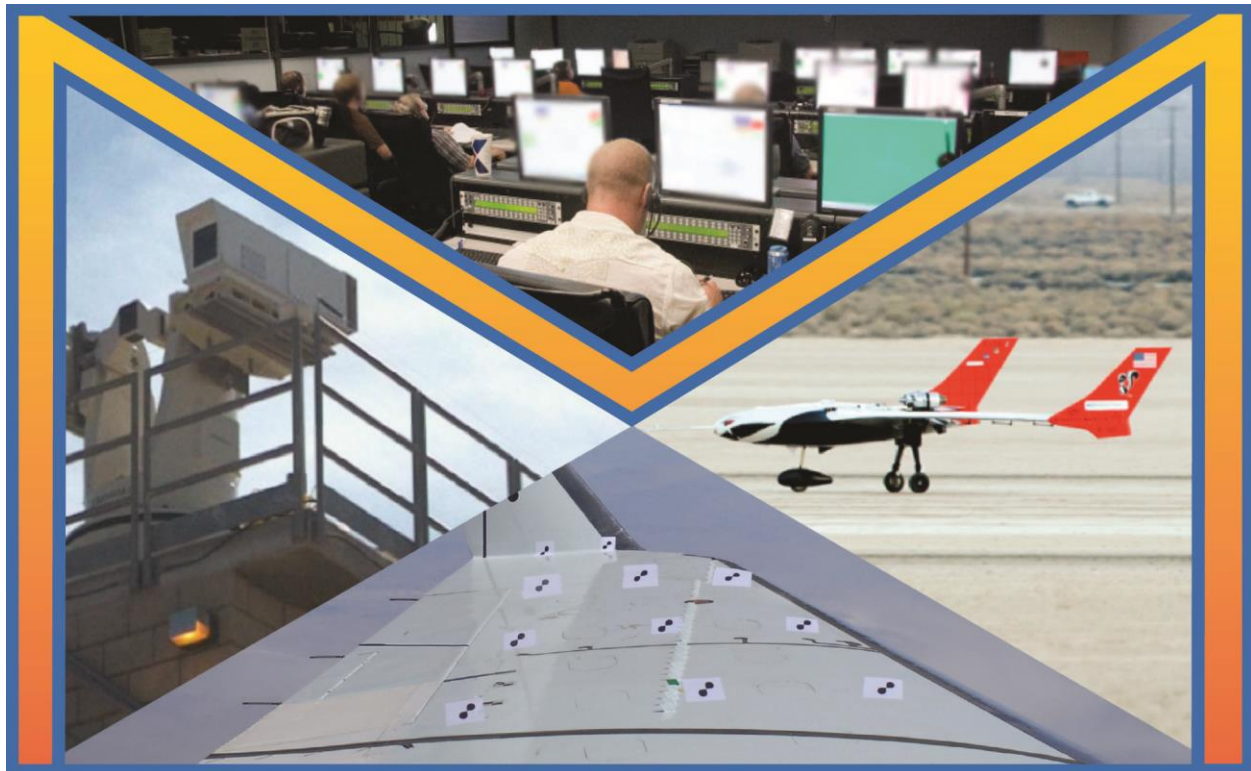


NASA/TM—2015–218343



# Mission Information and Test Systems Summary of Accomplishments, 2012–2013

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December 2015

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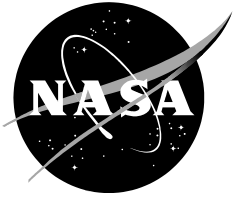
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## Preface

The Mission Information and Test Systems Directorate (Code M) annual report for 2012-2013 showcases the highlights and accomplishments of the Directorate by Branch in support of the following vision and mission statements.

- Code M Vision: To enable and showcase discoveries through flight.
- Code M Mission: Enabling the advancement of Aeronautics, Science, Technology, and Exploration through flight by evolving efficient and effective mission, information, and test systems.

### Facilities and Assets

The Research Aircraft Integration Facility (RAIF) provides the ability to seamlessly integrate simulation, and vehicle software and hardware systems under a single roof. This one-of-a-kind facility can simultaneously support a wide variety of advanced, highly integrated aerospace vehicles through all phases of a research program from conceptual design to flight. The RAIF offers high fidelity 6-degrees of freedom (DOF) batch and in-real-time flight simulation capabilities, as well as support for system integration and closed-loop verification and validation testing of vehicle components and flight vehicles. Also available are complete aircraft ground-support services including all electrical, hydraulic and cooling-air systems required for vehicle-system integration, functional checks, and routine aircraft maintenance.

Western Aeronautical Test Range (WATR) is located at the Dryden Flight Research Center, part of the Edwards Air Force Base complex. The mission of the WATR is to support flight research operations and low earth-orbiting missions. WATR supplies a comprehensive set of resources for the control and monitoring of flight activities, real-time acquisition and reduction of research data, and effective communication of information to flight and ground crews. Precision radar provides tracking and space positioning information on research vehicles and other targets, including satellites. Fixed and mobile telemetry antennas receive real-time data and video signals from the research vehicle and relay this data to telemetry processing areas. The processed data is displayed at the engineering stations in the mission control center and archived in a post-flight storage area.

The Consolidated Information Technology Center is Dryden's 22,000-square-foot facility state-of-art facility that consolidates all information technology (IT) services to enable reliable, secure, and rapid analysis of critical flight research data. The facility provides data processing, distribution, display, and storage.

### Code M Branches

Code MC—The NASA Dryden Flight Research Center Western Aeronautical Test Range's (WATR) Range Engineering Branch provides flight-test range development services and maintains two mission control centers. The major services that the Range Engineering Branch performs are range systems engineering, test information engineering, and data processing and display system/software development.

Code ME—The Simulation Engineering Branch develops high-fidelity engineering simulations that can support various research phases ranging from conceptual studies through flight testing as well as providing a research tool that enhances the quality, quantity, and feasibility of the research objectives.

Code MI—The Information Services Branch provides integrated, secure, and efficient information technology solutions and services that enable NASA Dryden's mission.

Code MR—The NASA DFRC WATR's Range Operations Branch is responsible for operating, maintaining, and building the WATR systems required to support safe flight test and research activities.

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## Range Engineering

The National Aeronautics and Space Administration (NASA) Dryden Flight Research Center (DFRC) Western Aeronautical Test Range (WATR) Range Engineering Branch (Code MC) provides flight-test range development services and maintains a mission control center (fig 1). The major services that the Range Engineering Branch performs are range systems engineering, test information engineering, and data processing and display system/software development.



Photo courtesy: NASA/Gary Kellogg

Figure 1. Launch Vehicle Adaptive Control (LVAC) project engineers prepare for the first flight.

## **Western Aeronautical Test Range Integrated Next Generation System (WINGS) 5.5**

### ***Summary***

The Western Aeronautical Test Range (WATR) Integrated Next Generation System (WINGS) 5.5 upgrade was conceived in order to address a number of issues and desires. The computers used in the control rooms were beyond the end of their lifecycle. Failures were becoming more frequent, and spares were less available. The operating system was no longer being supported, and the security patches were significantly behind, leaving potential vulnerabilities. The telemetry pre-processing software had moved forward several new releases and addressed several discrepancies that existed in the current software being used.

### ***Objective***

The goal of Range Operations was to prepare a plan for the WATR Management Team on how to move to a newer release of the Interactive Analysis and Display System (IADS) software, which had capabilities not present in the release that the WATR was using.

### ***Approach***

Range Operations presented their plan to the WATR Management Team on how the upgrade of the system would address all of these areas. The plan described the upgrade in two phases. The first phase would address the upgrade of the Gold Room, and the second phase would address the upgrade of the Blue Room. This two-phased approach was necessary to continue the support of the projects during this process. There was significant effort in coordinating this upgrade with the projects. Project schedules tend to be fairly dynamic, and the project managers don't like to commit to a specific time when they are willing to accept that resources will not be available. Projects also had to be willing to coordinate their migration from existing software platforms to the new software platforms that would be installed. For some it meant converting to the newer release of IADS sooner, and for others it meant remaining with the older version for a longer period of time.

Dryden Flight Research Center (DFRC) (Edwards, California) has a policy of only upgrading to a version of IADS that the Air Force has already tested and accepted. The Air Force has a fairly large group of testing personnel, and we at DFRC take advantage of their efforts. At the time of the upgrade the Air Force was running IADS 7.2.2.

WATR personnel upgraded the Gold Room and Telemetry and Radar Acquisition Processing System (TRAPS) 1, installing the latest software, replaced with workstations with newer versions, and upgraded the operating system to the latest version with current patches. After the system had been tested and released for operation, one of the projects noticed a buffering issue with IADS. Investigation of the issue verified that it was an error in that particular release. After discussions with Symvionics (Arcadia, California), the developer of IADS, the only option was to go with version 7.3.3, in which the error had been corrected. WATR personnel installed and tested release 7.3.3, and with agreement from the project, accepted that the issue had been corrected. The upgrade was operational in January of 2013.

The upgrade of the Blue Room and TRAPS 2 had to wait for several months while projects completed testing, and there was a break in the schedule. Towards the end of April 2013 the installation of the hardware had begun. The rest of the installation and system testing had been completed by the end of May 2013. During verification and validation testing in June 2013 an anomaly was discovered during the playback of the Stratospheric Observatory for Infrared Astronomy (SOFIA) data. We were able to run this data through a WINGS 4.3 system and discovered that the problem existed prior to the WINGS 5.5 upgrade. Other projects were tested, and the issue did not exist in other projects. After several weeks of testing, the problem was identified. The SOFIA project was attempting to process almost 3 million samples a second through

the system, exceeding the known limitations of the system. The results indicated that the archiving on the front-end could not keep up and would occasionally lose data.

***Status***

WATR personnel reduced the processing load to within the known limits of the system, and the errors no longer manifest. The system was released for operation on July 11, 2013.

***Contacts***

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## Positional Awareness Map3D 2.0

### *Summary*

The Positional Awareness Map3D (PAM3D) application completed its 2.0 development phase. The PAM3D software was developed to provide positional awareness to engineers in the Mission Control Center (MCC) during research flights and real-time missions.

### *Objective*

On completion of phase 1.0, the Western Aeronautical Test Range (WATR) received the requirement to add sonic boom functionality to PAM3D. Sonic boom functionality would give researchers in the MCC the ability to view where the impact of sonic booms will occur on the ground in the form of isopemps (fig. 1).

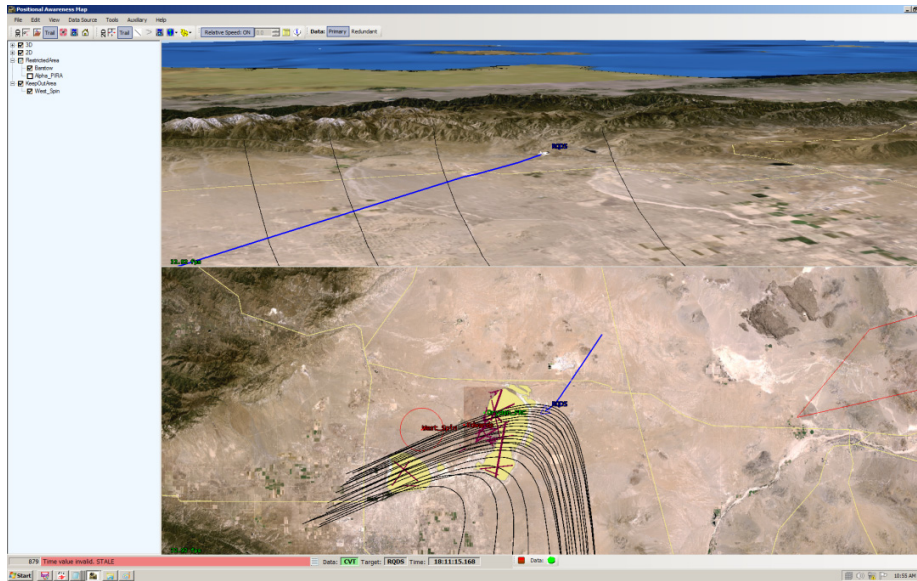


Figure 1. PAM3D 2.0 with isopemps.

### *Approach*

The sonic boom computational module was derived from a separate application known as Cockpit Interactive Sonic Boom Display Avionics (CISBoomDA). The application was developed by Dr. Kenneth J. Plotkin of Wyle Laboratories (El Segundo, California) to calculate sonic boom footprints and signatures from flight vehicles. CISBoomDA was ported from Fortran to C# and implemented in PAM3D by developing a near real-time wrapper and data interface between PAM3D and the Sonic Boom computational code. The CISBoomDA algorithm requires Mach, aircraft weight, and wind data (previously loaded in memory), and only activates if Mach has a value greater than 1.0. Data checking, smoothing, and filtering are provided, as well as computations for 1<sup>st</sup> and 2<sup>nd</sup> derivatives before processing data. The sonic boom application processes the data and passes the latitude, longitude, and elevation of the chevrons to PAM3D for display.

### *Status*

PAM3D 2.0 is expected to be used by researchers in the MCC to gather footprint data and study profiles that have not previously been flown. This data will help to improve understanding of the sonic boom model.

### *Contacts*

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## X-56A/Multi-Utility Technology Testbed (MUTT)

### *Summary*

The X-56A/Multi-Utility Technology Testbed (MUTT) vehicle (Lockheed Martin, Bethesda, Maryland) was designed for flight exploration of emerging lightweight aircraft technologies (fig. 1). The vehicle was developed by the Air Force Research Laboratory (AFRL) (Wright-Patterson Air Force Base, Ohio) under a contract with the Lockheed Martin Corporation (LMCO) Advanced Development Programs in Palmdale, California. After a series of what is being referred to as Lockheed-directed flights, The National Aeronautics and Space Administration (NASA) will take delivery of the vehicle and support equipment, and will operate the vehicle in support of the structural efficiency research theme under the Fixed Wing (FW) Project of NASA's Fundamental Aeronautics Program. This vehicle is a representation of a new design paradigm in which extremely lightweight vehicles are possible.



Figure 1. X-56A/MUTT aircraft landed on the Edwards Air Force Base lakebed after the first flight.

The overarching objective of this project is to augment structural stiffness with active structural control. Significant aircraft weight reduction is realized by retaining the strength of aircraft structures, but allowing for reduced stiffness. Active structural control is then used to compensate for the reduction in stiffness. Advances in structural modeling, sensors, and integrated structural control are required to realize the benefits associated with this new design paradigm.

### *Objective*

The overall X-56A/MUTT project goal is to develop supporting technology and provide sub-scale flight validation of emerging lightweight structure design paradigms, which are relevant to the development of future commercial transport aircraft. To accomplish this flight-test research on these new design paradigms, researchers require the ability to analyze, verify, and validate the flight data on the ground. The project needs to integrate with the NASA Dryden Flight Research Center (DFRC) Western Aeronautical Test Range (WATR) (Edwards, California).

### ***Approach***

During the initial LMCO directed flights, the project's primary ground base of operations for flight testing was the North Base area of Edwards Air Force Base (EAFB). Subsequent flights are leading the project to utilize NASA DFRC as the ground base of operations. With any new unmanned vehicle flight test, range safety is of utmost importance to ensure that any new technologies and new tests do not result in injury, asset loss, or loss of human life. The WATR also provided this capability to the project in the form of flight termination systems for the aircraft and a Range Safety Officer (RSO) Station from which the RSO may conduct range safety business, such as determining the aircraft's health and status, deciding whether a need to terminate (or destruct) the vehicle for public safety is needed, and terminating the aircraft should this worst case scenario occur.

To meet the North Base project's real-time mission support needs, the WATR needed to provide a situational awareness video, telemetry information, voice communications, and more to the project. Meeting these mission support needs required implementing a new solution due to the limited connectivity that NASA DFRC has to the North Base area. NASA DFRC utilized a new solution from a company named IPTec (Pleasanton, California), which multiplexed multiple data signals together (voice communications and video signals), and allowed bidirectional data transfer between the North Base area and NASA DFRC.

To meet the project's new real-time mission support needs with the project's move to NASA DFRC proper, the WATR had to build-up connectivity and infrastructure at two locations. While on North Base, the project experienced a handful of subpar quality data links. Once the move to NASA AFRC proper is completed, the DATR will be able to provide the project with improved quality voice communications, improved video links, and improved telemetry links.

In addition to the real-time mission support, the project required the WATR to post-flight process the on-board recorded flight data. The post-processed flight data allows the researchers to do further in-depth analysis of the flight testing that was unable to be accomplished real-time. This post-processed flight data is also archived, so that additional research may be conducted in the future. The post-flight data processing generated a project specific configuration file and required manipulation of the LMCO flight data into a NASA acceptable format.

### ***Status***

The X-56A/MUTT project has successfully flown eight stiff-wing flights under the direction of LMCO. LMCO is preparing to commence flight testing with flex-wing configurations on the X-56A/MUTT aircraft. The X-56A/MUTT project has just completed its move from North Base of Edwards AFB to NASA DFRC. The infrastructure build-up and upgrades have been completed to all sites. Connectivity to the X-56A/MUTT ground base of operations is still in process.

### ***Contacts***

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## **Virtual Presence (VP)**

### ***Summary***

Virtual Presence (VP) is the approach to allow remote participation of flight-test research activities into the mission control center (MCC). The current MCC paradigm is to have all participants, who want to partake in a flight-test research activity, to be present in the MCC. With the current budget situation, The National Aeronautics and Space Administration (NASA) Dryden Flight Research Center (DFRC) (Edwards, California) is innovating and engineering methods to help maximize the successes of projects, while minimizing the cost of projects. VP is one such innovation. VP offers the opportunity to have project researchers be at their home duty stations instead of traveling to NASA DFRC for the flight tests. By extending the participation in the MCC worldwide, much more research that would typically only be accomplished on paper will now get the opportunity to come to fruition on a true flight-test aircraft.

### ***Objective***

The primary goal of VP is to allow remote participation with the MCC to research engineers, scientists, or any other personnel, who may be with the project. The goal of VP is to provide remote access to real-time flight-test project mission data, project mission voice communications, and project mission video for mission monitoring only. The goal for the reach of this remote access is essentially anywhere; as close as on-site at NASA DFRC, to NASA Langley Research Center (Hampton, Virginia), and across the world.

### ***Approach***

With the current MCC paradigm, all project participants are physically collocated in the MCC. This situation requires all researchers as well as all the data processing and results to be located in the local MCC. By utilizing VP, a new data processing pipeline is created to process real-time data and transport it to allow remote users access. This approach ensures the safety, security, and integrity of the local MCC infrastructure and data.

To meet the data requirements for VP, a near identical data processing system to the real-time data processing of the MCC is duplicated. To support the voice communications requirements for VP, a speaker phone is tied in with the local voice communications infrastructure. Also, a teleconference could be generated via this phone line to allow multiple listeners. To support the video requirements for VP, local NASA DFRC video feeds to a remote server for users to access.

### ***Status***

A prototype VP system was created to demonstrate the capability with several NASA DFRC flight test projects. Due to schedule and budget constraints, remote users logged into local NASA DFRC systems and viewed instantiations of the duplicate NASA DFRC MCC data (video and flight data). The remote users were able to successfully monitor the flight tests during real-time with minimal latency. NASA DFRC has supported three projects with VP to date. The VP project team is currently generating a plan to determine what the future manifestation of VP will be.

### ***Contacts***

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## Dream Chaser Engineering Test Article Support

### *Summary*

Sierra Nevada Corporation's (Sparks, Nevada) Dream Chaser Engineering Test Article had unique ground tow test requirements. The testing had to occur off the main runway (fig. 1) at Edwards Air Force Base (EAFB), first for availability of other runway users as well as to ensure the unique nose skid would not damage the main runway surface. The ground tow tests were conducted in preparation for the approach and landing test. As such, these tests were held on the defunct Runway 06/24 by the South Base complex. The Western Aeronautical Test Range telemetry assets do not have RF line of sight to the intended test area, and there was no capability to get telemetry routed back to the main Dryden Flight Research Center (DFRC) campus for display in the mission control centers.

### *Objective*

Code MC had to develop a unique test capability to meet the unique test requirements. For the tests, Sierra Nevada Corporation (SNC) requested support with a telemetry asset as well as a mission control facility, all stationed off the main DFRC campus. The company is able to utilize the National Aeronautics and Space Administration (NASA) facilities and flight-test personnel through the reimbursable Space Act Agreement.

### *Approach*

Code MC and Code MR had just finished the upgrade to the mobile telemetry facility MOF1, so it was the prime candidate to be mobilized to the South Base test area. MOF1 is a 32-foot long trailer with a 6-foot telemetry antenna (Fig. 2a), and associated RF equipment (Fig. 2b) to support up- and down-link from the Dream Chaser vehicle. By re-purposing the Mobile Operations Facility, originally developed to support Crew Exploration Vehicle (CEV) Pad-Abort 1 activities at White Sands Missile Range (New Mexico), Code MC was able to deliver a best of class mission control center on wheels to the test area. The mobile MCC is referred to as MOF5. MOF5 is a 54-foot long trailer with 14 display stations. There are twelve workstations available to SNC for system monitoring, with two reserved for the DFRC Aeronautical Test Range (ATR) Test Information Engineer (TIE) and Range Control Officer (RCO).

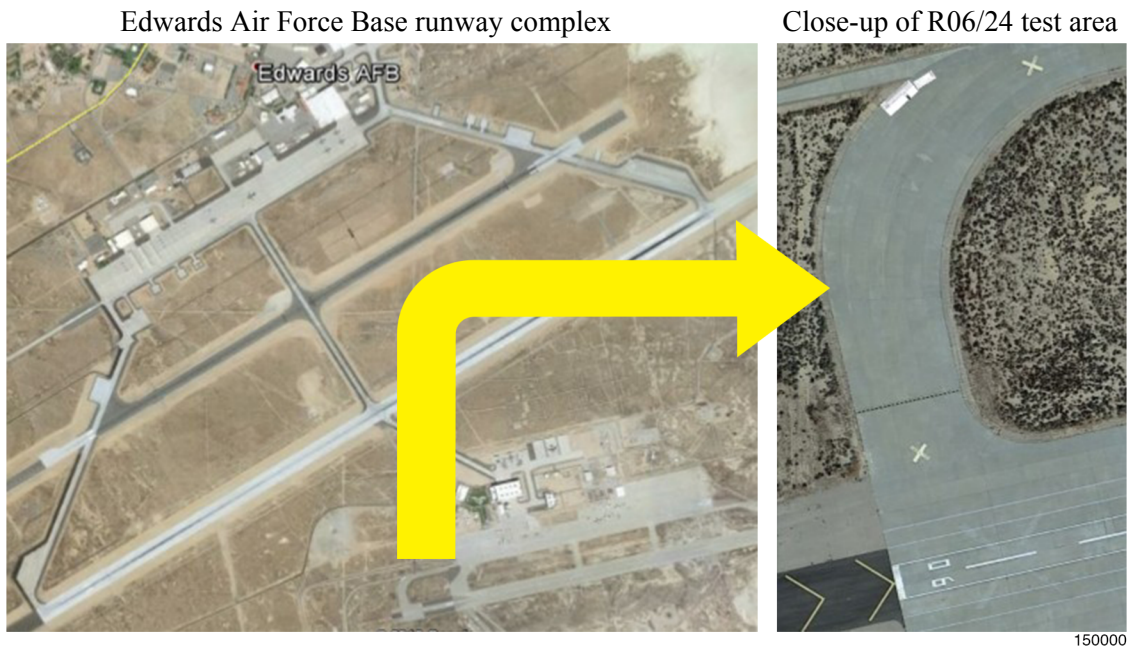


Figure 1. Dream Chaser unique test area.





Photo courtesy: NASA/Bill McMullen



Photo courtesy: NASA/Bill McMullen

Figure 2a. MOF1 Mobile Telemetry Tracking System. Figure 2b. MOF5 Mobile Mission Control Center.

Figure 2. Mobile systems for Dream Chaser operations at South Base Runway 06/24.

### ***Status***

The Dream Chaser performed four sets of sequential low and high speed ground tow tests over the course of two months. The test sequences were completed at 10 mph, 20 mph, 40 mph, and 60 mph to verify integrated spacecraft performance under landing and rollout conditions. The systems verifications included: flight computer and flight software; instrumentation; guidance, navigation, and control; braking and steering performance; flight control surface actuation; mission control and remote commanding capability; and landing gear dynamics. The tests ensured the Dream Chaser would operate properly upon landing and that the spacecraft would come to a controlled stop after touching down on the runway.

### ***Contact***

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## Ikhana/MQ-9 Reaper Support

### *Summary*

It was the first time an unmanned aircraft as large as Ikhana; with a 66-foot wingspan, a takeoff weight of more than 10,000 pounds, and a cruising altitude of 40,000 feet; has flown while equipped with ADS-B. The ADS-B data had to travel over the specialized data links available to the Ikhana aircraft and the Ground Control Station (GCS).

### *Objective*

The researchers designed and built the ADS-B system and support equipment to be installed on Ikhana (fig. 1), but didn't have the knowledge of the GCS capabilities to build the corresponding equipment for the GCS. Instead, the researchers went to the Ikhana team, and in turn they asked a range systems engineer to help out based on his extensive knowledge and understanding of the unique data links from the aircraft to the GCS.



ED12-0082-23

Figure 1. Ikhana flight with ADS-B equipment.

### *Approach*

The researchers had already designed the interfaces to get from the ADS-B equipment onto the data link from the Ikhana to the GCS, so an interface box was designed that turned all that back around, going from the GCS data link interface into the ADS-B equipment installed in the GCS for the flight tests. The unique data links between the Ikhana aircraft and the GCS are well defined at this point, so it was necessary to understand and reverse-engineer the data stream from the ADS-B equipment mounted in the Ikhana aircraft. Then a unique enclosure for the equipment required for the data stream was designed, as well as the cabling to be installed in the GCS. Drawings and wire diagrams were turned over to Flight Operations (Code O), who then had the enclosure and equipment assembled and installed by the Avionics and Instrumentation (Code OA) technicians using the cables they fabricated.

### ***Status***

The flight testing that followed the initial ground checks went flawlessly. The ADS-B data from each mission was also recorded by the FAA Technical Center in New Jersey to do a post mission evaluation. After the tests were completed, the team comprised of researchers, Ikhana crew, and partners in the Unmanned Aircraft System (UAS) in the National Airspace System (NAS) Program were honored with a NASA Group Achievement Award on August, 31, 2013

### ***Contact***

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# Global Hawk Operations Center Development, Buildup, Integration, Test, and Operations

## *Summary*

The National Aeronautics and Space Administration (NASA) Dryden Flight Research Center (Edwards, California) acquired two developmental Advanced Concept Technology Demonstration (ACTD) RQ-4 Global Hawk air vehicles to be used for high-altitude, long endurance (HALE) science campaigns. The Global Hawk Operations Center (GHOC) West (fig. 1) at NASA Dryden Flight Research Center located in the Research Aircraft Integration Facility (RAIF) consists of three rooms, a flight operations room (FOR), a payload operations room (POR), and the support equipment room (SER). The GHOC West supports flight operations and payload data from the science platform based on mission requirements. To support multiple science campaigns, two additional assets were developed based on the GHOC West model. This abstract covers the development of these systems.



Photo credit: NASA/Bart Rusnak

Figure 1. GHOC West.

## *Objective*

The Western Aeronautical Test Range (WATR) Range Systems Engineering group and the RAIF Simulation Engineering group worked together to develop, integrate, and test two new centers to provide mobile capability for world-wide deployment and an east coast presence.

## *Approach*

The GHOC West was used as a model to develop two mobile assets to replicate the SER, POR, and FOR. The SER, POR, and FOR are contained within two commercial 45-foot trailers (fig. 2). Additionally, a 4.6-meter Ku Satellite system (fig. 3) was procured to provide payload command and control, data delivery, and Air Traffic Control (ATC) communications. The GHOC West was used as a model to develop GHOC East that is located at NASA Wallops Flight Facility in Wallops Island, Virginia. By having this replicated asset, the Global Hawk project is able to reduce transit time to and from science campaigns, resulting in longer time over targets.



Photo credit: NASA/Bart Rusnak

Figure 2. One of two 45-foot commercial trailers used to house Global Hawk mobile operations.



Photo credit: NASA/ Thomas Cronauer

Figure 3. Global Hawk Mobile Operations Facility.

### *Status*

Both the mobile center (fig. 4) and GHOC East have been completed and are operational. The mobile systems were deployed to Guam for six weeks in support of Airborne Tropical Tropopause Experiment (ATTREX). The GHOC East has been used to support hurricane science campaigns. Upon completion of the ATTREX deployment, the trailers will return to Wallops for the final Hurricane and Severe Storm Sentinel (HS3) campaign. While at Wallops, the GHOC East and the mobile systems will be used to operate the two Global Hawk aircrafts.



Photo credit: NASA/Bart Rusnak

Figure 4. 6 meter Ku SatCom terminal.

For more information see: <http://www.nasa.gov/centers/dryden/aircraft/GlobalHawk/index.html>).

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## Simulation Engineering

The Simulation Engineering Branch (Code ME) is known for developing high-fidelity engineering simulations that can support various research phases ranging from conceptual studies through flight-testing as well as providing a research tool that enhances the quality, quantity, and feasibility of the research objectives (fig. 1). This branch provides an engineering service that is positively recognized by its customers for its responsiveness, quality, and productivity.



ED14-0009-02

Figure 1. Dream Chaser simulator view from right.

## Simulation Branch Support for NASA Global Hawk

### *Summary*

Dryden Flight Research Center (Edwards, California) operates two reconfigured Global Hawk aircraft, to conduct earth sciences research. Operations for the aircraft were conducted exclusively from the Global Hawk Operations Center (GHOC) (fig. 1) located in the simulation lab area. National Aeronautics and Space Administration (NASA) entered into a partnership with Northrop Grumman Corporation (Los Angeles, California) in order to share costs, and so both NASA and Northrop could benefit from the unique flight characteristics of the Global Hawk aircraft. Under the partnership, equal access to the aircraft is preplanned to enable both partners to satisfy customer requirements.

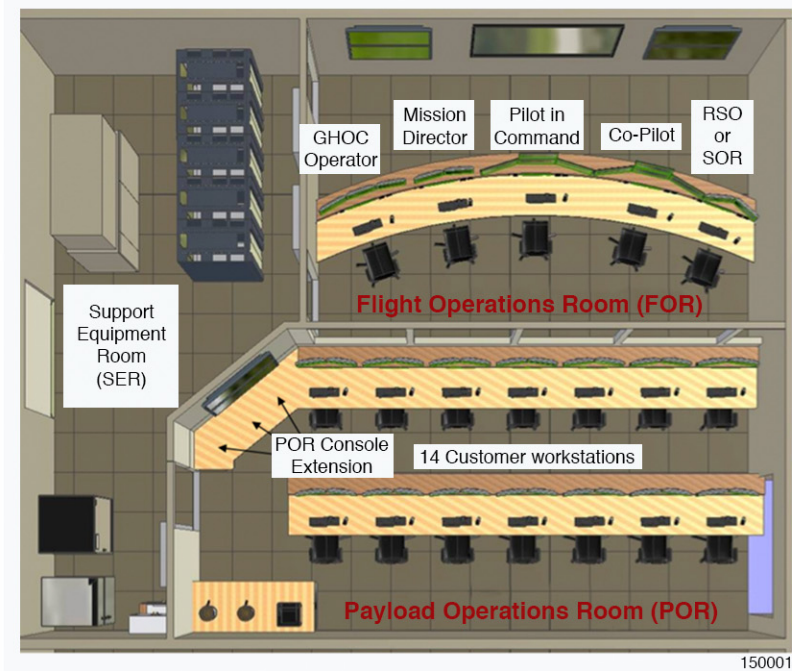


Figure 1. Dryden Flight Research Center Global Hawk Operations Center.

### *Objective*

After successful flight operations were completed using the GHOC and both aircraft, the Simulation Engineering Branch (Code ME), working with Range Engineering Branch (Code MC), designed and oversaw the building of a mobile GHOC. The mobile GHOC consists of the Global Hawk Mobil Operations Facility (GHMOF) (flies the airplane) and the Payload Mobil Operations Facility (PMOF) (supports payload users) trailers.

### *Approach*

In 2012 Northrop was under contract from the Defense Advanced Research Projects Agency (DARPA) to conduct preliminary tests for in-flight refueling between two Global Hawk aircraft. The project was known as KQX (fig. 2). Under the partnership the NASA Simulation Engineering Branch worked with Northrop software developers to link the GHOC, GHMOF, and a new dual Global Hawk pilot simulator.



Photo courtesy: Northrop Grumman

Figure 2. Global Hawk KQX aerial refueling.

### ***Status***

By linking the simulators, the mission planners and pilots were able to define, and refine their flight plans and contingencies to have a successful flight-test program. The Simulations group also worked with Code MC to link data between the GHOC and the AFRC main control rooms, allowing NASA, Northrop, and other support personal to view real-time data.

### ***Contact***

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## Google Earth Simulation Interface

### *Summary*

The National Aeronautics and Space Administration (NASA) Dryden Flight Research Center (DFRC) (Edwards, California) core simulation framework has been upgraded to interface with Google Earth (Google, Mountain View, California) permitting users to see the current location of the simulated aircraft and its flight path track on a high fidelity moving map. The same interface also allows Google Sky (part of Google Earth) to track the telescope position in the Stratospheric Observatory For Infrared Astronomy (SOFIA) simulation to provide accurate star charts in real-time.

### *Objective*

The objective of the Google Earth Simulation Interface is to provide a free, easy-to-use, multiplatform, high-resolution moving map application that will work with any simulation based on the NASA DFRC core framework.

### *Approach*

The old moving map application used in the simulation labs, the Global Real-Time Interactive Map (GRIM) provided low detail maps and was difficult to use and maintain. Instead of developing a new mapping program or purchasing expensive node locked software, it was decided to build an interface between the simulation and Google Earth. As shown in figure 1, Google Earth provides detailed maps with terrain and satellite imaging, and can be easily customized to meet DFRC needs. Google Earth is free and is available on most computer platforms.

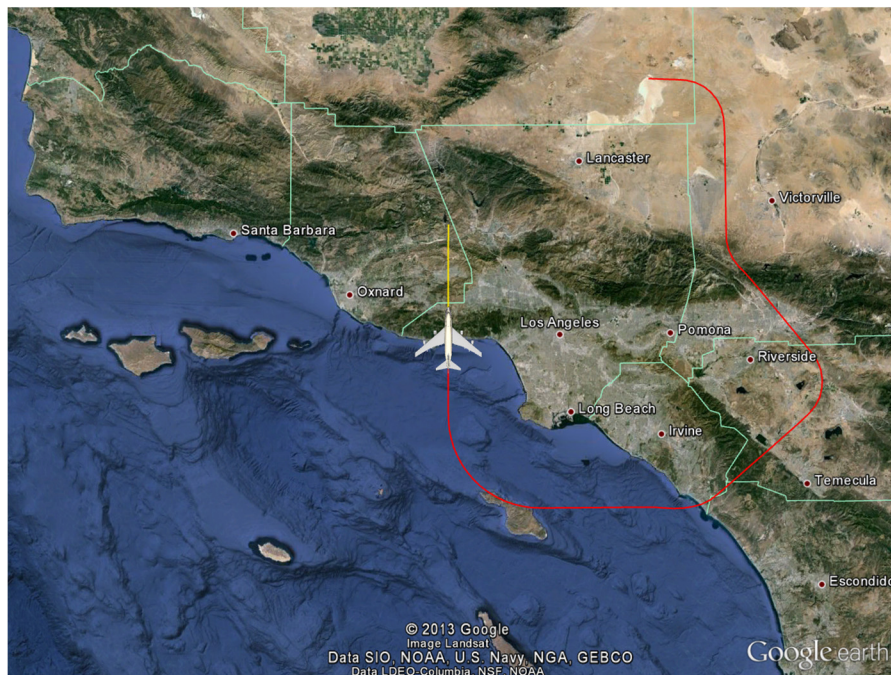


Figure 1. Google Earth image showing the flight of a simulated 747.

Keyhole Markup Language (KML) is a standard XML schema for defining geospatial data in programs like Google Earth, Google Maps (Google, Mountain View, California), and Marble (K Desktop Environment, Berlin, Germany). The position and attitude of an aircraft, the path the aircraft has travelled, the predicted future flight path, and even the 3D model of the aircraft can all be loaded into Google Earth using KML data. Google Earth is able to read KML data files from any HTTP network server.

A simple HTTP server application was created and built into the core simulation framework. Just like an Internet browser connecting to a web page, Google Earth can connect to the simulation just by specifying the address of the simulation computer. Once the connection is made, the simulation will start streaming 3D data into Google Earth for display. The simulation software continuously recomputes these KML data and sends updates to Google Earth at a high rate for smooth motion in the graphics.

A display page and graphical control panel (fig. 2) were added to the simulation's user interface allowing the user to easily adjust the map scale, orientation, tilt angle, and flight path options. Other options, such as whether or not to display highways, can be set using the Google Earth interface.

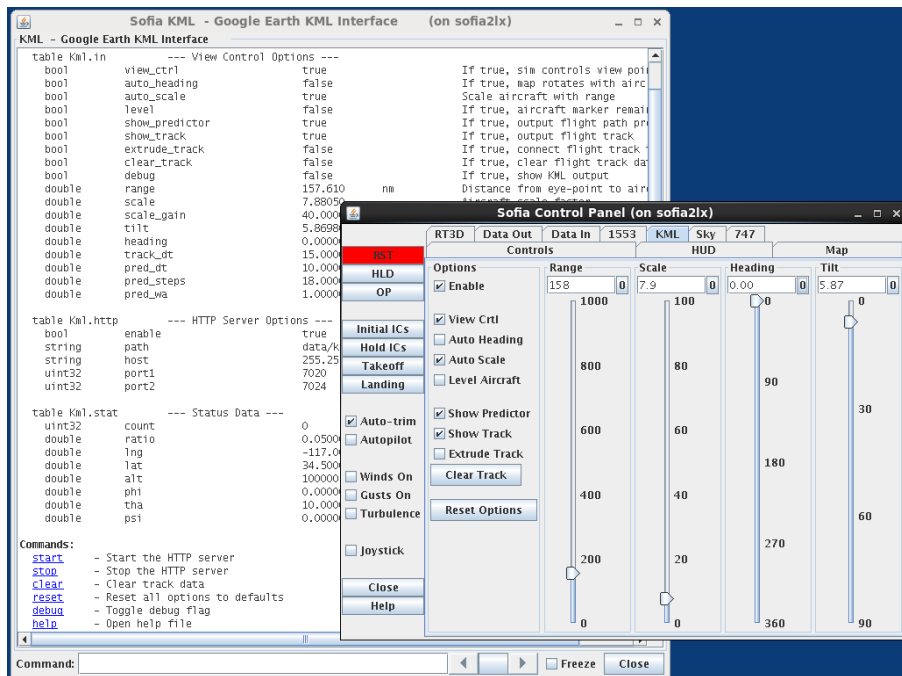


Figure 2. Simulation control panel for Google Earth.

The standard Google Earth application will work with any simulation based on the NASA DFRC core framework. Since the aircraft model, navigation markers, airspace boundaries, and other pertinent data are all loaded into Google Earth by the simulation server, there is no need for the user to manually install any special software.

### *Status*

The Google Earth interface software has been released and is now part of any current core based simulation.

### *Contacts*

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## Dream Chaser Simulation Cockpit

### *Summary*

A piloted simulation of the Dream Chaser Flight Test Vehicle (FTV) (Sierra Nevada Corporation, Sparks, Nevada) was required to evaluate the handling qualities of the vehicle while it was under tow from a tow aircraft. The Dream Chaser was a reusable, crewed suborbital lifting-body spaceplane that was designed to carry up to seven people.

### *Objective*

It was desired to simulate the view obstruction caused by the limited visibility through the small windows of the FTV (fig. 1). It was also decided to attach a canopy to the simulation cockpit (fig. 2) to obstruct the screen of the out-the-window view.



ED14-0009-02

Figure 1. View from right.



ED14-0009-03

Figure 2. View of cockpit simulator with canopy.

### ***Approach***

The canopy was built out of aluminum extrusion, and is electrically actuated for easy entry and exit of the cockpit. The window sizes and shapes of the Dream Chaser vehicle had yet to be decided upon, so a system using easily detached foam board cutouts of the window shapes was designed. This system allows for complete changing of the view in a few hours.

### ***Status***

The Dream Chaser Simulation cockpit is operational, but is not currently being used by any project.

### ***Contact***

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## Simulation Electric Stick Side Arm Controller

### *Summary*

A piloted simulation of the Dream Chaser Flight Test Vehicle (FTV) was required to evaluate the handling qualities of the vehicle while it was under tow from a tow aircraft. The piloted simulation required the simulator to have a reconfigurable side arm controller that could be adapted to different force profiles that could be changed while the design in the FTV was decided upon. The existing Dryden Flight Research Center (Edwards, California) designed Simulation Electric Stick II (SES-II) met the re-configurability requirements, but only a center stick and yoke/column version existed.

### *Objective*

The objective is to keep development cost down. It was decided to adapt the existing SES-II center stick motor assemblies to work as a side arm controller.

### *Approach*

A side arm controller mechanical assembly (fig. 1) was designed to fit in the existing simulation cockpit shells, with throw limits based on typical industry values. The SES-II motor assembly was mounted in the simulation cockpit on the existing center stick mounts, and high precision sheathed control cables were used to connect the output of the SES-II motors to the side arm controller mechanical assembly. Minor changes in the SES-II control software were made to adapt the new mechanical conversion values of the side arm mechanical assembly.



Photo courtesy: NASA/Michael Hill

Figure 1. Simulation electric stick side arm controller.

### *Status*

Though the FTV is planned to use a side arm controller for pilot control of the vehicle, Sierra Nevada Corporation (Sparks, Nevada) had not yet chosen or designed the controller that would eventually be used in the FTV.

### *Contact*

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## **F-18 Simulation**

### ***Summary***

The F-18 simulation has been used by a variety of different projects since it was started in the 1980s to support the High Alpha Research Vehicle (HARV) project. In 2012 the F-18 simulation supported the Airborne Schlieren Imaging System (ASIS) project, and the Intelligent Control for Performance (ICP) Airborne Research Test System (ARTS) experiment. The Launch Vehicle Adaptive Controls (LVAC) project was started at the end of 2012 and continued through 2013. The LVAC also made use of the F-18 simulation. On all of these projects, the Simulation Engineering (Code ME) staff was part of larger teams that also included Dynamics and Controls (RC), Flight Systems (RF), Flight Instrumentation (RI), and Dryden Aeronautical Test Range Engineering (MC) members.

In addition to project support, the F-18 simulation has been a favorite place to show visitors, including a visit by National Aeronautics and Space Administration (NASA) administrator Charlie Bolden on February 23, 2012 when he was shown the new test bench that had been developed.

During 2012 the F-18 simulation computer was upgraded from a Sun 890 (Sparc processor based computer) to a Sun 4640 (AMD X86) based computer) (Oracle Corporation, Redwood City, California).

## Airborne Schlieren Imaging System (ASIS)

### *Summary*

The Airborne Schlieren Imaging System (ASIS) was one of three projects supported by the Simulation Engineering branch (ME) in 2012-13. The images captured by the ASIS project will enable researchers to validate sonic boom data from supersonic models and wind tunnel tests.

### *Objective*

The initial step to support the ASIS project was to connect the F-18 and F-15 simulations together into the same real-time 3D (RT3D) graphics airspace along with voice communications between the two cockpits. This RT3D allowed the pilots to practice some of their techniques for correctly positioning the two airplanes for the Schlieren pictures. One of these earliest simulation sessions was done March 19, 2012.

### *Approach*

The project then started using the RT3D graphics, tubes in the sky, to help provide guidance for the two simulations. The RT3D graphics was then updated to correctly position the sun in the sky based upon date and time. The simulation was modified to pass the RT3D graphics the needed time information and to be able to change the simulated time of the mission.

Next, the simulation was modified to emulate the serial output of the Ashtec Z12 GPS receivers (Magellan Navigation, Inc., Santa Clara, California), in order to drive the laptop computer with the Schlieren display for the pilot. This modification provided the engineers with the ability to check out their Schlieren guidance software in the simulation lab.

A simulation session was conducted on August 1, 2012 which used both the F-18 and F-15 piloted simulations, and the Schlieren laptop computer to guide the airplanes to the correct locations so that the F-15 airplane (McDonnell Douglas, now The Boeing Company, Chicago, Illinois) would fly in front of the sun off the left wing of the F-18 airplane (McDonnell Douglas, now The Boeing Company, Chicago, Illinois) (fig. 1).

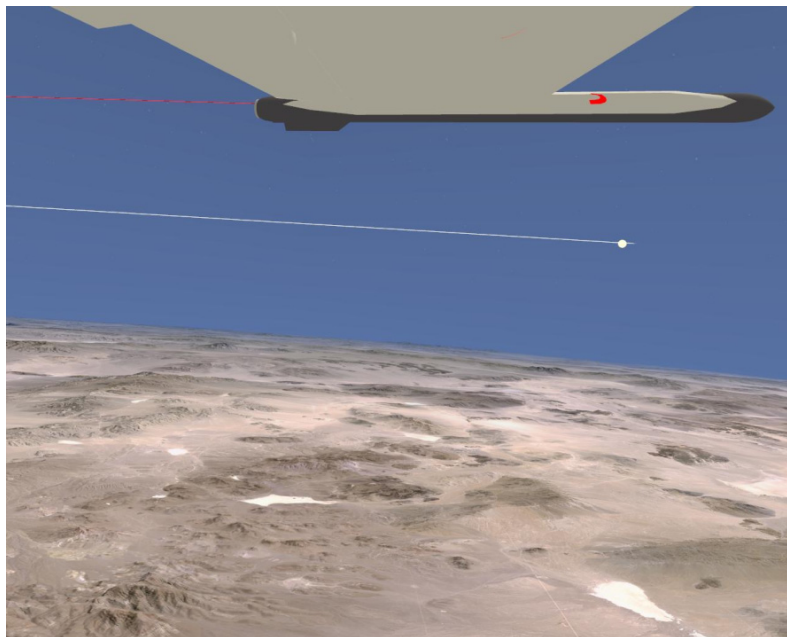


Figure 1. Screen capture of simulated F-15 airplane (dot) off the left wing of an F-18 airplane.

After this initial session, minor updates and enhancements were made, and multiple more simulation sessions were performed through the remainder of the 2012 calendar year. Several of these sessions interfaced not only to the laptop, but to the actual Schlieren flight hardware.

### *Status*

After this initial session (fig. 2), minor updates and enhancements were made, and multiple simulation sessions were performed through the remainder of the 2012 calendar year. Several of these sessions interfaced not only to the laptop, but to the actual Schlieren flight hardware.



Photo courtesy: NASA/Gary Kellogg

Figure 2. ASIS team, consisting of pilot, project manager, and simulation engineers, flies initial session in the F-18 simulator.

### *Contact*

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## **Intelligent Control for Performance (ICP)**

### ***Summary***

As part of the Intelligent Control for Performance (ICP) research project, a special peak-seeking algorithm was programmed into the Airborne Research Test Systems (ARTS) computer of an F/A-18 aircraft (McDonnell Douglas, now The Boeing Company, Chicago, Illinois). This code enables the computer to adjust flight control surface deflections precisely to reduce aerodynamic drag.

### ***Objective***

To support this project, the F-18 simulation was modified to model the higher fidelity research fuel flow sensors that were added to the F-18 aircraft. The Pulse Coded Modulation (PCM) lineup was changed, so a new Telemetry Attributes Transfer Standard (TMATS) file had to be added to the simulation, and the signal selection file was updated for the new fuel flow sensors.

### ***Approach***

The simulation was used in the development phase of the ICP software to test that the design worked correctly. The ICP flight software was then validated and verified using the F-18 simulation. The simulation was also used by the project pilots to practice the flight cards prior to the actual flights. The first flight for the ICP experiment was conducted on September 19, 2012.

### ***Status***

The first flight for the ICP experiment was conducted on September 19, 2012. In December 2012, the F/A-18 Full Scale Advanced Systems Testbed (FAST) aircraft completed the flights that explored reducing fuel consumption during cruise flight conditions by making small modifications to existing control laws and mechanisms in the flight control computer of the aircraft.

### ***Contact***

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## **Launch Vehicle Adaptive Controls (LVAC)**

### ***Summary***

The Launch Vehicle Adaptive Controls (LVAC) project was a partnership between National Aeronautics and Space Administration (NASA) Marshall Space Flight Center (MSFC) (Huntsville, Alabama) and Dryden Flight Research Center (DFRC) (Edwards, California). The LVAC project will demonstrate the use of a NASA F/A-18 aircraft to simulate a rocket in its early flight phase to test adaptive software for NASA's new rocket, the Space Launch System (SLS), the launch vehicle for deep space missions.

### ***Objective***

The objective of the simulation engineers' LVAC work was to implement and fly the adaptive augmenting control scheme designed by MSFC for the SLS in the F-18 Airborne Research Test System (ARTS) computers. The F-18 simulation was used for the development of the ARTS software, pilot evaluation, and flight software qualification.

### ***Approach***

The control room display system in the simulation lab was upgraded to The Western Aeronautical Test Range (WATR) Integrated Next Generation System (WINGS) version 5.3. The NetAcquire system was modified to be able to accept the instrument landing system (ILS) commands from the ARTS computer and pass them on to the aircraft interface computer (AIC) box that fed the commands to the F-18 hardware computers to drive the cockpit digital display indicators (DDIs).

Project engineers from DFRC and MSFC updated the Interactive Analysis and Display System (IADS) displays in the simulation lab and then used these displays during the validation and verification testing of the flight software. These same displays were then moved to the mission control room to support the actual flights.

Since many of the MSFC team members were not familiar with aircraft control room operation, the project decided to conduct mission control room training sessions using the F-18 simulation to supply the data. The simulation provided the control room with the two aircraft PCM streams and the two virtual streams from the NetAcquire. The simulation also passed the radar data needed to drive the control room Global Real-time Interactive Map (GRIM) displays. Additionally the simulation passed the real-time 3D (RT3D) graphics display to the control room to use in place of the head-up-display (HUD) video.

The first of these control room training sessions was conducted on July 18, 2013. The control room was staffed, and the simulation was flown through a set of flight cards representative of an LVAC flight (fig. 1).



Photo courtesy: NASA/Gary Kellogg

Figure 1. LVAC project engineers prepare for the first flight.

The simulation was also used by the project pilots to practice the real flight cards with engineers monitoring the WINGS displays in the simulation lab, prior to the actual flights.

### *Status*

The first LVAC flight occurred on November 14, 2013. In December 2013, the team of engineers, technicians, and pilots completed the test flights to assess the adaptive augmenting controller software planned for the rocket on a modified NASA F/A-18 aircraft at NASA Armstrong.

### *Contact*

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## G-III Simulation

### *Summary*

The Gulfstream III (G-III) (Gulfstream Aerospace Corporation, Savannah, Georgia) (fig. 1) piloted simulation can be summarized by each software release that documents its development as a high-fidelity simulation of the Subsonic Research Aircraft Testbed (SCRAT). The SCRAT project performed aeronautics research, gathered high-quality research data, and validated design and analysis tools.



ED-12-0191-12

Figure 1. G-III aircraft.

### *Objective*

The seven G-III simulations, developed to aid in integrating research experiments, were performed by the Simulation Engineering branch for the 2012-13 calendar years. Each simulation is described briefly in this abstract.

### *Approach*

Each simulation is described by name, date, and version number, and describes the basic capabilities for each simulation done for the G-III aircraft.

#### **V2.0 06-FEB-2012**

This release added the capability of a desktop simulation, allowing the user to control the aircraft with a joystick and a Graphical User Interface (GUI). Improvements were made to the actuator, control, aerodynamic, mass properties, and landing gear models. An out-the-window (OTW) display system was added, using real-time 3D (RT3D) graphics display software and interface.

#### **V2.1 16-APR-2012**

This release added additional aircraft configurations in support of the Subsonic Aircraft Roughness Glove Experiment (SARGE) project and the Adaptive Compliant Trailing Edge (ACTE) project. Modifications were made to the aerodynamic and mass properties models.

### **V2.2 30-APR-2012**

This release fixed a problem found in the aerodynamic model for the ACTE configuration. The release was used for the ACTE Preliminary Design Review (PDR) conducted on May 23–24, 2012.

### **V3.0 10-JUL-2012**

This release upgraded the simulation to the newest version of the Dryden Core Simulation (V5.1) framework. The aircraft models, written in Fortran, were kept in their original format, but were wrapped in a C++ model class, to improved display and command line processing. The newer framework offered improved hardware drivers, telemetry, and a strip chart capability.

### **V4.0 15-OCT-2012**

This release added the piloted simulation capability, utilizing cockpit hardware located in the Research Aircraft Integration Facility (RAIF) simulation lab. A new Simulation Electric Stick (SES) was used to simulate the reversible control system forces experienced by a pilot during flight. The cockpit included 3 touchscreen displays, serving as a head-down-display (HDD) system that simulated real cockpit instruments and gauges.

### **V5.0 21-MAR-2013**

This release includes aircraft model refinements based on ACTE Project Phase 0a flight data. The simulation was used to investigate ACTE safety of flight issues involving reduced roll authority for the Dryden Independent Review Team (DIRT) meeting on February 5, 2013.

### **V5.1 15-MAY-2013**

This release includes aircraft model refinements based on ACTE Project Phase 0a and 0b flight data. This simulation was used in support of the ACTE Flap Critical Design Review on June 25–26, 2013.



Photo courtesy: NASA

Figure 2. This photo of the Adaptive Compliant Trailing Edge (ACTE) was taken by an automated Wing Deflection Measurement System (WDMS) camera in the G-III that photographed the ACTE wing every second during the flight.

***Status***

All simulations for the 2012–13 calendar year are contained in a single document.

***Contact***

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## **Dream Chaser Simulation**

### ***Summary***

The National Aeronautics and Space Administration (NASA) Dryden Flight Research Center (DFRC) (Edwards, California) Dream Chaser (Sierra Nevada Corporation, Sparks, Nevada) simulation was started in January 2013. The buildup of this simulation was a team effort by people not only from the Simulation Engineering Branch (Code ME), but also the Dynamics and Controls Branch (Code RC) and the Aerodynamics and Propulsion Branch (RA). Code RC did most of the Simulink (MathWorks, Natick, Massachusetts) autocoding of the control system, actuator, and landing gear models. Code RA provided the technical expertise on the tow cable model. Code ME did the coding of the aerodynamic model, the cable model, the linearizer, and the mass properties. Code ME also did the integration of all the models into the core infrastructure. The building of the cockpit and interfacing between the simulation software and the cockpit hardware was also done by Code ME.

### ***Objective***

The HL-20 simulation, which had been built for a different effort, was the starting point for the Dream Chaser simulation. The HL-20 simulation was ported from a Sun Sparc processor (Sun Microsystems, now Oracle Corporation (Redwood City, California) to work on a Sun X86 processor. Initially the simulation was connected to an existing F-18 simulation cockpit with the large three-projector screen. From this initial starting configuration, the simulation was updated with new models from NASA Langley Research Center (Hampton, Virginia) and Sierra Nevada Corporation (SNC). As the Dream Chaser design evolved, many of these models were updated several times.

The first HL-20 model to be replaced by a Dream Chaser model was the mass properties. The primary reason for the Dream Chaser simulation at NASA DFRC was to evaluate the possibility of towing the Dream Chaser vehicle to altitude and then releasing it, in order to conduct approach and landing tests. To support this simulation testing, the tow cable model that had been used by the Eclipse project was copied into the Dream Chaser simulation. The RT3D graphics code was updated for the tow cable, and the simulation was modified to send the needed cable information to the graphics. The initial tows were done using a pre-recorded time history from an F-18 simulation as a substitute for a tow vehicle.

The HL-20 aerodynamics model was replaced with a Dream Chaser aero model. The landing gear model was updated, and an optional control system originally from the National Aero-Space Plane (NASP) project was added. SNC astronauts flew this Dream Chaser simulation with the tow cable model on April 16, 2013.

### ***Approach***

The Dream Chaser aerodynamic model was updated, and the HL-20 control system was replaced with the control system model for the Dream Chaser. The simulation was modified to be able to read an IRIG time source (which would be needed for synchronizing with a separate tow simulation). Code was added to extrapolate the tow plane's information up to the current Dream Chaser simulation's frame time.

The C-17 simulation, which had not been used for a few years, was brought back to operational status and interfaced to the new simulation electric stick (SES). This C-17 (The Boeing Company, Chicago, Illinois) simulation was then used to record tow plane trajectory time history files that were used by the Dream Chaser simulation. The designer of the Eclipse tow cable model continued to refine the model in the Dream Chaser simulation.

The Dream Chaser simulation was then updated to the latest Core simulation version. The F-18 cockpit was replaced with a dedicated Dream Chaser cockpit that included a new SES, a side arm controller, toe brakes, flat panel displays, and cockpit windows to more accurately represent the vehicle (fig. 1).

The aerodynamics and control system models were again updated. The tow cable model was moved to a separate thread so that it could be run at a higher frequency. The C-17 simulation was used to record tow trajectories more representative of operational constraints.

The Dream Chaser simulation was used for SNC astronaut evaluations on June 24-25, 2013. The tow cable model was updated to be a multiple segmented rope, and a trim model for the cable was added.

Another round of SNC astronaut evaluations (fig. 2) were made on the simulation July 29-31, 2013. The linearizer model was updated to include tow cable states. The Dream Chaser actuator model was added to the simulation. The Ethernet Transmission Control Protocol (TCP) interface between the C-17 and the Dream Chaser simulations was implemented so that the two simulations could interact in real-time, instead of just using pre-recorded time histories for the tow plane. The control system model was updated again.

The SNC astronaut flew the simulation again on September 9-10, 2013. A model of the Dream Chaser vehicle was added to the RT3D graphics code, until this point the graphics had been using the HL-20 model. The old HL-20 simulation was brought up to the current simulation standard in order to support visitors who are not part of the Dream Chaser project. The Ethernet TCP interface to the F-15 simulation was implemented, so that the F-15 airplane could act as an alternative tow plane to the C-17 airplane.



Figure 1. Screen shot of the Dream Chaser simulator interior.



Photo courtesy: NASA/Gary Kellogg

Figure 2. Sierra Nevada Corporation astronaut flying the Dream Chaser simulator.

### ***Status***

The SNC astronaut flew the simulation October 29, 2013. The mass properties of the Dream Chaser simulation were updated. The tow cable model was ported from FORTRAN to C++. The aerodynamics and landing gear models for the Dream Chaser were both updated to the latest versions. The landing gear was added to the RT3D model of the Dream Chaser vehicle. The HL-20, C-17, and F-15 simulations were used for evaluations by the United States Air Force Test Pilot School (Edwards, California) on December 3-5, 2013.

### ***Contact***

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# nuPlot Dryden Time History Plot Software

## Summary

The nuPlot Graphical User Interface software (fig. 1) is the replacement of the legacy QuickPlot tool, with a merging of functionality with the dthData tool. The nuPlot tool provides backwards compatibility and features that were unavailable in QuickPlot alone. nuPlot is written in-house, and in the modern programming language, Java. Writing the software in a modern programming language allows any software developer familiar with the modern programming language to provide support. Writing a new in-house tool allows for the ease of implementing future updates, and is solely owned by the National Aeronautics and Space Administration (NASA). The new tool is a subset of the Dryden Core Framework simulation software and will serve as a common tool for plotting simulation data amongst the NASA centers.

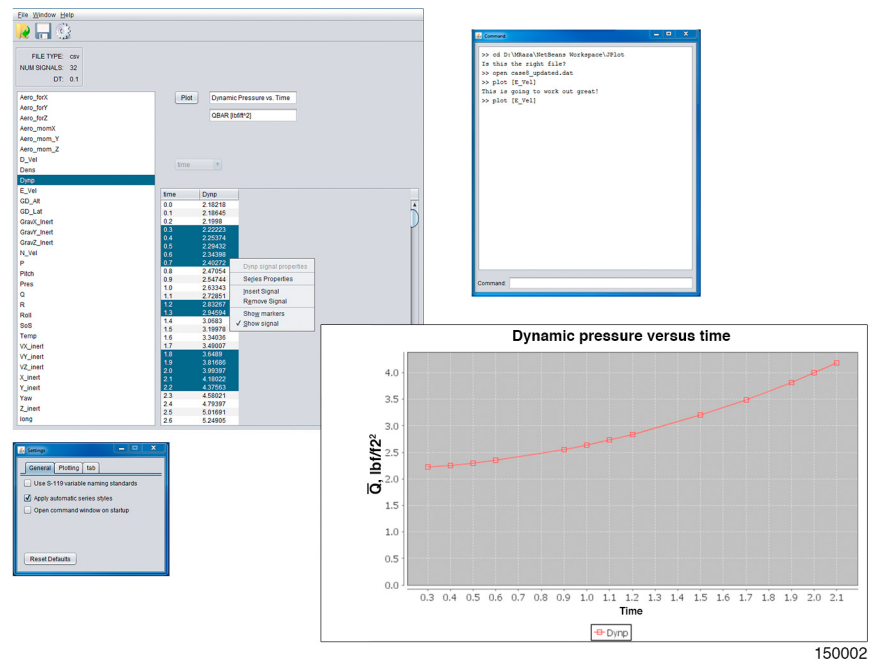


Figure 1. nuPlot Graphical and Scripted Interface.

## Objective

The objectives in developing the nuPlot tool were to replace the QuickPlot tool, with a high quality, well documented tool that had similar functionality, was written in a modern programming language, was designed with a modern graphical user interface, implemented functionality from the dthData tool, and was maintained to be independent of any particular computing platform.

## Approach

After a quick proof-of-concept was developed, steps were undertaken to determine the full set of software requirements. The developed Software Requirements Document (SRD) was studied to determine if the capabilities would be feasible to implement. The features, some of which are shown in the figure below include:

1. The continued support for a scripted interface for functions such as:
  - a. Opening, closing, saving, and plotting of data.
  - b. Generating scripts using graphical inputs (that is, everything the user is allowed to do in the graphical environment is mimicked in the scripted environment and vice-versa).
  - c. Additional functions from within the scripted interface include those mentioned below.

2. The ability to customize the signal series to be plotted (for example, line thickness, line color, et cetera).
3. The ability to save and execute scripts from the graphical or command driven environments.
4. The ability to plot selected signals for selected data points, inserting signals (based on user defined equations), and removing signals.
5. The ability to plot signals in the time domain, or in the signal domain of the user's choosing.
6. The ability to read in data from multiple file formats, including the MATLAB (mat) format (that is, asc1, asc2, cmp3, cmp4, csv1, mat, rir1, sif1, unc0, unc2, and unc3). A utility tool to batch convert file formats will be included.
7. The ability to save/load user preferences
8. The ability to save/load a user's session.
9. The ability to perform unit conversions.
10. The ability to map project signals to the S-119 variable naming standards.

### ***Status***

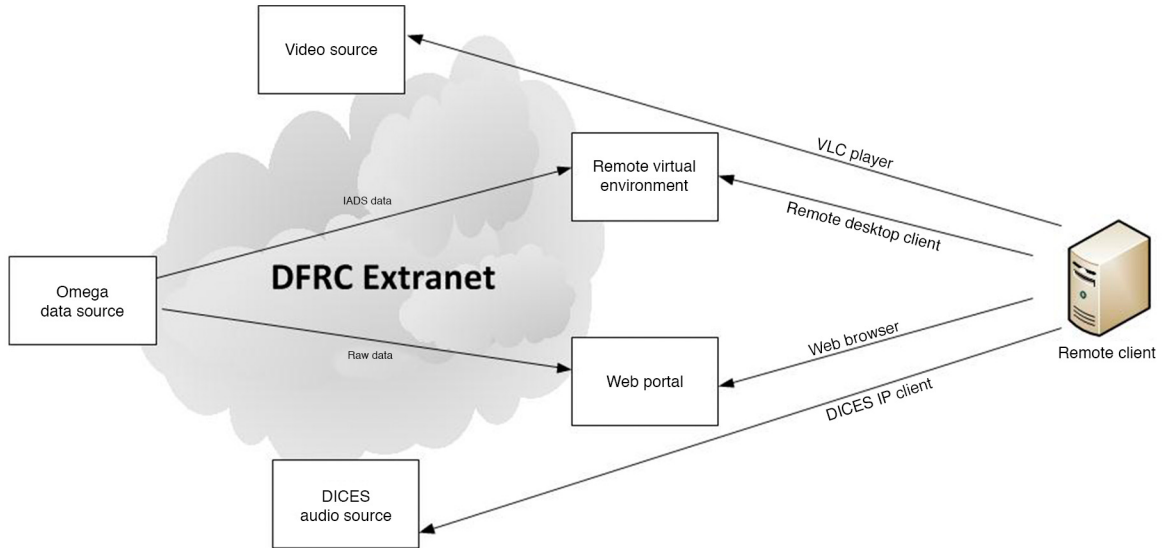
The nuPlot tool is currently under development with many requirements already verified informally. As more feasible options emerge, or as the code evolves, the requirements documentation is being updated. Some of the high priority items which remain include the completion of the scripted environment, the ability to completely define the properties for a plot series (for example, line thickness, marker size, et cetera), controlling the visible domain and range of the plot, building in the appropriate error checks and warning messages, and the ability to save a user session. After completion of development, the software will be tested and verified against individual requirements, and for major paths in the software.

### ***Contact***

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## Information Services

The Information Services Branch (Code MI) provides integrated, secure, and efficient information technology solutions and services that enable the mission of the National Aeronautics and Space Administration (NASA) Dryden Flight Research Center. The mission of the NASA information technology (IT) organization is to increase the productivity of scientists, engineers, and mission support personnel by responsively and efficiently delivering reliable, innovative, and secure IT services (fig. 1).



150003

Figure 1. Virtual flight research center.

## Global Hawk Support

### *Summary*

The Global Hawk project (fig. 1) is in its second year of the Hurricane Severe Storm Sentinel (HS3) mission as part of the support team to assist with relocation efforts at Dryden Flight Research Center (DFRC) (Edwards, California) for IT systems, monitor the transcontinental link between DFRC and Wallops Flight Facility (WFF) (Wallops Island, Virginia), and collaborate on System Security and Contingency Plans. The relocation of the Global Hawk Operations Center (GHOC) hangar required coordination between cable plant and Network Operations personnel for enabling ports in the GHOC cage. The transcontinental link required layer 2 provisioning (L2TPv3) to allow for network connectivity during flight missions from Wallops Flight Facility. The System Security Plan and Contingency Plan have been collaborative efforts in gathering information and completing written documentation to comply with NPR 7120.7.



ED13-0399-06  
Figure 1. Global Hawk 872 on its 100<sup>th</sup> NASA flight.

### *Objective*

The continued systems engineering support for the Global Hawk mission(s) is to evaluate all aspects of the information technology that pertains to the valid security plan for the beneficial purpose of enhancing the scientific research conducted by various universities and global entities. This support allows for greater understanding of Earth Science and improves the measurement process of severe storms that will determine more precise predictions in the future of severe storms and tropical disturbances.

### *Approach*

The Information Systems Branch (Code MI) has completed all sections of the System Security Plan adhering to version 3 of the System Security Plan in RMS have been completed. Code MI has identified the information types in the System Security Plan and has assisted the Global Hawk project in the successful Authorization to Operation Extension. All systems associated with the Global Hawk Security Plan have been inventoried, and boundaries including Appendix A referencing Global Hawk East have been documented. Guidance for network and hardware best practices has been provided in an effort to minimize vulnerabilities within the GHOC local area network.

### *Status*

Code MI support is an ongoing process that will require Systems Engineering support throughout the life cycle of the HS3 mission and beyond with respect to future programs.

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## **Ikhana Annual Report**

### ***Summary***

The Ikhana (fig. 1) unmanned aerial system (UAS) is designed for long-endurance, high-altitude flight and is utilized for Earth Science, advanced aircraft systems research, and technological development. The ground control station along with all science and engineering workstations are housed in a mobile trailer making Ikhana ideal for remote missions around the world. The systems engineering support that was provided includes in depth vulnerability scans, inventory management, and Systems Security and Contingency Plan documentation.



ED12-0082-12

Figure 1. Ikhana being prepared for an early morning flight.

### ***Objective***

The objective is to enhance the technology utilized within the science and engineering workstations to improve the capability, reliability, and safety of unmanned aircraft. The UAS validates electronic sensor technologies, and conducts extensive Earth observations.

### ***Approach***

As support for the Ikhana project continues and a better understanding of the complete mission(s) goals is developed, Code MI will provide informative feedback regarding the information technology infrastructure will be provided. The goal of providing quality systems engineering while completing contingency plan testing and documentation will continue. The local area network for Ikhana is isolated and provides the scientists and engineers with a safe computing environment with regard to external sources.

### ***Status***

Ikhana continues to advance in its research of Automatic Dependent Surveillance-Broadcast (ADS-B) technology that provides for aircraft tracking that must be adopted in the U.S. by 2020. This NextGen technology grants air traffic control greater insight as to aircraft GPS positioning making air travel safer and more efficient. The engineering and scientific computer workstations and network design are all part of the system security and contingency plans that are provided for guidance.

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## **Enterprise Architecture**

### ***Summary***

The Dryden Flight Research Center (DFRC) (Edwards, California) initiated an enterprise architecture program designed to document and facilitate the analysis of DFRC activities from an integrated strategy, business, and technology perspective. In coordination with the National Aeronautic and Space Administration (NASA) Chief Enterprise Architect and as a member of the Agency Enterprise Architecture Working Group, the DFRC team drafted a Center EA strategic plan, developed domain roadmaps, and began the process of fully documenting information technology services. In 2013, the Information Services Branch (Code MI) established a full time enterprise architect position and partnered with the Executive Office of the President and the Office of Management and Budget to move beyond the initial stages of architecture development.

### ***Objective***

Objectives of the enterprise architecture program include:

- Shorter planning cycles.
- Shorter decision cycles.
- Reduction of duplicative resources and services.
- Improved communication.
- Improved resource integration and performance.

### ***Approach***

The Dryden Enterprise Architecture Working Group is leveraging a service oriented enterprise (SOE) model of the Center in its development of a center architecture. Working with the NASA Chief Enterprise Architect and the Federal Chief Enterprise Architect, the DFRC Enterprise Architecture Working Group is working to develop service design packages and a comprehensive service catalog that will inform customers, facilitate operations and management, and inform the budget and acquisition process. In the SOE approach to enterprise architecture, services take the place of traditional business units in the Federal Enterprise Architecture Framework and therefore form the foundation of the architecture.

### ***Status***

The DFRC Enterprise Architecture program is a level 1 program according to the Architecture Capability Maturity Model. Some Enterprise Architecture processes are defined but are localized or informal. The working group established collaboration sites and initial artifact repositories. Work continues on the service catalog and architecture development.

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## **Agency Vulnerability Assessment and Remediation (AVAR)**

### ***Summary***

The Agency Vulnerability Assessment and Remediation (AVAR) project establishes vulnerability assessment policies and directives for each National Aeronautics and Space Administration (NASA) facility across the Agency to adhere to. In an effort to take a preemptive approach to avoid IT security incidents from occurring throughout the Agency, the project evaluates, selects, and manages the appropriate tools necessary for vulnerability discovery, assessment, and mitigation. The project serves as a central hub of technical expertise to assist all NASA centers and their vulnerability assessment administrators.

### ***Objective***

By instituting a set of standards that all NASA centers comply to and report on, comparison of scan data that is collected by the Enterprise Data Warehouse (EDW) would be more consistent between centers. The support and research the AVAR project provides aims to enhance scanning capabilities and improve services to system owners.

### ***Approach***

With the development of baseline scan templates, and the use of only Agency approved vulnerability assessment tools, standardization of gathered vulnerability data between centers is being accomplished. The AVAR project worked closely with the centralized database and the EDW in designing compliance checks and scripts used to collect and display an accurate representation of the security posture at each center. New passive monitoring devices were tested and evaluated to determine if their capabilities would meet Agency directives and benefit the Agency. A project website and SharePoint (Microsoft Corporation, Redmond, Washington) site were developed for a collaboration of knowledge and a platform for discussions.

### ***Status***

The AVAR project has ongoing outreach to every NASA facility across the Agency to foster amity and communication within the AVAR community. As threats to NASA information technology systems continue to evolve, the AVAR project continues to equip the system owners with the ability to protect against exploits, malicious programs, and risks to the confidentiality, integrity, and availability of their systems.

### ***Contact***

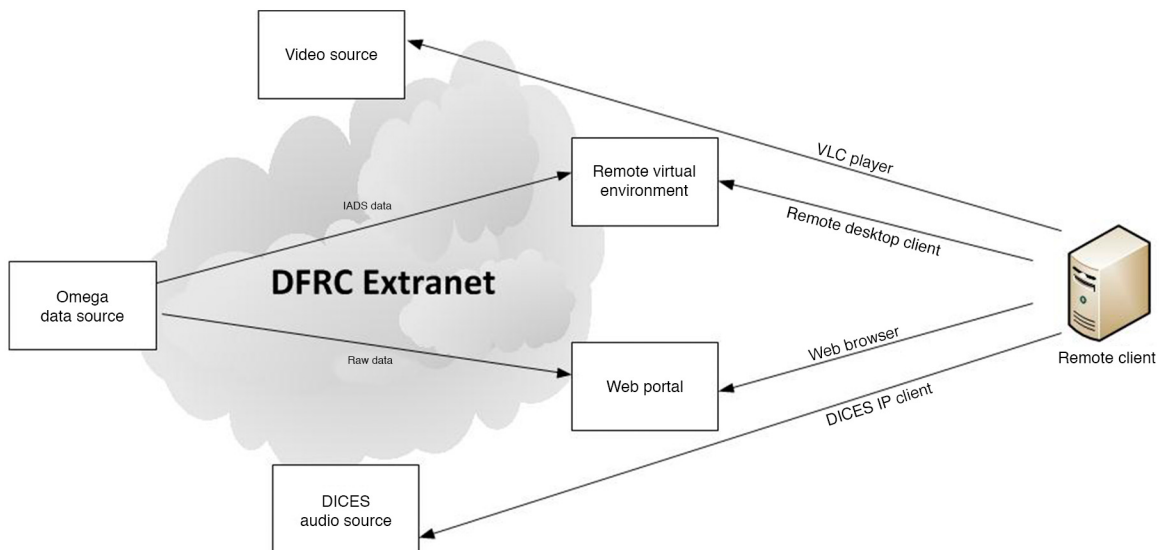
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## Virtual Presence

### Summary

The National Aeronautics and Space Administration (NASA) seeks innovative and efficient approaches to conducting flight-test operations. An element of the future vision includes the ability for a subset of researchers to participate in flight-test activities from essentially anywhere. For two decades Dryden Flight Research Center (DFRC) (Edwards, California) researchers have referred to this ideal end state as a virtual flight research center (fig. 1). The focus of this effort targets extension of flight project control room operations to other NASA field centers. The Virtual Presence project would allow a remote engineer to participate in flight research activities occurring at DFRC from another NASA center. This remote participant would receive audio, video and flight data through the NASA Wide Area Network.



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Figure 1. Virtual flight research center.

### Objective

The Virtual Presence project will provide flexible solutions for remote flight research participants. These solutions must include support for multiple platforms, support for lower bandwidth connections, and both clientless and client based systems. The system must be flexible enough to provide the proper level of information security, while still being able to support multiple remote use cases.

### Approach

The Virtual Presence project is testing multiple methods of allowing remote connectivity. One method requires a specific client that allows for greater real-time data visibility, while the other method is web-based and provides visibility into a subset of real-time flight data. Initial demonstrations were limited and intended as proof-of-concept; the system is now transitioning to a prototype or pilot phase for more robust testing.

### Status

The Virtual Presence project has currently completed some proof-of-concept tests to demonstrate the capabilities and assess some of the technologies involved in sending and displaying real-time flight data to remote participants. The project will be transitioning to a pilot phase and additional tests will be conducted

against both the web and client based applications. A portal to integrate this and other flight data related services is being tested and enhanced.

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## **Lean Six Sigma**

### ***Summary***

Since February 12, 2013, a cross-organizational Lean Six Sigma project has been facilitated to include team members from Engineering Support (OC), Information Systems (MI) and Flight Instrumentation (RI) called Flight Data Delivery Process Improvement. This team will baseline and document the current telemetry van process and create a formal process to improve the way the vans distribute data to end users. Since the vans are isolated with no network connectivity, the telemetry group collects data manually, stores it on external drives, and hand carries the media to customers.

### ***Objective***

The objectives for the group are to:

- 1) create a formal process for delivering flight data;
- 2) reduce the time span for making data available to customers to near real-time;
- 3) eliminate the use (as much as possible) of portable media and instead move data in a trustworthy fashion via efficient use of network connectivity; and
- 4) create an implementation plan.

### ***Approach***

#### **Schedule:**

- January 30, 2013—Obtained approval from the Dryden Flight Research Center (DFRC) (Edwards, California) Lean Six Sigma Program Manager to proceed with the project.
- February 12, 2013—Initial Sponsor meeting to write the charter, identify team members, and the team lead.
- March 4, 2013—Champion/sponsor/team lead briefing to review the charter and get the go ahead to proceed with the project.
- March 7–27, 2013—Process walk interviewing Codes OC and RI to get an understanding of the current process.
- May 16, 2013—Included sponsors representing Codes OC and RI and briefed them to get buy-in.
- July 16, 2013—Held final champion/sponsor/team lead meeting.
- July 18–August 29, 2013— Concluded team meetings.
- September 5, 2013— Completed Center out-brief.

### ***Status***

Once the proposed improved process has been approved by DFRC leadership, an implementation team will be assembled with a 0-6 month timeframe to complete and test the proposed pilot process.

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## SOFIA Program IT Support

### *Summary*

The Information Services Branch (Code MI) provided information technology (IT) support for the Dryden Flight Research Center (DFRC) (Edwards, California) Stratospheric Observatory for Infrared Astronomy (SOFIA) program (fig. 1). This support includes ensuring required IT security document is maintained for SOFIA systems and that required IT systems tests are completed as required. These tests include annual testing of system controls, contingency plans, and system risk assessments.

In addition Code MI supports SOFIA by ensuring that required IT services are implemented and tested for program activities. These services included:

- Testing and documenting the deployable National Aeronautics and Space Administration (NASA) Aircraft Maintenance Information System (NAMIS) to ensure maintenance information can be maintained and retrieved while SOFIA is on deployment.
- Working with visiting instrument and experimenter teams to ensure communication and security requirements are tested and in place.
- Facilitate the implementation of required communication links for connectivity to Ames Research Center (Moffett Field, California), Line operations testing and connectivity for SOFIA Deutsches Zentrum für Luft- und Raumfahrt/Deutsches SOFIA Institut (DLR/DSI) partners.

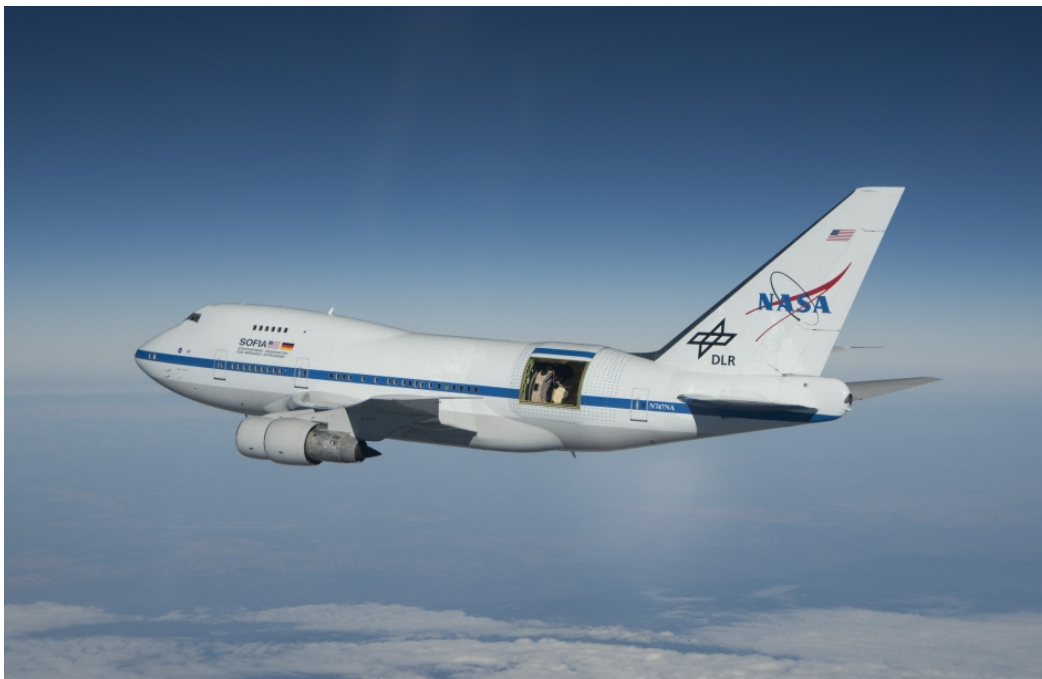


Figure 1. The Stratospheric Observatory for Infrared Astronomy (SOFIA) aircraft with telescope door open.

### ***Objective***

The objective for the SOFIA program IT support is to integrate an IT person with the program and facilitate communication between the program and the IT organization. The goal was to provide closely integrated IT support for the Program to ensure current and future requirements are planned and implemented per program requirements.

### ***Approach***

Arcata Associates, Incorporated (Las Vegas, Nevada) provides system engineering support for DFRC projects. IT personnel work directly with SOFIA personnel, visiting experimenters, and other SOFIA customers to ensure required IT services are delivered and meet program requirements. IT personnel also work closely with project engineers to gather information to ensure required program documentation is complete and accurate.

### ***Status***

SOFIA support is an on-going effort that will continue to demonstrate a successful partnership between Mission Information and Test Systems (Code M) and DFRC mission customers.

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## **Data Management Working Group**

### ***Summary***

The evolution of Dryden Flight Research Center (DFRC) (Edwards, California) information infrastructure must be guided to support the vision and needs of multiple customer groups. The Dryden Data Management Working Group has been established to develop and communicate a consistent enterprise view for data management. Without a formal data management plan (DMP), Center organizations lack direction for the proper management of data.

### ***Objectives***

The objectives of the DMP are to:

- Provide an enterprise-focused approach for DFRC data management applications, infrastructure, and procedures.
- Develop and maintain an improvement and modernization roadmap for DFRC data management architecture.
- Identify and document capability gaps and opportunities within the center for improving end-user productivity via new and improved data management capabilities.
- Maintain cognizance over technology trends related to trustworthy, useful, secure, and reliable data distribution tools and techniques.
- Effectively communicate status, plans, and progress to the Dryden community as appropriate.
- Identify and oversee sub-team related to specific areas of data management.

### ***Approach***

The Dryden Data Management Working Group plans to create a centralized storage infrastructure based around recent investments. The new architecture will not require major changes; however, minor tweaks and data realignment may be needed. Data Management policies and procedures need to be created to set standards and provide guidance to the stakeholders (organizations, projects, contracts, et cetera). This restructuring will allow for a Center wide data management guidance document to be developed. This document will set policies and procedures to govern the current storage architecture (fig. 1). The completed document will set standards and provide guidance for the creation of subordinate Data Management Plans to be written by individuals, organizations, projects, and other DFRC data owners. All DFRC data management plans should align with the Agency IT Enterprise current strategies.

**Current state storage architecture**

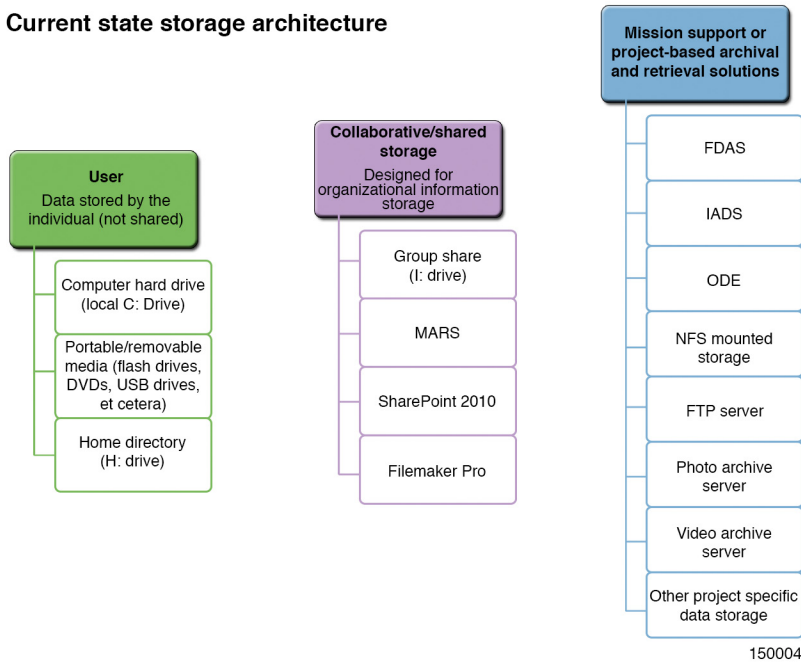


Figure 1. Current storage architecture.

***Status***

The Data Management Working Group meets weekly concentrating on the buildup of the new storage architecture, and processes and procedures to govern the infrastructure. Once the IT infrastructure is ready the stakeholders will join the group that meets weekly on Mondays 2–3 PM. The working group SharePoint site is located at this URL where there are paragraphs describing the status of the research: <https://dfrcshare.ndc.nasa.gov/Orgs/codeM/codeMI/EA/DataMgmt/SitePages/Home.aspx>

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# X-31 Data Curation Challenge

## Summary

The legacy flight data archive for Dryden Flight Research Center (Edwards, California) is the Flight Data Access System (FDAS); a home-grown database for telemetry, and simulation time history storage and retrieval. Research engineers use it as the authoritative source for flight data to be analyzed. FDAS is a suite of FORTRAN-90 programs executing on a Sun Unix (Sun Microsystems, now Oracle Corporation (Redwood City, California) platform. The highly efficient Compressed 4 file format (CMP4), a compression scheme within the FDAS (unrelated to the MPEG video compression scheme) helps maintain a small archive footprint, but not an industry standard, creating long-term sustainability problems.

It has been recognized for a number of years that the combination of loss of software engineering personnel familiar with FORTRAN-90 and maturation of commercial tools force Dryden to clarify and implement a roadmap for long-term curation of Dryden flight data. The dominant commercial product that has been championed for that purpose is the OMEGA Data Environment (ODE) (Smartronix, Hollywood, Maryland). ODE is a post-test data mining tool designed for large datasets typically found in the aerospace research, development, test, and evaluation (RDT&E) industry. ODE has been in use in prototype, pilot, and limited production use at Dryden since 2003.

Recent discussions between the deputy center director and ODE champions focused on the unknown limitations of the ODE environment, and perhaps more importantly, the limitations of Dryden supporting processes and workflows when importing pre-2003 FDAS datasets. Importing hard copies of flight data reports and flight cards, for example, is a feature we have not explored in depth. Other process questions focused on the workload in managing configuration changes in the time history parameter lineup. In particular, the X-31 project (Rockwell International, Milwaukee, Wisconsin, and Messerschmitt-Bölkow-Blohm, now the European Aeronautic Defence and Space Company, Leiden, Netherlands) was characterized by numerous lineup changes.

The deputy center director challenged the ODE advocates to use the X-31 archives (fig. 1) to further explore, validate, and demonstrate how well ODE serves our needs. This challenge is the justification for the initiative described here. Given the obvious overlap between the focus of Information Services (Code MI) here and the interests of the emerging data management council, this initiative is under the auspices of the Enterprise Architecture/Data Management Working Group, and the final report and out brief will be forwarded to the deputy center director after review by the Data Management Council.

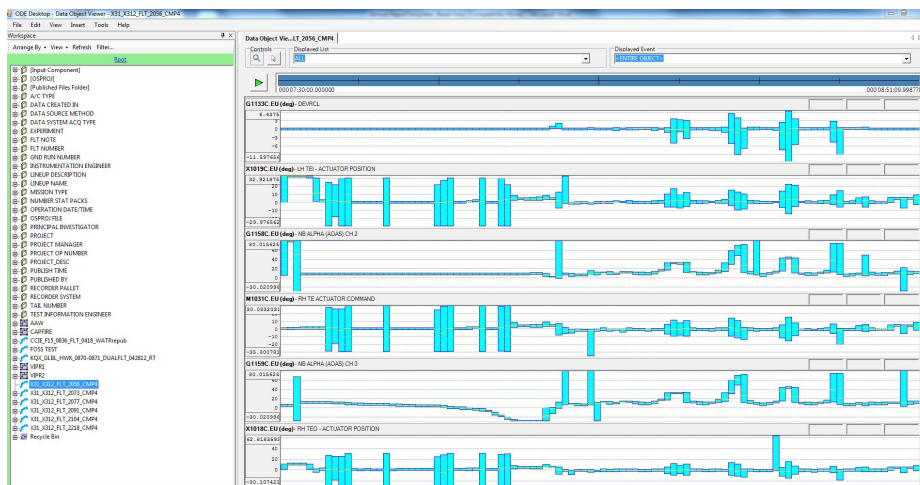


Figure 1. ODE X-31 desktop.



### ***Objective***

The objectives are to:

- Capture and document the CMP4 to ODE data conversion process.
- Document the process of publishing the legacy flight data into the Omega data Environment.
- Perform data quality verification/validation using the available flight cards, strip charts and flight reports to validate approximately 6 published flights.
- Determine the selection and number of flights by the available flight records and Calibration Information Management System (CIMS) files available.
- Identify and mitigate bugs and feature deficiencies.
- Summarize report and recommendations.
- Out brief to the data management council.

### ***Approach***

Information Systems (Code M) branch and Research engineering (Code R) will collaborate on post processing six X-31 flights. This post processing will be done by two groups; the Flight Instrumentation (Code RI) ODE admins will use the Omega Data Environment to process the data; and Code MI will provide the converted CMP4 flights. Range Engineering (Code MC) will process the data natively pulled from the FDAS system. Once the flights have been published by both groups, they will meet and perform a data comparison using MatLab (MathWorks<sup>®</sup>, Natick, Massachusetts). If successful the data analysis should match exactly.

### ***Status***

Information Services (Code MI) has converted six X-31 flights and provided the conversions to Flight Instrumentation (Code RI) ODE admins. The flights have been published, and flight-related metadata is being gathered to enable data verification with Range Engineering (Code MC). Only the CMP4 to ODE script process has been recorded.

This initiative is an as-time-permits project nominally intended to be completed by January 2014. Resources include Code RI, Code MI, and Code MC personnel.

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## Virtual Desktop Infrastructure Demonstration using VMware View

### Summary

Dryden Flight Research Center (DFRC) (Edwards, California) mobile community continues to grow with both bring your own device and U.S. Government-issued mobile devices. Each user experiences different levels of service availability depending on the applications necessary for their job, and no user has full the full functionality of a desktop system. Most users have internet and email access only using applications that are standard load. A virtual desktop environment will allow all mobile users to execute one application that will allow them to reach all applications and services currently available on their desktop computer. Virtual desktop infrastructure (VDI) is the practice of hosting a desktop operating system within a virtual machine (VM) running on a centralized server (fig. 1). VDI is a variation on the client server computing model, sometimes referred to as server-based computing.

### Accessibility

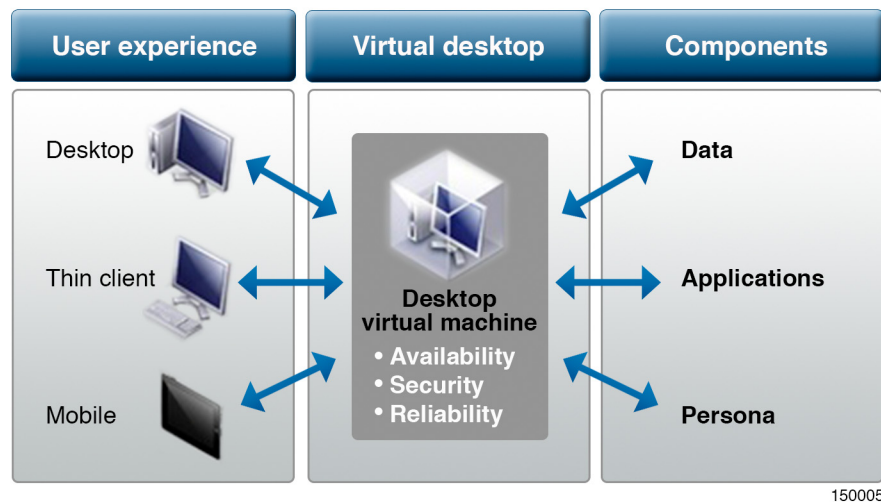


Figure 1. VDI block

### Objective

The objective is to create a virtual desktop infrastructure proof of concept using current VMware (VMware, Incorporated, Palo Alto, California) VSphere datacenter infrastructure. This infrastructure will allow users to access a virtual desktop environment that will enable access to DFRC information technology (IT) services from any IT zone. The first objective is to demonstrate the virtual desktop technology using three mobile platforms, a Windows (Microsoft Corporation, Redmond, Washington) tablet, Apple IOS (Apple Incorporated, Cupertino, California) and Android (Google Incorporated, Mountain View, California) devices using the server based VMware Horizon view. The second phase would be to demonstrate the ability to use mobile devices to connect from the internet public zone using a secure identification (ID) or personal identity verification (PIV) card.

### Approach

The Information Services (Code MI) approach was to:

- Purchase extra mobile devices and install VMware View application on each device.
- Install standalone VMware ESX host.
- Install and configure VMware View using 60-day evaluation licenses.
- Install and configure virtual desktop host for all testers (approximately 15–20 users).
- Develop and execute a test plan.

- Move product to production, if the proof of concept is successful.

### ***Status***

The VDI demonstration was held on technology day, May 29, 2013. This demonstration was a big success; two half hour briefings were held, one at 10:30 am and one at 12:30 pm, each followed by a demonstration using the mobile assets connected to the VMware VDI infrastructure. The proof of concept phase is ongoing involving Information Services (Code MI) and Research and Engineering (Code R).

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## Range Operations

The Western Aeronautical Test Range (WATR) is a network of facilities used to support aerospace flight research and technology integration, space exploration concepts, airborne remote sensing and science missions, and operations of the International Space Station. This branch operates the telemetry tracking systems (fig. 1), space positioning systems, audio communication systems, video systems, mission control center, and mobile systems.

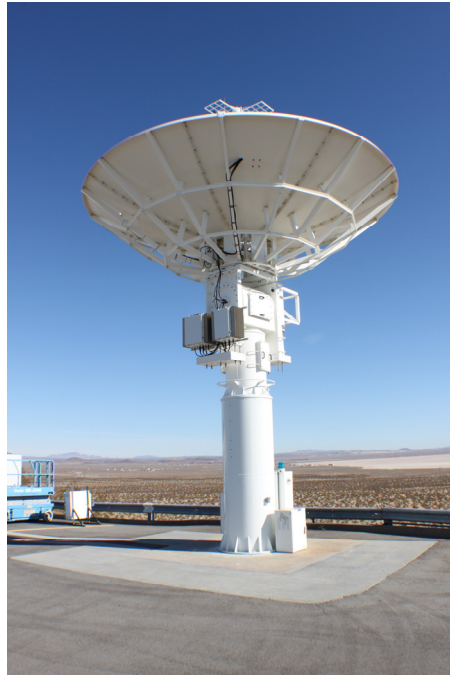


Photo courtesy: NASA/Robert Guere

Figure 1. WATR supports, Edwards Air Force Base airspace, ground sites, and current aircraft.

## Data Distribution Systems

### *Summary*

The data distribution systems (fig. 1) link the Western Aeronautical Test Range (WATR) systems with internal and external support and/or user facilities in support of real-time mission data and monitoring. Capabilities include the WATR video center switching system; the Aeronautical Tracking Facility (ATF)-1 data processing rack, which provides a direct data link to Goddard Space Flight Center (GSFC) (Greenbelt, Maryland); data quality monitoring; Viterbi 1/3 and 1/2 rate decoding; and command uplink modulation processing. Other capabilities provided through the data distribution systems include data distribution patching and fiber infrastructure; a direct T-1 link between Point Mugu Naval Air Station (now Naval Base Ventura County, Point Magu, California) and ATF-1 for radar data transmission/reception; OC-3 fiber link between the Air Force Flight Test Center and the Dryden Flight Research Center (DFRC) (Edwards, California) for telemetry (TM), video, voice, and radar data distribution; National Technology Refresh (NTR) system; and a voice communication distribution system. The WATR group maintained the current capabilities and upgraded the distribution amplifiers.

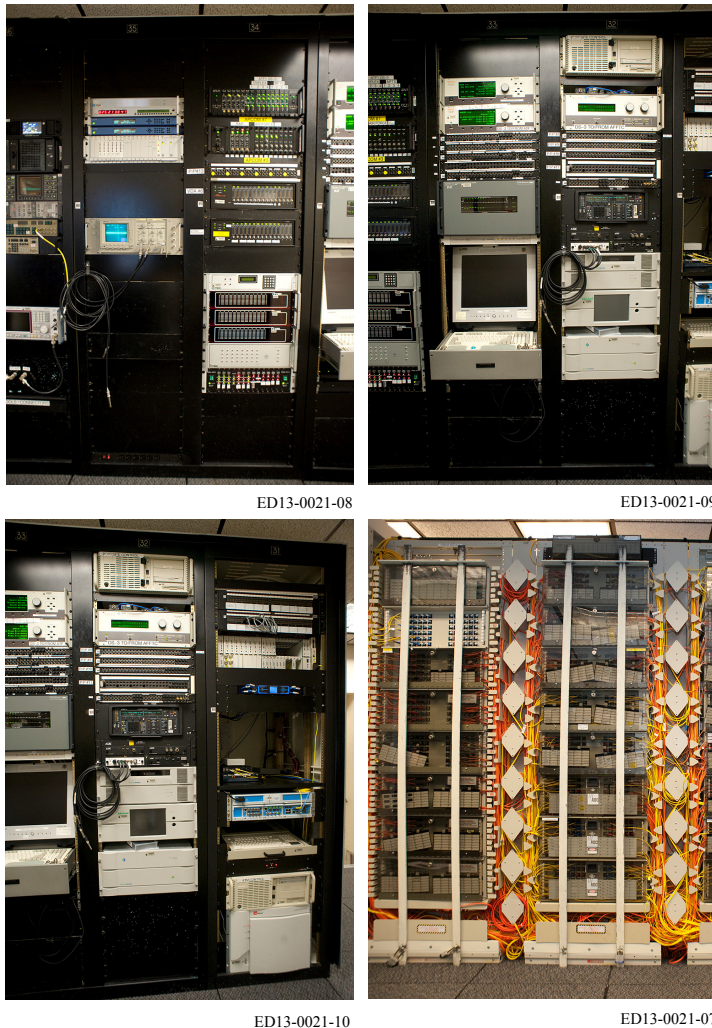


Figure 1. Data distribution racks.

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## Ground Voice Communications Systems

### *Summary*

The ground communications system is supported by Quintron Systems, Inc. (Santa Maria, California) Digital Integrated Communications Electronics System (DICES) communications equipment (fig. 1), handling up to 512 circuits simultaneously. There are two DICES system (nodes) which drive alternate Mission Control Center (MCC) communications panels throughout the MCC for system redundancy. The DICES system has the ability to assign up to 24 circuits at each station. The ground communications network ties together all National Aeronautic and Space Administration (NASA) Western Aeronautical Test Range (WATR) facilities in support of local aeronautical research and space program missions. Additionally, the DICES system is connected to inter-center data and voice links at the Dryden Flight Research Center (DFRC) (Edwards, California) communications facility, allowing connectivity to Goddard Space Flight Center (GSFC) (Greenbelt, Maryland), Johnson Space Center (JSC) (Houston, Texas), and Langley Research Center (LaRC) (Hampton, Virginia). The communications building also hosts a digital mission audio recording system that can record up to 72 channels of audio, and reproduce it in an MP3 format for quick user access. The communication group began engineering the requirements and development plans of the DICES Replacement System scheduled to be completed in 2015.



ED13-0021-06

Figure 1. DICES communication panel.

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## Land Mobile Radio/Emergency Communications

### *Summary*

The Dryden Flight Research Center (DFRC) (Edwards, California) Land Mobile Radio (LMR) and Emergency Communication Center (ECC) group was established this year within The Mission Information and Test Systems Directorate (Code M). The LMR will maintain and operate the mobile communication systems for DFRC, supporting handheld, fixed, and vehicle radios. The ECC communication supports the Center Disaster Response Team within Protective Services (Code J) and then provides the Dryden Emergency Operation Center (figs. 1–3) with communication links to other National Aeronautics and Space Administration (NASA) centers, emergency command centers, and/or disaster and rescue organizations.



Photo courtesy: NASA/Bill McMullen

Figure 1. The Dryden Emergency Operation Center.



Photo courtesy: NASA/Bill McMullen

Figure 2. Interior of Dryden Emergency Operations Center.



Photo courtesy: NASA/Bill McMullen

Figure 3. Exterior of Dryden Emergency Operations Center.

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## Legacy Range Safety Ground Systems

### *Summary*

Range Safety Officers monitor flight-critical data as well as time-space positioning data. The command transmitter systems (CTS) (fig. 1) along with the command panels located in the control room are used for flight termination of errant vehicles.

The Range Safety Ground Systems consist of two pairs of transmitters with multiple command panels for activation; Global Real-Time Interactive Map (GRIM) for situational awareness; legacy and backup support Enhanced Flight Termination System (EFTS) capability; and dual sites for dual mission support requirements.

Improvements and upgrades in Fiscal Year 2012/2013 included the completion of the EFTS install (Phase 1) operational support for the Air Force Test Center (AFTC) and Western Aeronautical Test Range (WATR) EFTS Control Center system (fig. 2).



Photo courtesy: NASA/Robert Guere

Figure 1. Flight Termination System (FTS)/backup EFTS control building.

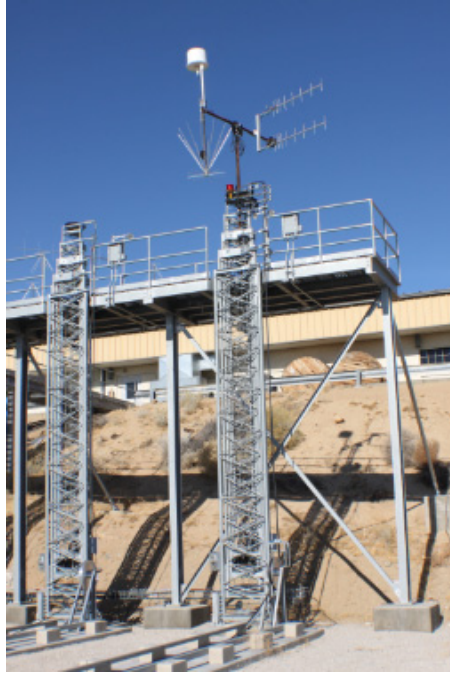


Photo courtesy: NASA/Robert Guere

Figure 2. EFTS Control Center.

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## Real-Time Data Processing/Monitoring Systems

### *Summary*

Data are acquired and merged from multiple sources in various formats to a single, time-correlated, composite stream for processing, distribution, real-time display, and storage archival (fig. 1). Segments of post-mission data are immediately available on portable media. Post-flight radar data are provided in the appropriate engineering parameters. The mobile operations system can process and display data onsite, or reformat data and transmit it to a customer's facility.

The Western Aeronautical Test Range (WATR) Mission Control Center (MCC) (fig. 2) provides real-time mission operations for test conductors, research engineers, range safety, and other project personnel. The MCC is used for monitoring of data for flight safety and mission success with data analysis for in-flight test point clearance.

The real-time data processing/monitoring systems include the following capabilities:

- Capable of up to 6 Pulse Code Modulation (PCM) and custom data streams.
- Capable of up to 3,000,000 samples per second of data.
- Handles both telemetry and radar data.
- Capable of six telemetry streams from 1 to 30 Mbps each.
- Accommodates complex user computational models.
- Provides data archival.

The following improvements and upgrades were noted in Fiscal Year 2011:

- WATR Integrated Next Generation System (WINGS) Cache Data Server (CDS) Replacement.
- Mission Control room video upgrades to high definition video wall.
- Upgraded the Digital Integrated Communications Electronics System (DICES) development and engineering work.



ED07-0093-07

Figure 1. Telemetry Radar Acquisition Processing System (TRAPS) 2.62.



Photo courtesy: NASA/Robert Guere

Figure 2. Mission Control Center 2.

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## RF Communications Systems

### *Summary*

The Western Aeronautical Test Range (WATR) radio frequency (RF) communications system provides the user with a full spectrum of air-to-ground frequency alternatives, to include the HF, VHF, and UHF bands in both AM and FM modulation formats. Users can access the various transceivers using the Digital Integrated Communications Electronics System (DICES) communications panels at any given mission control center (MCC) location. Typically, the MCC has a standard communication panel configuration, giving the user access to five UHF transceivers, two VHF transceivers, and one HF transceiver. Typically, the VHF radios are on omni-directional antennas that operate in the 116 MHz to 152 MHz frequency band. Directional Yagi antennas, operating in the frequency range of 121 MHz to 135 MHz, can be configured for use when greater performance gain is required. The ATF-2 EFTS and mission radios (fig. 1) supports Edwards Air Force base and Dryden Flight Research Center (Edwards, California) unmanned Aerial vehicle (UAV) requirements.

The UHF radios (fig. 1) are normally configured on omni-directional antennas, and operate in the frequency range of 225 MHz to 399 MHz. The standard UHF radio RF power output is 20 watts. However, a long-range UHF system, comprising of a pre-amplifier, external 100-watt power amplifier, and the choice of a high-gain omni-directional antenna or directional tracking (parabolic) antenna is available. An HF transceiver is offered, and is configured to a steerable high-gain log periodic (LP) antenna, operating in the 2 to 30 MHz band, with a transmit output power of 1000 watts. The communications facility has also incorporated two wideband radio systems, operating on any frequency between 2 MHz to 1000 MHz, with AM or FM modulations available, and up to 250 watts of transmit power. Lastly, the communications facility (fig. 2) has integrated four VHF, 500 watt FM transceiver systems used in support of the International Space Station (ISS).

The retractable 80-foot steel tower systems supporting Encrypted Flight Termination systems (EFTS) and tone based system now supports mission UHF and VHF communications. The Flight Termination systems (FTS) within the FTS building and the towers provide the FTS capability to DFRC and Edwards Air Force base.



Photo courtesy: NASA/Bob Guere

Figure 1. EFTS support facility.

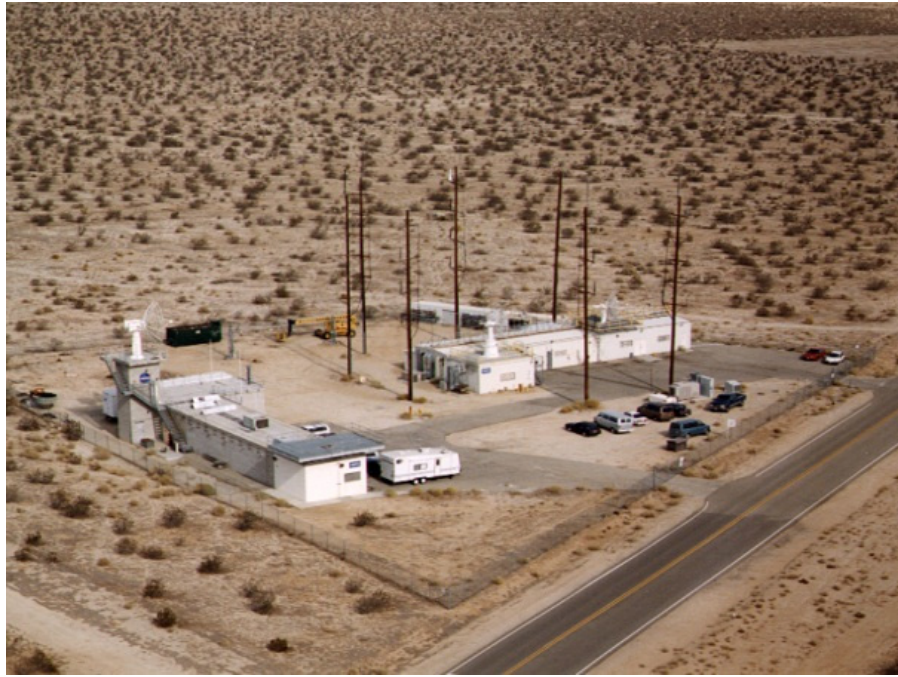


Photo courtesy: NASA/Bill McMullen

Figure 2. Communications facility.

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## Telemetry Systems

### *Summary*

The Western Aeronautical Test Range (WATR) system supports downlink telemetry data and aircraft air-to-ground video. The system provides command uplink for unmanned aerial vehicles (UAVs), remotely piloted vehicles (RPVs), and piloted vehicles. The WATR also supports low earth orbit (LEO) vehicles for data acquisition, uplink commands, voice and video to Dryden Flight Research Center (DFRC) (Edwards, California) control rooms and other National Aeronautics and Space Administration (NASA) mission command centers. The WATR telemetry tracking systems consist of multiple fixed antennas and available mobile systems (downlinked telemetry and video signals in C-, L-, and S-bands; uplinked commands in either L- or S- bands; horizon-to-horizon target tracking; and full on-orbit capability certification (downlinked telemetry may be received in either analog or digital format). Capabilities include two operational 7-meter fixed C-, L-, and S-band tracking stations and one operational 3.7-meter fixed C-, L-, and S-band tracking station (both stations are able to provide support in winds up to 55 mph).

The WATR Telemetry group achieved the following upgrades and improvements: Mobile Operation Telemetry Van replacement (fig. 1). Twelve-month effort to modify, install racks and equipment, install antenna systems on retractable platform (figs. 2 and 3), and transition the system back into operations.



Photo courtesy: NASA/Bill McMullen

Figure 1. MOF-1 Telemetry Support Trailer.



Photo courtesy: NASA/Bill McMullen

Figure 2. Multiple Frequency Tracking System (MFTS).



Photo courtesy: NASA/Robert Guere

Figure 3. Triplex.

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## Time Space Position Information Systems

### *Summary*

The two high-accuracy C-band instrumentation radars (fig. 1) provide time space positioning information (TSPI) of research aircraft and low earth orbiting spacecraft to the mission control center. The targets can be tracked out to 3,000 nautical miles with accuracies to 0.0006 degrees in angle and 30 feet in range. The radar antennas have the capability to accept acquisition data in various formats, record the data onsite, and provide post-flight radar data in engineering parameters. The radars provide coverage for the National Aeronautics and Space Administration (NASA) and the Air Force Test Center (AFTC) (Edwards, California) customer base.

The Differential Global Positioning Satellite (DGPS) ground station (fig. 2) can up-link error corrections to research vehicles. Downlinked GPS embedded in the aircraft telemetry signal can provide positioning information to ground controllers.

Federal Aviation Administration (FAA) radar surveillance data is provided by way of the AFTC and is also available in the mission control center. Capability improvements and upgrades included depot level maintenance, which was completed fiscal year 2011.



Photo courtesy: NASA/Bill McMullen

Figure 1. Radar 34 and 38.



ED13-0021-05

Figure 2. DGPS Station.

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## Video Systems

### *Summary*

Numerous fixed and mobile camera systems are used to acquire mission video for flight monitoring and safety concerns in the Mission Control Center (MCC). Within these systems, one long-range optics (LRO), broadcast-quality, high-definition (HD) and infrared tracking optical system is included. This platform provides both day and night coverage of the local airspace. This system is mounted on a first of its kind Kineto Tracking Mount (KTM) (L-3 Communications Holdings Incorporated, New York City, New York) tracking pedestal, using a fiber optic rotary joint to transport broadcast-quality HD video over 2 km to the Video Control Center (VCC) (fig. 1). Several other standard HD camera systems provide close-up coverage of flight line, ramp, and runway areas during a mission. Mission video is routed to the MCC, and other desired locations, by the use of a digital video switcher. Mobile video vans (fig. 2) cover remote locations and relay live-action imagery via a ground video van utilizing C-band Telemetry (TM) uplink to the WATR telemetry antennas or through a local microwave system for video coverage to the MCC. Downlink video from research or chase aircraft can be received in C-, L-, or S-band frequencies from the telemetry systems and is also available for display into the MCC.

The VCC records and distributes both standard definition analog and HD video via a 208 x 256 Phillips (Eindhoven, The Netherlands) router and a 64 x 64 HD router. Video can be recorded on a variety of formats to include Beta Superior Performance, D2 digital (slow motion viewing), DVD, and HD recorders. All recorded video is available to the end user, copies are archived for a period of 30 days in VCC, then transferred to a long term controlled storage center.

The Western Aeronautical Test Range (WATR) group continues to provide advanced range video capabilities to the Air Force Test Center (AFTC) with Long Range Optics (LRO) (fig. 3), infrared (IR), and ramp HD video. Upgrades were deployed within the third floor foyer and additional HD mission video displays were installed in the MCC areas.



ED13-0021001

Figure 1. Video Control Center (VCC).



Photo courtesy: NASA/Bill McMullen

Figure 2. Mobile video vans.



Photo courtesy: NASA/Bill McMullen

Figure 3. Long Range Optics (LRO).

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## WATR Mobile Operations Facility Systems

### *Summary*

The Western Aeronautical Test Range (WATR) Mobile Operations Center (fig. 1) provides diverse support capabilities and systems. The WATR mobile systems are available for rapid deployment to a specified user location on short notice. These systems provide air to ground communication, telemetry downlink video, and telemetry downlink data. Uplink commands in support of end user test missions outside local airspace boundaries or inside the local support areas where fixed WATR assets are not available.

The WATR mobile operational facilities included the following capabilities:

- 35-ft semi-trailer (fig. 2) equipped with 6-ft telemetry antenna (L-band uplink, L/S-band receiver), Differential Global Positioning System (DGPS), UHF/VHF air-to-ground communications-and intercom systems. Two 4-foot trailer-mounted telemetry (TM) antennas (fig. 3) and one suitcase deployable 4-foot antenna with (L-band uplink, L/S-band receiver).
- Several end user convenience trailers.
- Trailer mounted generators
- Hosted mobile real-time support sites with power and fiber connections.
- End user work areas and short term storage.

The following improvements and upgrades were noted in fiscal year 2012 and 2013:

- Increased the WATR Mobile Operations Center capabilities for project build-up, deployment to include real-time mission support, with communications and fiber connection points.
- Increased interface capabilities (fiber/copper) in support of Air Force Test Center (AFTC) mission support and requirements.



Photo courtesy: NASA/Bill McMullen

Figure 1. Mobile Systems Operations Center.



Photo courtesy: NASA/Bill McMullen

Figure 2. Mobile Telemetry Support Trailer.



Photo courtesy: NASA/Bill McMullen

Figure 3. Mobile Suite Case Telemetry Systems.

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# Western Aeronautical Test Range (WATR) Operational Test

## Summary

The mission of the National Aeronautics and Space Administration (NASA) Dryden Flight Research Center (DFRC) (Edwards, California) Western Aeronautical Test Range (WATR) is to support NASA and Edwards Air Force Base flight operations within the Edwards 2508 Range Complexes and NASA low Earth-orbiting spacecraft when required for data drops and or time space positioning information (TSPI) data. WATR supplies a comprehensive set of resources for the control and monitoring of flight activities, real-time data acquisition and reduction, and effective air-to-ground communication to control room engineers and aircraft ground crews (fig. 1).

Two high-accuracy C-band radar tracking systems provide TSPI data from NASA research aircraft and space orbiting targets to NASA control rooms, and/or other NASA centers. Fixed and mobile telemetry antennas receive real-time data and video signals from the research vehicles, and relay this data to telemetry processing areas providing test vehicle flight data to test conductors and flight engineers. Air to ground audio communications and communication networks support research operations within the 2508 Range Complex for NASA/Edwards Air Force Base flight support and other linked test centers throughout the contiguous United States.

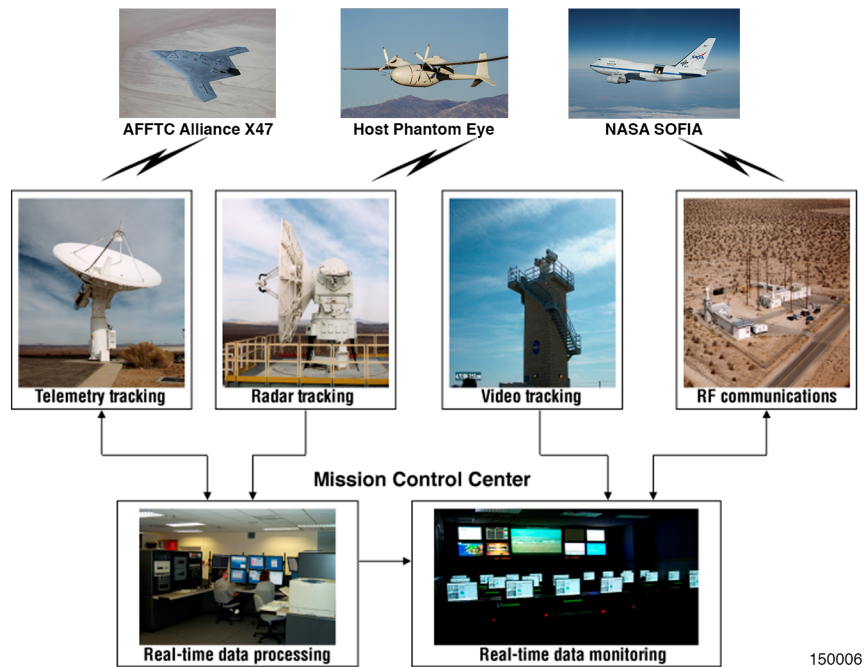


Figure 1. Real-time support configuration options.

## Contact

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## **Consolidated Information Technology Center (CITC)**

The Consolidated Information Technology Center (CITC) provides a secure environment for all of the Dryden Flight Research Center (DFRC) (Edwards, California) consolidated information technology (IT) services. The CITC was designed to lower operating costs, conserve energy and water, be safer and healthier for occupants, and reduce greenhouse gas emissions.

Dryden combined several smaller data centers into the new CITC. This consolidation has already improved the overall reliability of IT service delivery to DFRC customers, having met 100 percent of the uptime metrics in its first year of operation. This energy-efficient Tier III infrastructure has allowed the DFRC to reduce IT operations and maintenance costs while delivering increased value to the DFRC community. Being a Tier III facility, maintenance on electrical and heating, ventilation, and air conditioning (HVAC) equipment can occur without requiring any shutdown of data center computing. Half of the uninterrupted power supplies and HVAC systems supporting the data center can be shut down completely for maintenance, with the data center continuing to operate at full capacity. With this redundant power and cooling, should a one-component failure occur, it will not impact IT service delivery.

The new state-of-the-art facility meets current and anticipated future IT requirements. The building provides energy conservation, recycling, and water efficiency, as well as making the DFRC flight research mission more sustainable by reducing long-term costs of facility operation, minimizing natural environment impacts, and designing work spaces to maximize productivity. This DFRC facility is a certified silver building, a second of four tiers used to describe new Leadership in Energy and Environmental Design, or LEED buildings, as designated by the U.S. Green Building Council.

The CITC is the first green building to be constructed at DFRC. The new building consists of steel-frame, concrete masonry construction, with aluminum and glass wall elements, and perforated metal overhangs. The new facility is in line with Agency-wide goals to consolidate IT resources and building more environmentally sound buildings. The new information technology center is a model for National Aeronautics and Space Administration (NASA) data centers of the future.

### **Communication Services**

- Network (wired and wireless networks, remote Access (VPN), Video over IP, video portal)
- Firewall management
- Cable plant
- Voice (telephones; VoIP, secure phones, analog phones)
- Land mobile radio (LMR)
- Overhead paging
- E911/CER-Center Emergency Response

### **End User Services**

- Computers (PC/Mac/Linux desktop and laptops)
- Mobile devices (cell phones, smartphones, tablets, air-cards/MiFi mobile hot spots)
- Printers (network printers, multi-function devices)
- Other (ACES product catalog, loaner pool, web conferencing, home use software)

### **Direct Mission Support**

- IT systems engineering (IT consulting, IT solutions architects, system security plan support)
- DFRC local service desk



## **Multimedia Services**

- Photography (in flight and standard, production, archive)
- Graphics
- Video (in flight, production, conference room A/V design, archive)
- Reproduction (quick copy services)
- Web team and web designers

## **Data Center Services**

- Hosting (computing services, data storage, virtual machines)
- Housing (Tier 3 center, rack space, cooling, power)
- Value-added services (system administration, lab and engineering seat management, data management and delivery—flight data)

## **Application Services**

- Application development
- Content management
- Application administration

## **Security Services**

- IT security policy
- Assessment and authorizations (security plan management, A&A scheduling and coordination)
- Identity, credential, and access management (NAMS workflow development)
- Monitoring (intrusion detection, incident response)
- Threat vulnerability (vulnerability scanning, patch management)

## **Contact Information**

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## **Research Aircraft Integration Facility (RAIF)**

The Research Aircraft Integration Facility (RAIF) is part of the Aeronautics Test Program (ATP), which ensures that wind tunnels, air-breathing propulsion test facilities, and flight operations services at the National Aeronautics and Space Administration (NASA) are available to government, corporations, and institutions.

The NASA Dryden Flight Research Center (DFRC) (Edwards, California) RAIF provides the ability to seamlessly integrate simulation and vehicle systems under one roof. This one-of-a kind facility can simultaneously support a wide variety of advanced, highly integrated aerospace vehicles through all phases of a research program, from conceptual design to flight.

The RAIF offers high-fidelity six degree of freedom, batch, and real-time flight simulation capabilities. The facility provides support for system integration and closed-loop verification and validation testing of components, systems, and entire vehicles. Also available are complete aircraft ground-support services, including all electrical, hydraulic, and cooling-air systems required for vehicle-system integration, functional checks, and routine aircraft maintenance.

### **Facility Benefits**

- Provides research teams with the means to conduct efficient, thorough testing of advanced, highly integrated research vehicles.
- Provides configurable systems for all facets of a research program including simulation software, hardware, and direct vehicle support infrastructure.
- Provides scalable systems for:
  - Evaluation of design concepts,
  - Piloted or vehicle-and hardware-in-the-loop operations
  - Combined systems testing,
  - System integration and full mission support,
  - Control-room training, mission planning, and data analysis.
- Can be configured to accommodate up to 11 simulation laboratories.
- Can be tailored to support varying access and security requirements within each lab.
- Offers audio, video, and data connectivity to any of the six facility hangar bays as well as to the DFRC Mission Control Center.

### **Facility Applications**

The RAIF has been a critical asset for the successful implementation of some of the nation's most revolutionary and valuable research efforts. These efforts supported a variety of research vehicles that cover subsonic through hypersonic flight regimes, including X-43A(Hyper-X), F-18, F-15, and C-17 aircraft.

### **Data Acquisition and Processing**

- Simulation software capabilities include:
  - High-fidelity, 6-DOF simulation packages,
  - Software simulation package supports both real-time (human-in-the-loop and hardware-in-the-loop) and non-real-time (desktop) operations,
  - Common, configurable software supporting multiple projects,
  - Multiple operating system platforms (Solaris and Linux),
  - Support multiple programming languages (FORTRAN, C, C++,Java, and Ada),
  - Multiview out-the-window graphics with heads-up displays (HUD) and articulated three-dimensional models of flight vehicles,
  - Operable by one person.

- Simulation hardware capabilities include:
  - Dedicated or configurable fixed-base engineering simulation cockpits,
  - Configurable hardware interface units for vehicle-systems integration testing,
  - Common configurable hardware to support multiple projects,
  - Configurable Simulation Electric Stick (SES) and rudder pedal systems,
  - Configurable Cockpit Interface Unit (CIU),
  - Flight hardware interface capability (MIL–STD–1553, ARINC 429, and analog and discrete signals).

### **Characteristics**

- Test bays 1, 2, and 3 provide over 30,000 square feet of hangar space.
- The 225- by 135-ft hangar is accessible through a split 225- by 50-ft door.
- Test bays 4 and 5 provide a total of 12,500 square feet of hangar space.
- Test bay 6 is a single-vehicle bay providing 1000 square feet of hangar space that can be configured to support programs with more stringent security requirements.
- Test bay data and communication connectivity to RAIF simulation labs and DFRC control rooms
- Co-located vehicle maintenance support staffing
- Co-located program and vehicle engineering and technician staff
- Complete vehicle support systems (aircraft cooling, electrical power, and hydraulics)
- Electrostatic Discharge Association (ESD) certified support labs

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## Western Aeronautical Test Range (WATR)

The Western Aeronautical Test Range (WATR) is part of the Aeronautics Test Program (ATP), which ensures that wind tunnels, air-breathing propulsion test facilities, and flight operations services at the National Aeronautics and Space Administration (NASA) are available to government, corporations, and institutions. The following information on the WATR is taken from: [http://www.aeronautics.nasa.gov/atp/facilities/watr/M187017\\_watr\\_508.pdf](http://www.aeronautics.nasa.gov/atp/facilities/watr/M187017_watr_508.pdf) (accessed February 11, 2013).

The NASA Dryden Flight Research Center (DFRC) (Edwards, California) WATR supports aerospace flight research and technology integration, space exploration concepts, airborne remote sensing, and a wide variety of science missions.

The WATR supplies a comprehensive set of resources for the control and monitoring of flight activities, real-time acquisition and reduction of research data, and effective communication of information to flight and ground crews.

### Facility Benefits

- Precision radar provides time space positioning information (TSPI) on research vehicles, the International Space Station (ISS), and other targets, including satellites.
- Fixed and mobile telemetry antennas receive real-time telemetry data and video, and have the capability to transmit uplink commands to research vehicles.
- The processed data is displayed at the engineering stations in the mission control center and archived in a post-flight storage area.
- Audio communication networks support aeronautics research and space operations in the WATR, covering a broad frequency spectrum for transmitting and receiving voice communications and flight termination signals for unmanned aerial vehicles.
- Video monitoring provides real-time and recorded data for the control and safety of flight test missions.

### Facility Applications

The WATR supports aerospace flight research and technology integration, space exploration concepts, airborne remote sensing and science missions, as well as the ISS operations.

### Characteristics

#### *WATR Mission Control Centers*

- 26 test engineering stations in MCC1 and 19 in MCC2 including:
  - Communications (radio and intercom) panels.
  - Video monitors.
  - Weather data.
  - IRIG-B timing.
  - Specialized graphics displays.
- Range and mission control, test operations, range safety and test director consoles provide critical analysis and display capabilities.

#### *The WATR mobile systems*

- Available for rapid deployment to a specified location on short notice. These systems provide:
  - Radio-frequency communication.
  - Video and telemetry-tracking support.
  - Telemetry tracking for test missions outside local airspace boundaries.
  - Uplink commands to research vehicles.

### ***Data Acquisition and Processing***

Data is acquired and merged from multiple sources in various formats to a single, time-correlated, composite stream for processing, distribution, real-time display and storage archival. Segments of post-mission data are immediately available on portable media. Post-flight radar data can also be provided if reverted. The mobile operations system can process and display data onsite, or reformat data and transmit it to a customer's facility.

### ***Telemetry***

WATR telemetry tracking systems consist of:

- Multiple fixed antennas and available mobile systems.
  - Downlinked telemetry and video signals in C-, L-, and S-bands.
  - Uplinked commands in either L- or S-bands.
  - Track targets from horizon to horizon.
  - Certified for full on-orbit capability. Downlinked telemetry may be received in either analog or digital format.

### ***Communications***

- Extensive Range Intercommunication system (DICES System) consisting of:
  - Over one hundred 24-channel communications panels.
  - Interconnects with commercial telephone systems.
  - Links to military ground-communication networks.
  - Links to multiple other NASA centers.
  - Extensive ground-based fiber optics.
  - Interface with the RF communications system.
- Radio Frequency (RF) communications include:
  - More than 30 ultra-high-frequency (UHF) transceivers.
  - 3 UHF high gain Omni antennas.
  - 3 UHF parabolic dish directional antennas.
  - More than 10 very-high-frequency (VHF) transceivers.
  - 4 VHF high gain antennas.
  - 2 high frequency (HF) transceiver systems with high gain log antenna.
  - 2 broadband (100–1000 MHz, AM & FM) transceivers.
- International Space Station (ISS) emergency communications system comprised of:
  - 2 ISS VHF FM transceivers.
  - 2 Soyuz VHF FM transceivers.
  - 6 VHF directional antennas.

### ***Flight Termination Systems***

- 4 UHF IRIG/ EFTS flight termination systems.
  - 4 FTS high gain Omni antennas.
  - 4 FTS high gain directional antennas.

### ***RADAR***

- Two high-accuracy, C-band instrumentation radars.
- Track targets out to a distance of 3,000 nautical miles with accuracies to 0.0006 degrees in angle and 30 feet in range.

### ***Video***

- Numerous fixed and mobile camera systems for flight monitoring, safety and mission control.
- Long-range, broadcast-quality, high-definition optical system providing day and night (including infrared) coverage.
- Coverage of the flight line, ramp areas, and runways.

- Mobile video vans

- Capability to relay live-action imagery via microwave links.
- Capability to relay live action imagery via ground video van C-Band TM uplink.
- Downlinked video from research vehicles or chase aircraft can be received in C-, L-, or S-band frequencies.
- Video recording is provided on Super VHS, Beta Superior Performance, DVD, and other high-definition media.

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## **NASA/Edwards Air Force Test Center Range Alliance**

The objective of the National Aeronautics and Space Administration (NASA)/Air Force Test Center (AFTC) memorandum of understanding (MOU), signed in 2003, was to develop and sustain a working alliance between the Air Force Flight Test Center (now Air Force Test Center), NASA Dryden Flight Research Center (DFRC) (Edwards, California), and the Air Force Research Laboratory, Propulsion Directorate (AFRL/PR), located at Edwards Air Force Base (AFB), while preserving the unique mission responsibilities and capabilities of the three organizations. The long-range vision is to provide a national flight research and flight test center to serve the national needs in the most cost-effective, competent, and timely manner possible. The purpose of the MOU is to establish and cultivate a trilateral, cooperative, beneficial working relationship between the AFTC, NASA/AFRC, and AFRL/PR in a mutual alliance operation at Edwards AFB to improve service, and lower cost to internal and external customers of all parties.

The following are benefits of the alliance for fiscal year 2012 and fiscal year 2013: AFTC requirements for radar coverage, long range video support, high gain UHF/VHF radios for real-time flight operations were accomplished through the Range Alliance. The DFRC provides the only radar tracking capability at the Edwards Flight Test Range. Projects that required these assets were the Global Hawk (Block 40), Euro Hawk, X-47, Avenger, Multi-Platform Radar Technology Insertion Program (MP-RTIP), Airborne Laser Test Bed (ALTB), JSF, F-22, JSTARS and other small projects. A recurring cost avoidance for AFTC from not having to pay for operations and maintenance cost of a radar capability is \$450,000 per year.

There are several DFRC projects that have a requirement to analyze and display vehicle parameters in real time. DFRC was able to procure a site license through the alliance for a tool developed for the AFTC, the Interactive Analysis and Display System (IADS), at a substantially reduced cost. The DFRC realizes a recurring cost avoidance of \$187,500 for the software maintenance and also in the reduction in staff that are not needed to develop and maintain an in-house application. DFRC has been using this tool substantially since fiscal year 2006 and anticipates continuous use.

Through the alliance, the AFTC and DFRC developed the next generation flight termination system with the development of the Enhanced Flight Termination System (EFTS) digital encoder, monitor and encryption/decryption unit. The EFTS team is currently in the process of developing the final implementation of an EFTS capability that will support both the AFTC and DFRC for unmanned vehicle flight and research testing. The final capability is called the Advanced Command Destruct System (ACDS).

The reduction of AFTC Range Safety Officer positions was made possible by close collaboration between the two Range Safety Offices of AFTC and DFRC. This Recurring cost avoidance for AFTC was \$75,000 in fiscal year 2012 and fiscal year 2013.

Table 1. NASA/AFTC Range Alliance.

Project	Aircraft type	Operation type	
Air Force	ABL	Ground test/flights	Telemetry support, range control, DICES, long-range optics, local flight A2508 data to 412th mission control rooms. (mission canceled)
Air Force	X-47	Ground test/flights	Telemetry support, range control, DICES, long-range optics, local flight A2508 data to 412th mission control rooms.
Air Force	757	Test flight	F-22 Avionics test bed, N757A, Air Force Plant 42, Palmdale, California, 5 flights, radar TSPI support, Plant 42 over Edwards A2508 air space.
Air Force	A-10	Test flight	Range control, dual radar TSPI support, communication nets, local flight within A2508.
Air Force	B-1	Ground test	Long range optics, ramp camera 17, low speed/ high speed runway, upgraded brake system functional testing.
Air Force	B-2	Test flight	Telemetry support, range control, DICES, long-range optics, local flight A2508 data to 412th mission control rooms. (mission canceled)
Air Force	F-15	Test flight	Radar support, range control, communication nets, long-range optics, local flight, taxi, takeoff and landing.
Air Force	F-16	Test flight	Telemetry support, range control, DICES, long-range optics, local flight A2508 data to 412th mission control rooms. (5 missions supported)
Air Force	F-22	Test flight	Radar data enhancement system (Radar), range control, communication nets, Navy Sea Range Radar data to 412th Mission Control rooms. (5 missions supported)
Air Force	F-35	Test flight	Long range optics, ramp cameras, taxi takeoff, landing video support to 412th mission control rooms. (8 missions supported)



Table 1. Continued.

Air Force	JSTARS		Flight	Radar, RF communication, communication nets, MOF 4 mobile telemetry, range control, A2508 flights, navy radar jamming test. (2 missions supported)
Air Force	SpaceShip 2		Flight	Range control, radar, RF communication, communication nets, long range optics, video to 412th mission rooms, radar tacking to low earth orbit, civilian aircraft. (2 missions supported)
Air Force GH CTF	Global Hawk		Test flight	Range control, radar, RF communication, communication nets, long-range optics, video to 412th Mission rooms, radar tacking, local flights and off range deployment.
BWB	X-48	Experimental unmanned aerial vehicle (UAV) for investigation into the characteristics of blended wing body (BWB) aircraft, a type of flying wing.		Range control, receiver rack, telemetry, RF communication, enhanced flight termination, long-range optics, ramp cams, TV vans. (39 flights 7 ground test)
CISBoomDA	F-18	Sonic boom reduction testing.		Range control, TRAPS, mission control room, dGPS, radar, telemetry, RF communication, long-range optics, ramp cams.
Dream Chaser	Dream Chaser	Access to space vehicle	62 missions supported	Range control, duel TRAPS, mission control room, range safety, radar, RF communication telemetry, FTS, EFTS, long range optics, ramp cams.
FaINT	F-18	Low-supersonic, high-altitude flight profiles during the Farfield Investigation of no boom threshold.		Range control, TRAPS, mission control room, dGPS, radar, telemetry, RF communication, long-range optics, ramp cams. (24 mission supported)
FAST	F-18	Full Scale Advanced Systems Testbed (FAST) reducing fuel consumption during cruise flight conditions.		Range control, TRAPS, mission control room, dGPS, radar, telemetry, RF communication, long-range optics, ramp cams. (16 missions supported)
GASPS	F-15	Images of supersonic shockwaves emanating from aircraft.		Range control, dGPS. (2 missions supported)

Table 1. Continued.

G-III	No A/C type	Gulfstream (G-III) business jet, modified and instrumented as a multi-role cooperative research testbed, flight research experiments.	Range control, TRAPS, RF communication nets. (3 missions supported)
G-III ACTE	G-III	Advanced flexible trailing-edge wing flaps to improve aircraft aerodynamic efficiency and reduce airport-area noise.	Range control, TRAPS, mission control room, dGPS, radar, telemetry, RF communication, long-range optics, ramp cams. (22 missions supported)
G-III SCRAT	G-III	Subsonic Research Aircraft Testbed, or SCRAT	Range control, TRAPS, mission control room, dGPS, radar, telemetry, RF communication, long, video distribution. (16 missions supported)
Global Hawk	Global Hawk	Airborne science platform within the Earth science division, supports science and advance the use of satellite data.	Range control, radar, RF communication long-range optics, video distribution. (26 missions supported)
Ikhana	Ikhana	Remotely piloted General Atomics Predator B aircraft, serves as an aeronautical research aircraft to the Earth sciences community.	Range control, WYE 122. (28 mission supported)
ISS	Space vehicle	International Space Station or a habitable artificial satellite in low-Earth orbit, a modular structure launched in 1998.	Range control, radar, communication nets. (12 missions supported)
LVAC	F-18	Launch Vehicle Adaptive Control F-18 experiment, Adaptive Augmenting Controller for Space Launch Systems.	Range control, TRAPS. (42 missions supported)
MUTT	X-56A	The Multi-Use Technology Testbed, is a small unmanned aircraft test technologies for lightweight, flexible aircraft.	Range control, TRAPS, range safety, telemetry, RF communication, FTS, long range optics, video distribution. (66 missions supported)

Table 1. Concluded.

PEYE	Phantom Eye	Boeing Phantom Eye is a high altitude, long endurance (HALE) unmanned aerial vehicle liquid hydrogen-powered aircraft.	Range control, dual TRAPS, mission control room, range safety, radar, RF communication telemetry, EFTS, long-range optics, ramp cams. (37 missions supported)
SBLT2	F-15	Supersonic Boundary Layer Transition research flights on the NASA Dryden F-15B Research Testbed aircraft	Range control, TRAPS, dGPS, mission control room, radar, RF communication telemetry, long-range optics, ramp cams, video distribution. (57 missions supported)
SOFIA	747	Stratospheric Observatory for Infrared Astronomy (SOFIA) is a joint project of NASA and the German Aerospace Center (DLR) to construct and maintain an airborne observatory.	Range control, dGPS, communication nets. (33 missions supported)

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## 2012-2013 Awards, Recognition, and Conference Papers

### NASA Medals, 2012

***Exceptional Service Medal (ESM)***

Dennis daCruz

***Exceptional Engineering Achievement Medal (EEAM)***

Robert Downing

***Early Career Achievement Medal (ECAM)***

Michael Hill

***Exceptional Achievement Medal (EAM)***

Russell Leonardo

***Exceptional Service Medal (ESM)***

Joseph Lopko

***Exceptional Engineering Achievement Medal (EEAM)***

Michael Yettaw

### NASA Medals, 2013

***Exceptional Engineering Achievement Medal (EEAM)***

Russell James

***Exceptional Achievement Medal (EAM)***

Michael Nesel

***Exceptional Engineering Achievement Medal (EEAM)***

Benjamin Pearson

***Early Career Achievement Medal (ECAM)***

David Spivey

### NASA Medal, Group Achievement Awards, 2012

***DFRC Critical Chain Project Management Core Team***

Sonja Belcher, Darryl Burkes, Ken Norlin, Desiree Sylvia

***DFRC Shuttle Communications and Outreach Team***

Jaimie Baccus, Tim Burt, Dennis Calaba, Monroe Conner, David Faust, Tim Fisher, Al Guajardo, Monica Hoffman, Todd Kunkel, Tony Landis, Angela Lasley, Robert Law, Marcos Lopez, Lori Losey, Justine Mack, Charlie Neptune, Steve Parcel, Lincoln Pardue, Tim Peters, Theresia Pettit, Hector Rodriguez, James Ross, Jim Round, Brian Soukup, Greg Strombo, Carla Thomas, Tom Tschida, Mary Whelan, Donna White

***Mars Science Laboratory DFRC Team***

Tracy Ackeret, Sonja Belcher, Lori Losey, James Pavlicek, Emily Peterson, Marlin Pickett, Jeffrey Ray, Jim Ross, Barbara Salisbury, Carla Thomas

***Space Shuttle Operations, Landing, and Post-Flight Support Team***

Jason Abueg, Tracy Ackeret, Jon Batchelor, Rich Batchelor, Jovany Bautista, Gregg Bergman, Doug Boston, Kevin Bryant, Daniel Burgdorf, Tim Burt, Jennifer Campbell, Richard Chambers, Richard Courtois, Anne Crowell, Ryan Daily, Kevin Dolber, Rick Dykstra, Andrew Fortunato, Al Guajardo, Robert Guere, Joe Innis, David Jones, Robert Jones, Marcos Lopez, Lori Losey, Samantha McGovern, Bill McMullen, Tim Miller, Stacey Hendy, Antonio Moreno, James Pavlicek, Emily Peterson, Robert Racicot, Pat Ray, Brady Rennie, Hector Rodriguez, Richard Rood, James Ross, Jack Sheldon, Greg Strombo, Leigh

Ann Szymczak, Carla Thomas, Guy Thomas, Justin Thomas, Jesse Vazquez, Miguel Vigil, Mike Webb, Jennifer Yasumoto, Michael Yettaw

***The Sonic Boom Team***

Tracy Ackeret, Marlin Pickett

***NICS Communications Contract Transition Team***

**NASA Medal, Group Achievement Awards, 2013**

***Dryden Shuttle Delivery, Media and Family Day Team***

Jason Abueg, Tracy Ackeret, Stephanie Allison, Haig Arakelian, Jaimie Baccus, Richard Batchelor, Jovany Bautista, Sonja Belcher, Gregg Bergman, Doug Boston, Zach Bowen, Daniel Burgdorf, Tim Burt, Dennis Calaba, Richard Chambers, Greg Coggins, Monroe Conner, Dawn daCruz, Dennis daCruz, Ryan Daily, Rick Dykstra, David Faust, Tim Fisher, Andrew Fortunato, Doug Garvin, Yvonne Gibbs, Al Guajardo, Denise Harris, Jaime Herrera, Elizabeth Higgins, Perry Hogan, Joe Innis, Robert Jones, Todd Kunkel, Robert Law, Marcos Lopez, Lori Losey, Justine Mack, Gus Marmolejo, Frank Mazzeo, Samantha McGovern, Tim Miller, Antonio Moreno, Todd Mostyn, Jeff Nelms, Rodger Nelson, Charlie Neptune, Steve Parcel, Lincoln Pardue, Jorge Paredes, Tim Peters, Robert Racicot, Pat Ray, Brady Rennie, Hector Rodriguez, Jim Ross, Jim Round, Roberta Sherrard, Karla Shy, Steve Simison, Brian Soukup, Greg Strombo, Leigh Ann Szymczak, Carla Thomas, Guy Thomas, Justin Thomas, Tom Tschida, Steve Unander, Jesus Vazquez, Miguel Vigil, Michael Webb, Rich Wheaton, Mary Whelan, Donna White, Kim Yapching, Jennifer Yasumoto

***Global Hawk Support/ARC***

Carl Baccus

**NASA Letter of Appreciation**

NICS Support of Endeavour Ferry Flight

**Dryden Peer Awards, 2012**

***Mission Support: Information Technology***

Craig Sayler, Arcata

***Mission Support: Other Support Services***

Carla Thomas, Arcata

***Pride in NASA (PIN) Award***

Jack Sheldon, Arcata

***Technician/Mechanic***

Robert Novy, NASA

***Teamwork Award: Small Unmanned Aerial Vehicles Auto Ground Collision Avoidance System***

Gayle Patterson and Ben Pearson, NASA

***Unsung Hero Award***

Michael Nesel, NASA

**Dryden Peer Awards, 2013**

***Create Your Own Award: The Good Samaritan***

Stacey Hendy, Arcata

***Mission Support: Information Technology***

Greg Coggins, NASA  
John Lockwood, SAIC

***Pride in NASA***

Lincoln Pardue, SCSC  
Debbie Phillips, Arcata

***Teamwork Award***

Ikhana DB-110 Test Team  
Dan Burgdorf and Jesus Vazquez, Arcata; Russell James, Rich Rood, and Greg Strombo, NASA

***Unsung Hero***

Tracey Pardue, Arcata

**Arcata Associates Spot Awards**

Richard Batchelor, Jovany Bautista, Doug Boston, Daniel Burgdorf, Tim Burt, Anne Crowell, Richard Courtois, Ryan Daily, Rick Dykstra, Joe Fernandez, Andrew Fortunato, Al Guajardo, Shruti Iyer, Todd Kunkel, Marcos Lopez, Antonio Moreno, Kelly Perez, Tim Peters, Robert Racicot, Pat Ray, Brady Rennie, Barbara Salisbury, Steven Simison, Jesus Vazquez, Miguel Vigil, Keith Wesson, Jennifer Yasumoto

**Arcata Associates Certificates of Appreciation**

Jason Abueg, Jovany Bautista, Daniel Burgdorf, Kevin Dolber, Jules Ficke, Dalton Leach, Steve Parcel, Brady Rennie, Craig Sayler, John Wong

**Arcata Associates Customer Satisfaction Award**

Brandon Banks, Sonja Belcher, Zach Bowen, Tim Burt, Dennis Calaba, Greg Cole, Monroe Conner, Ben Delgado, Kevin Dolber, Gary Edwards, David Faust, Elizabeth Higgins, Randall Johnson, Todd Kunkel, Ryan Lazarony, Dalton Leach, Daniel Lehan, John Lockwood, Lori Losey, Justine Mack, Gus Marmolejo, Frank Mazzeo, Trevor McMahon, Ray New, Tustin Norris, Mariela Ortega, Steve Parcel, Tracey Pardue, Jorge Paredes, Tim Peters, Theresia Pettit, Debbie Phillips, John Pitre, Eric Rand, Brady Rennie, Jim Round, Barbara Salisbury, Joel Sasse, Craig Sayler, Steven Simison, Desiree Sylvia, Guy Thomas, Tom Tschida, Ken Ulbrich, Miguel Vigil, Joe Walters, Keith Wesson, Donna White, Jesse Zamarripa

**Customer Letters of Appreciation to Employees of Arcata Associates**

Jaimie Baccus, Travis Barnett, Rich Batchelor, Jovany Bautista, Sonja Belcher, Doug Boston, Daniel Burgdorf, Tim Burt, Jennifer Campbell, Rich Chambers, Monroe Conner, Ryan Daily, John Dandurand, Joe Fernandez, Tim Fisher, Andrew Fortunato, Doug Garvin, Al Guajardo, Denise Harris, Elizabeth Higgins, Joe Innis, Todd Kunkel, Rob Law, Marcos Lopez, Lori Losey, Gus Marmolejo, Frank Mazzeo, Tim Miller, Ray New, Steve Parcel, Kelly Perez, Tim Peters, Theresia Pettit, John Pitre, Robert Racicot, Pat Ray, Brady Rennie, Hector Rodriguez, James Ross, Jim Round, Craig Sayler, Steven Simison, Brian Soukup, Desiree Sylvia, Leigh Ann Szymczak, Carla Thomas, Tom Tschida, Ken Ulbrich, Jesus Vazquez, Mary Whelan, Donna White, Brenda Williams, Jennifer Yasumoto, Jesse Zamarripa

**SAIC Awards**

09/24/12 – Kudos from TMR (Rich Wheaton)–NICS staff for support during Shuttle Family Day  
NASA Letter of Appreciation–Support of Endeavour Ferry Flight:  
Haig Arakelian, Dawn daCruz, Jaime Herrera, Perry Hogan, Todd Mostyn, Rodger Nelson & Kim Yapching

Customer Recognition via email:

Haig Arakelian, Carl Baccus, John Haenny, Jaime Herrera, Perry Hogan, John Lockwood, Bobby Montez, Todd Mostyn, Rodger Nelson

11/13/12 – Peer Recognition via email from Leigh Ann Szymczak – NICS team for their support during the Gateway transition

11/13/12 – Customer Recognition via email from CIL (Russell Leonardo) – NICS team for their support during the Gateway transition

11/20/12 – NASA Group Achievement Award – Dawn daCruz for the NICS Communications Contract Transition Team

04/24/13 – Recognition from SOFIA to deputy CIO (Ken Norlin) – Greg Cole and Jaime Herrera on their assistance with SOFIA flight operations

08/22/13 – Customer Recognition via email from Denise Harris – NICS Network and Cable Plant teams for supporting SharePoint classes in the DLC

### **Newspaper/Newsletter Articles**

Upgrades Increase Capabilities, July 2013

[http://www.nasa.gov/centers/dryden/news/X-Press/mcc\\_renovations.html#.Um6cLrZgN7Y](http://www.nasa.gov/centers/dryden/news/X-Press/mcc_renovations.html#.Um6cLrZgN7Y)

### **News Releases**

NASA Dryden Hosts Mars Science Laboratory Exhibit, July 2012

<http://www.nasa.gov/centers/dryden/news/NewsReleases/2012/12-15.html#.Um6dsbZgN7Y>

NASA Hosts Social Media Event to Welcome Endeavour to California, August 2012

<http://www.nasa.gov/centers/dryden/news/NewsReleases/2012/12-22.html#.Um6ekLZgN7Y>

NASA'S SOFIA to Embark on New Cycle of Science Observations, August 2012

<http://www.nasa.gov/centers/dryden/news/NewsReleases/2012/12-24.html#.Um6eyrZgN7Y>

### **Conference Papers Published in 2012**

Monica Hoffman, Earl Allen, John Yount, and April Norcross, “Positional Awareness Map 3D (PAM3D),” ITC 12-10-02, presented at the International Telemetry Conference, San Diego, California, October 25-28, 2012.