



Commercial Space Activities at Goddard Space Flight Center

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Commercial Space at Goddard

- Goddard has been involved in Commercial Space for over 30 years
 - During this time period, every Goddard spaceflight mission has included at least one major element for which industry was responsible, be it the spacecraft, an instrument, the science, or the launch vehicle.
 - Rapid Spacecraft Development Office
 - Commercial Utilization of Integration & Test Facilities
 - Commercial Payload Partnerships/Rideshares
 - Technology Infusion to Industry
 - Technology Transfer
 - Satellite Servicing
- Goddard's Wallops Flight and Independent Verification & Validation facilities also involved in commercial activities that expand upon involvement with industry in spaceflight

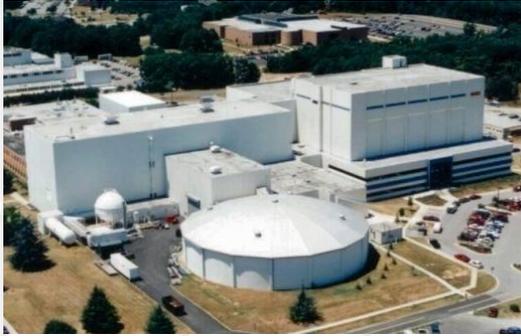
Rapid Spacecraft Development Office

- Originated in 1997
- Government-wide procurement vehicle
- Goal: to develop a rapid and flexible spacecraft procurement process that leveraged industry's commercial practices and processes
- Brief summary of procurement activities under the three Rapid Catalogs:
 - Rapid I: QuickScat, QuickToms, Coriolis, IceSat, and Swift spacecraft
 - Rapid II: The NPP, GLAST and LDCM spacecraft and Glory Cloud Camera
 - Rapid III: JPSS-1(NPP Clone) and ICESat-2 spacecraft
- First RSA Contract – Rapid I (1997 – 2000)
 - FAR Part 15 – Commercial-like Acquisition
 - Firm Fixed Price
 - Indefinite Delivery/Indefinite Quantity
 - Commercial-like
 - Reduced government reporting and review requirements
 - General acceptance of contractor development process
 - Emphasis on government insight
- Second RSA Contract – Rapid II (2000 – 2008)
 - FAR Part 12 – Commercial Acquisition
 - Firm Fixed Price
 - Indefinite Delivery – Indefinite Quantity
 - Fully commercial acquisition process
- Current RSA Contract – Rapid III (2010 to 2015)
 - Returned to FAR Part 15
 - Firm Fixed Price
 - Indefinite Delivery – Indefinite Quantity
 - Leverage commercial practices and processes when possible
 - NASA mission assurance, environmental verification, and engineering 'Best Practices' requirements

Commercial Utilization of Facilities

- The NASA contract allows the support service contractor to offer the NASA/GSFC Integration and Test Facilities to commercial (non-NASA) customers.
- Main objective: level the workload during times of fluctuating project work and demand in the Integration and Testing Facility.
- Over 30 non-NASA customer have processed and qualified their flight hardware through this program since it's inception by performing over 140 successful environmental tests in the past 12 years.
- Over \$750,000 has been returned to NASA for use of the facilities and the cost of approx 50 FTE's have been reduced from various NASA contracts over the years.

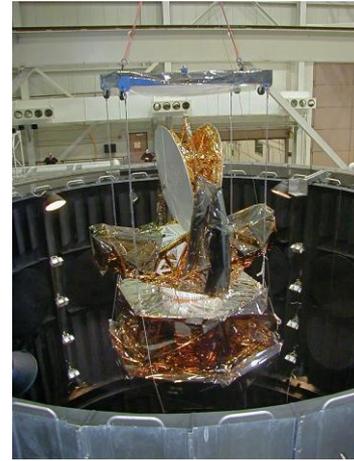
Integration and Test Complex



I & T Complex
Buildings 7, 10, 15 and 29



Acoustic Test
Facility



WMAP Loading into
the SES TV Chamber



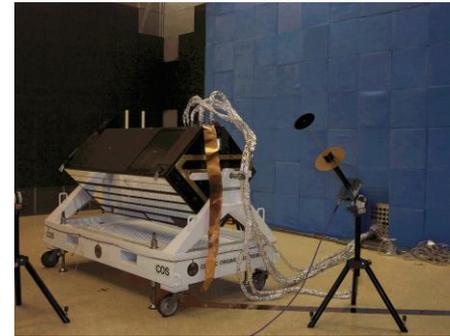
GPM Qualification Unit on
the High Capacity
Centrifuge



Spacecraft Systems
Development and
Integration Facility



Universal Static Test
Facility



HST/COS in the Large
Electromagnetic
Compatibility Test Facility



Space Simulation
Laboratory

Benefits to NASA & Private Industry

- Assists in retaining the 'core-competency' of the workforce when the workload has been less than desired and the potential for reduction in staff was being considered.
- Consistently 'lowers' the cost to NASA flight programs for each integration and testing activity by sharing the 'fixed' yearly cost of staffing, maintaining and operating the facility over a larger number of tasks.
- Contributes financially to NASA by way of a reimbursement payments (i.e. rental of facility, civil servant oversight, maintenance and NASA overhead).
- Allows multiple customers access to the 'world-class' integration and testing facilities for their flight hardware qualification programs.

Commercial Payload Partnerships/Rideshares

With increasing cost/decreasing availability of launch vehicles, and to leverage resources, Goddard is looking at commercial partnerships for science and technology payloads.

- GSFC was part of early exploration of this concept
 - Early 1980s – Leasecraft was to be a privately owned space platform built by Fairchild on which industrial and Government customers could rent slots for payloads. Issues of liability and insurance hindered the project's development, although later successful missions built on Leasecraft's concept of modularity and serviceability.
 - TDRS 1-6 – Contract had government leasing the satellite services from Western Union. Government was to use the satellites for 7 years at both Ku and S Band and then turn over to Western Union to use a Ku Band and C-band commercial service. Ultimately, NASA chose to negotiate out the commercial services.

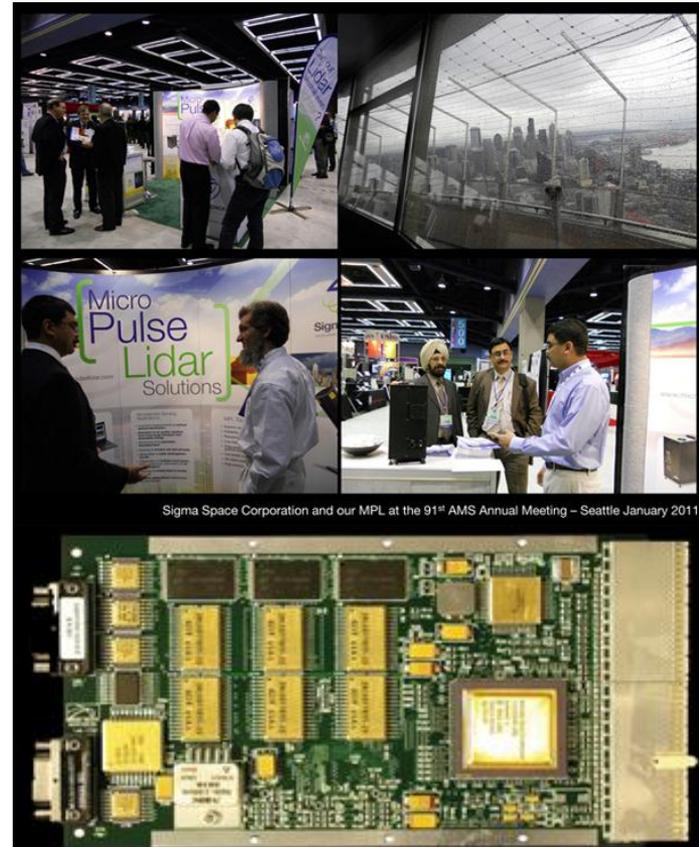
Commercial Payload Partnerships/Rideshares (cont'd)

- Recent Commercial Collaborations
 - On April 10, 2012, Space Systems/Loral (SS/L) announced it would team with Goddard to host a laser communications relay demonstration (LCRD) on a commercial satellite to be launched in 2016. NASA's Space Technology Program selected Goddard's mission proposal to use the SS/L satellite platform to help enable the next era of space communications.
 - Proposed Cryosphere Dynamics Explorer (CryoDynE) mission is an innovative partnership that leverages Goddard science and engineering experts, the advanced radar developers of Northrup Grumman, and a DragonLab spacecraft and Falcon 9 launch contributed by SpaceX. CryoDynE would provide high spatial and temporal resolution data complementary to that which will be produced by the NASA ICESat-2 mission and document motions associated with natural hazard events as a precursor to 2020's era missions such as DESDynI. While not selected in recent EV-2 AO, GSFC looking for ways to re compete mission.

GSFC Office of Technology Transfer (OTT)

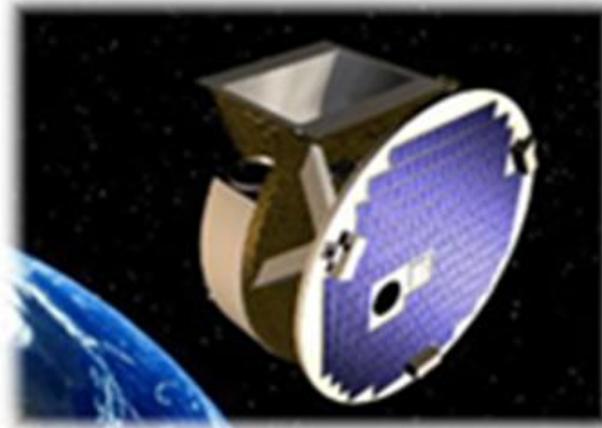
Technology transfer is an important part of the mission at NASA's Goddard Space Flight Center. Goddard's OTT is responsible for:

- Seeking out Goddard research and development that can potentially meet industry and national needs
- Documenting newly developed technologies
- Patenting Goddard-developed inventions
- Promoting Goddard technologies, facilities, and capabilities to potential partners
- Negotiating partnership agreements for technology transfer



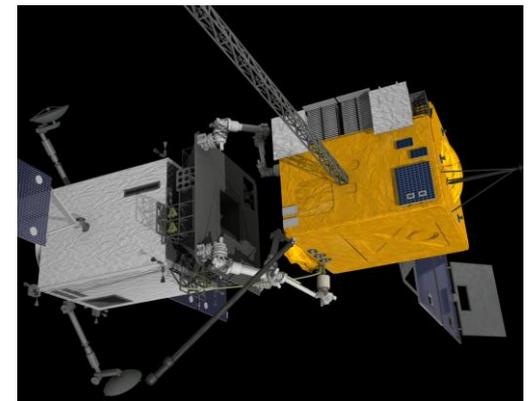
Representative Technology Transfers

- Design America Inc (DAI) – facilitated licensing Advanced System for Integration and Spacecraft Test (ASIST) for commercial applications and Space Link Extension-Return Channel Frames (SLE-RCF) and Command Link Transmission Unit (SLE-CLTU) for the development of mission control protocols for managing space telemetry data.
- Sigma Space – transferred the Micro-Pulse Laser Radar (MPL) used to generate atmospheric optical properties in real time.
- Broad Reach Engineering – NASA copyright licenses of GPS Enhanced Onboard Navigation System (GEONS) that provides high-accuracy real-time spacecraft position
- The Hammers Company (tHC) – NASA exclusive Copyright license of Integrated Test and Operations System (ITOS) used for applications with large amounts of data that needs to be received, processed, monitored, and have the ability to communicate with other devices.

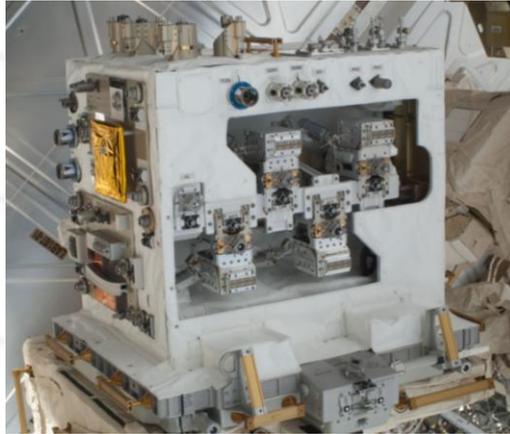


Goddard Satellite-Servicing Activities: Enhancing Flexibility for Government and Industry

- Multiple government and commercial entities have expressed the need for satellite-servicing in geosynchronous Earth orbit
- For commercial robotic satellite servicing to take flight, two factors must be resolved:
 - The Risk Factor
 - Fully robotic satellite servicing to an operational satellite has never been attempted
 - Pathfinder mission to an operational satellite needed to establish technology capability
 - The Business Case
 - Need right combination of private and public support to make business case close
 - Must balance capabilities with viable customers
- Goddard is working to energize/stimulate/enable the development of a domestic and commercial capability in robotic satellite servicing by infusing technology, capital, and the investment of government resources to reduce the risk and close the business case



*Notional Servicing Vehicle
Refueling a Customer Satellite*



RRM is an International Space Station (ISS) experiment designed to demonstrate and test the tools, technologies, and techniques needed to robotically refuel and repair satellites in space – especially satellites not designed to be serviced.

- Joint effort with the Canadian Space Agency's Dextre robot on ISS
- Launched to ISS in July 2011 on STS-135, the last shuttle mission
- Dextre performed the most intricate task ever attempted by a space robot
- Houses several commercial interfaces that are directly applicable to the satellites built and operated in the commercial sector including a launch adapter interface that is representative of payloads delivered to orbit on Atlas and Delta launch vehicles. Also several models of commercial spacecraft fill/drain valves that represent a wide spectrum of Satellite currently in operation.
- Refueling demo scheduled for August with subsequent demonstrations continuing through 2013 and beyond

Commercial Space at Wallops Flight Facility

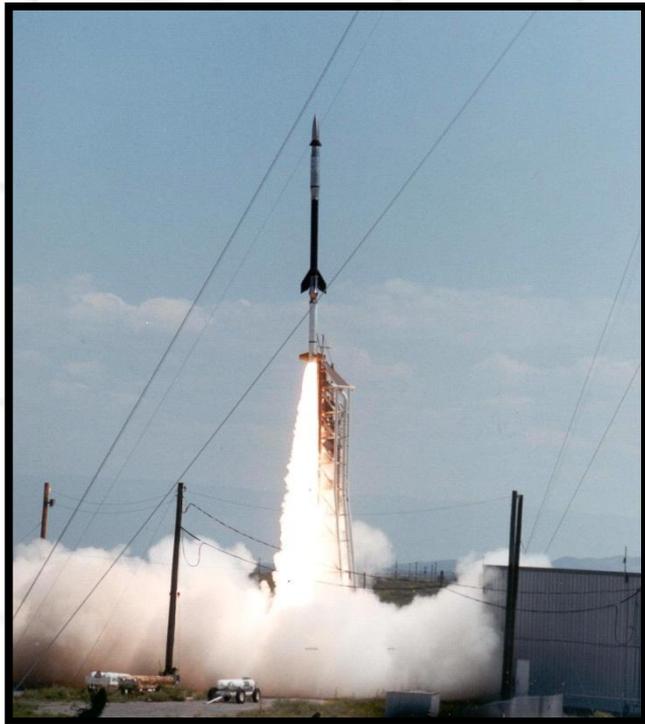
- Wallops has an extended history of supporting commercial space and aviation dating from the 1980's
 - 1st commercially licensed launch (+ 5 subsequent missions, from WSMR)
 - 6 licensed orbital launches + 10 more in queue
 - Support of commercial aviation testing since the 1980's
- Recent & current activities include:
 - Orbital Sciences: Serving as Antares launch site
 - SpaceX: Downrange tracking for recent COTS Falcon 9 flight. Antenna testing, GPS testing, NASA-developed Autonomous Flight Safety System flown on Falcon 1
 - Kodiak Launch Complex: Range safety personnel & WFF Mobile Instrumentation services
 - Nanoracks: Discussions concerning commercial use of WFF lab for processing of late-access cargo
 - Ventions LLC: Range services for development flight of nanosat launcher. Suborbital demo planned for 2012.
 - Whittinghill Aerospace: Range services for development flight of nanosat launcher. Suborbital demo planned for late 2012/early 2013.
 - Suborbital Reusable: Preliminary planning with several emerging sRLV companies
- Due to the low-cost, responsive nature of its NASA projects, Wallops has an extended history and is particularly well-suited technically and culturally to enable small, emerging aerospace companies.

Areas of Support to Commercial Aviation & Space Launch Industry at Wallops

- **Launch Range**
 - Launch approvals, facilities, range safety, tracking & data services, recovery, logistics, emergency services, public affairs
- **Integration and Testing**
 - Clean rooms, vacuum chamber, antenna patterning, EMI chamber, vibration testing, spin balancing, GPS testing
- **Engineering Expertise**
 - Flight termination systems, fin design, avionics designs, space-based communications & safety systems
- **Research Airport**
 - Runways, hangars, and other airfield services
- **Wallops Research Park**
 - Real estate, institutional services, and airfield access

Supporting Commercial Space at Wallops

- Consort 1, the very first FAA-licensed commercial mission (3/29/89), was launched from WSMR, supported by GSFC/WFF-provided I&T, tracking, & launch facilities.
 - Consort 1's Starfire rocket was based on the suborbital Black Brant rocket developed by the GSFC/WFF-managed Sounding Rocket Program
 - Wallops facilities and services supported six additional Starfire 1 commercial missions for Space Services Inc. (eventually EER Systems)
 - Several of these missions were part of a NASA voucher program in the mid-1990's to incubate the commercial launch industry



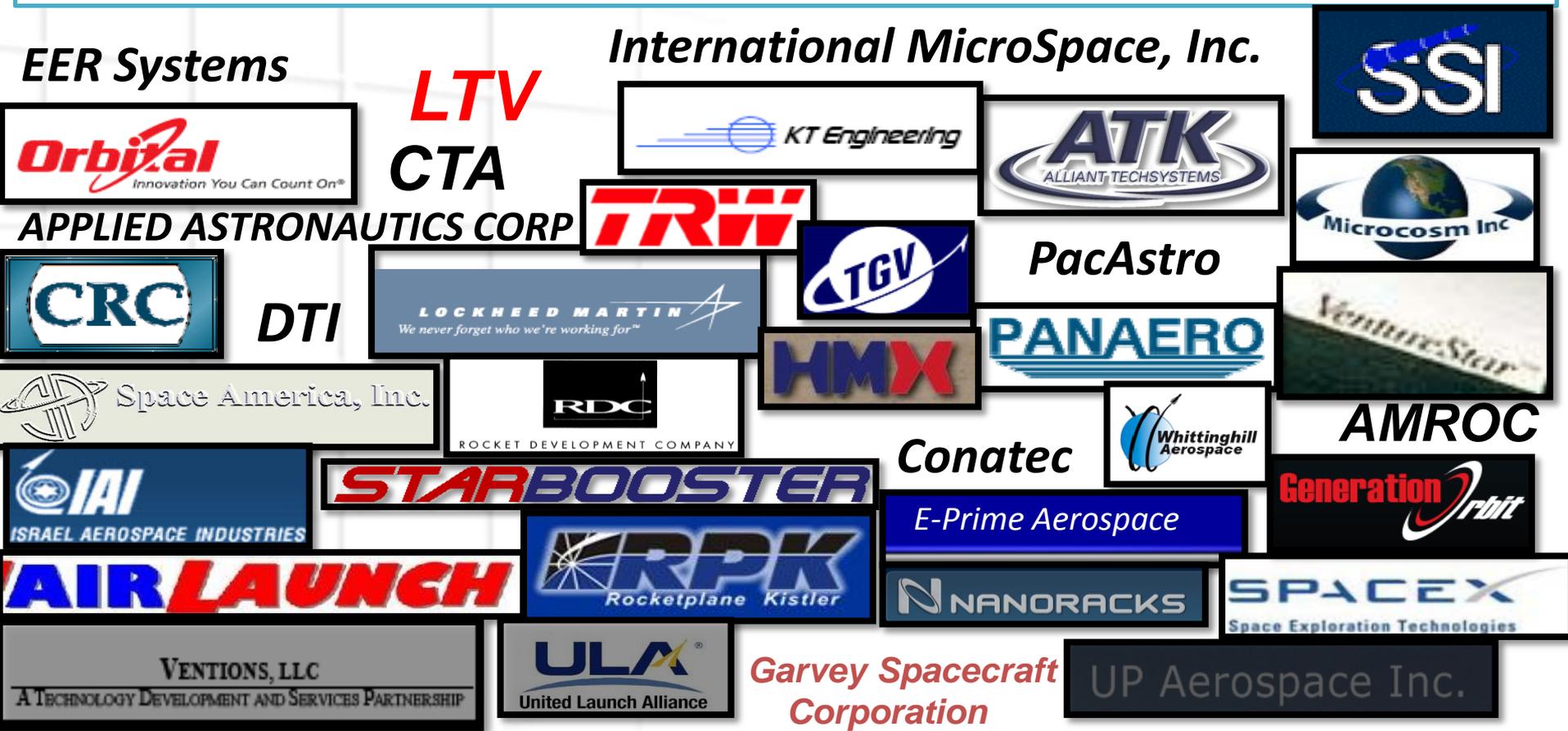
Supporting Commercial Space at Wallops



- Wallops served as lead-range for six commercial Orbital Sciences Corp. Pegasus missions
 - Initial mission, SCD-1, launched on 2/9/93
 - Includes MiniSAT, launched from the Canary Islands in 1997, supported by the Wallops Mobile Range
- Wallops served as launch site for EER Systems' Conestoga launch vehicle
 - NASA's COMET/METEOR project, launched in 1995 using the Conestoga, was another NASA initiative to incubate the commercial space industry
 - A precedent-setting Space Act Agreement allowed EER to develop a commercial launch complex on NASA property

Supporting Commercial Space at Wallops

- Wallops has substantially collaborated with/supported more than 35 different commercial space companies over the last two decades
 - Principally vehicle developers
 - Lower-level collaborations with several dozen additional companies



Commercial Airfield Support

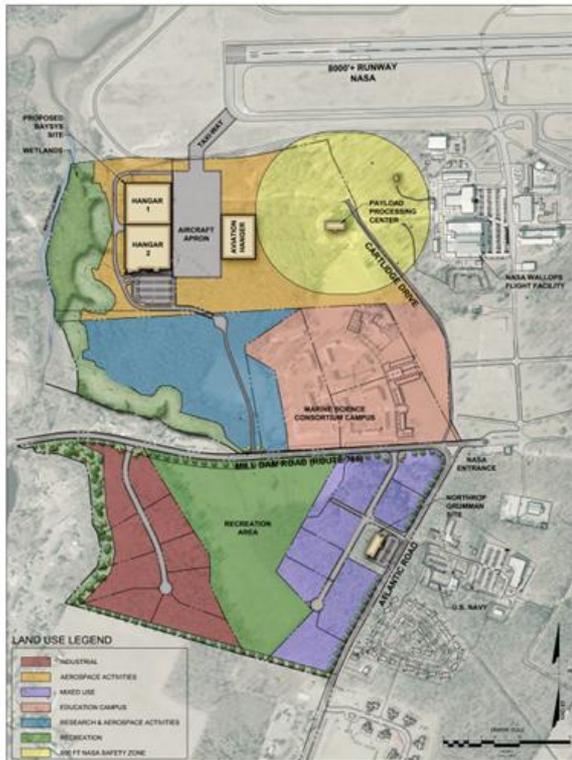
- Water Ingestion Testing
 - Commercial aircraft certification by FAA requires aircraft developers to prove wet runways will not adversely affect engines
 - Wallops Research Airfield is one of few U.S. locations capable of providing water ingestion testing
 - Testing provided ~once/year since the 1980's
- Airfield also supports other commercial-use research (e.g., landing systems, tire design, noise)
- Aircraft Basing
 - Facilities able to support commercial reusable launch vehicle companies (e.g., XCOR, Virgin Galactic) in future



Wallops Research Park (WRP)



- NASA has contributed ~67 acres toward a 240 acre land parcel, adjacent to Wallops (outside of security perimeter)
 - Partnership with Accomack County & Marine Sciences Consortium (12 university coalition)



- WRP land designated to accommodate business, light industrial, & educational institutions affiliated with NASA & tenants performing
 - Commercial aircraft modifications
 - Unmanned aerial systems development
 - Launch vehicle & spacecraft development/operation
 - Science/technology research & education
- Virginia recently budgeted \$4M for connecting taxiway to Runway 10/28 to enable dual use of Wallops airfield

Wallops Partnership with VA Commercial Space Flight Authority



- In 1992, Wallops organized a coalition of interested industry and local government representatives to leverage NASA/Wallops launch capabilities for commercial space launches
 - Coalition led to formation of the Virginia Commercial Space Flight Authority (aka Mid-Atlantic Regional Spaceport)
 - Precedent-setting Space Act Agreements with VCSFA enabled use of NASA buildings and services, and brought tens of \$M of non-NASA investment to establish two commercial launch complexes at Wallops
 - Agreements enable VCSFA to serve as an easy gateway to integrated VCSFA/NASA services at Wallops for commercial users
 - VCSFA capabilities also enable support of non-commercial missions (e.g., NASA's Lunar Atmosphere & Dust Environment Explorer) via a NASA/Wallops contract

- Orbital Sciences announced selection of Wallops as their Antares launch site in 2008
 - Followed >1 year of quiet technical/financial negotiations with NASA/Wallops & Commonwealth of Virginia (pre-dating COTS)
 - Joint-offerings of NASA/Wallops & VCSFA were key
 - Commercial Antares missions (e.g. COTS/CRS) conducted via VCSFA's Space Act Agreements with NASA
- Antares has become another anchor customer for the Wallops Research Range
 - 2-3 missions expected annually
 - Expected to also support non-commercial NASA/DoD missions
- Orbital's selection led NASA to invest in upgrade of Wallops Range capabilities
 - New rocket Horizontal Integration Facility, upgrades to spacecraft processing/fueling facilities, and modernization of range instrumentation
 - NASA investments will benefit many government & commercial range users



NASA IV&V's Commercial and Non-Traditional Work



- New York City's Office of Emergency Communication (OCEC) Emergency Communications Transformation Program (ECTP) Stage 2
 - ECTP is the consolidation of services, systems and operations provided by the NYC Police Department and Fire Department, which includes Fire Dispatch and Emergency Medical Dispatch
 - The IV&V project is planned to begin at the end of July 2012 and will have a project size of 18 NASA engineers/analysts for up to 3 to 5 years.
- Commercial Orbital Transportation Services (COTS) missions to the ISS
 - IV&V performed an assessment of the IV&V performed by Odyssey Space Research for both SpaceX and Orbital Sciences Corporation (OSC)
 - The objective was to assess the effectiveness of the commercial software IV&V services provided to assure the safety of the ISS. The IV&V findings were used to request additional evidence of assurance from both SpaceX and OSC.
- Goddard Mission Services Evolution Center (GMSEC)
 - Agreement between the United States Air Force Space Development & Test Directorate (USAF SD&T) and NASA GSFC for Multi-Mission Satellite Operations Center Support.
 - IV&V is responsible for providing independent analysis and information assurance guidance.
- Autonomous Flight Safety System
 - Joint NASA WFF/KSC project to develop an autonomous on-board range safety system that can augment or replace the functions of the traditional human-in-the-loop system.
 - IV&V led preliminary hazard analysis for the system and is performing an independent software assurance assessment.
 - The purpose of the project is to foster a commercial source for a qualified, commercially available Autonomous Flight Safety System (AFSS).

Goddard Space Flight Center has a long history of involvement with commercial space, and we continue to leverage our assets and relationships with industry partners to expand and enhance our missions.

QUESTIONS?

BACKUP

Integration and Test Facility Commercial Customers

Major Customers:

- Merrimac Industries
- Northrop Grumman
 - ATK Space
 - Orbital Sciences
- Johns Hopkins University/ Applied Physics Lab
- National Highway Transportation Safety
 - EarthWatch / Digital Globe
- Naval Research Laboratory
 - Rockwell
 - General Dynamics
 - Boeing

<u>Type</u>	<u>Number of Tests</u>	<u>Average Duration/days</u>
Vibration	31	2
Acoustic	9	2
HCC	3	15
EMI	13	4
Mag	6	3
Thermal Vacuum	27	10
Bakeout/Temp Cycling	53	7

Commercial Servicing Technology Developments

	Commercial Service		
	Remote survey	Towing	Refueling
Goddard Technology Development	Autonomous Rendezvous and Docking Test	Robotic capture of satellite via advanced gripper tools	Hose Management System (Ground Test); Robotic Refueling Mission on International Space Station
Commercial Benefit	Visual diagnostics of satellite anomalies	Relocate customer satellite to desired location, preserving onboard fuel for continued operations	Extension of satellite life

