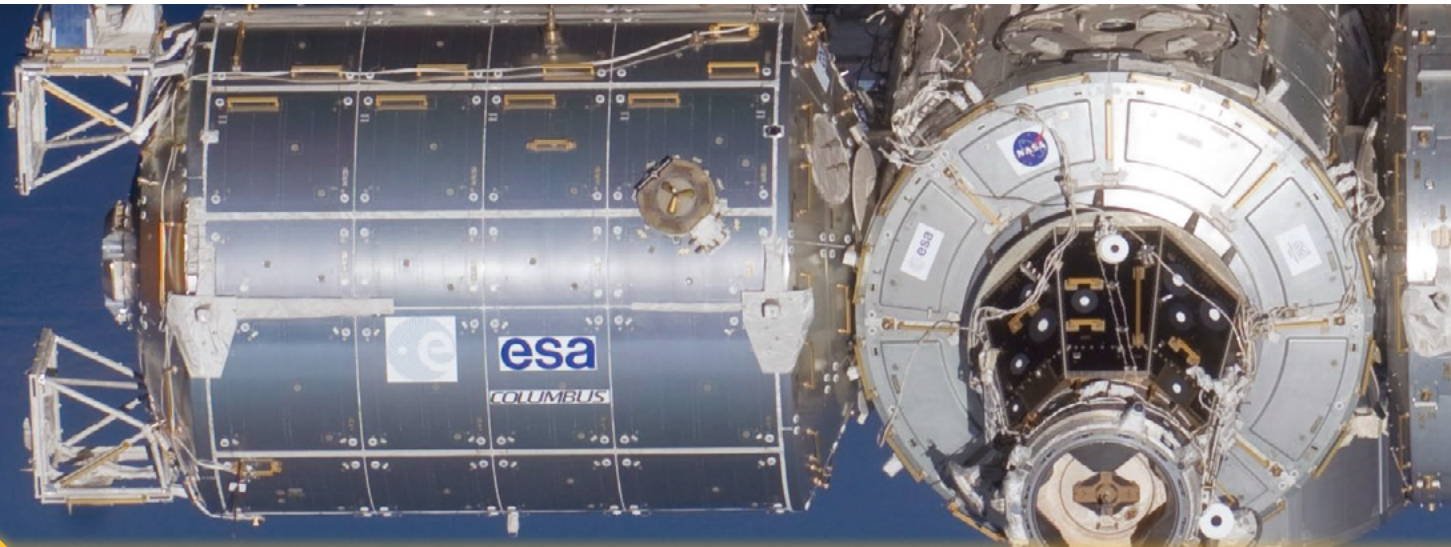




Human Spaceflight Operations





Human Spaceflight Operations

GSOC has started with Human Spaceflight Operations in the beginning of the 1980's with the preparation of the STS-9 (Spacelab-1, FSLP) shuttle mission which used the European Spacelab module for the first time. Hence, GSOC has the most long-lasting experience with human spaceflight operations in Western Europe.

ISS Missions

- Eneide, STS-134, May - June 2005
- Astrolab, Thomas Reiter, Expedition 13/14, July - December 2006
- Columbus, since 2008
 - 1E, Hans Schlegel, STS-122, February 2008
 - 1E, Leopold Eyharts, Expedition 16, February - March 2008
 - OasISS, Frank De Winne, Expedition 20/21, May to December 2009
 - Alissé, Christer Fuglesang, STS-128, August - September 2009
 - MagISStra, Paolo Nespoli, Expedition 26/27, December 2010 to May 2011
 - DAMA, Roberto Vittori, STS-134, May - June 2011
 - PromISSe, André Kuipers, Expedition 30/31, December 2011 to July 2012
 - Volare, Luca Parmitano, Expedition 36/37, May to November 2013
 - bluedot, Alexander Gerst, Expedition 40/41, May to November 2014
 - Futura, Samantha Cristoforetti, Expedition 42/43, November 2014 to May 2015

- iriss, Andreas Mogensen, Expedition 44, September 2015
- Principia, Tim Peake, Expedition 46/47, November 2015 to June 2016
- Proxima, Thomas Pesquet, Expedition 50/51, November 2016 to June 2017
- vita, Paolo Nespoli, Expedition 52/53, July 2017 to December 2017
- horizons, Alexander Gerst, Expedition 57/58, June 2018 to December 2018
- Beyond, Luca Parmitano, Expedition 60/61, July 2019 to February 2020
- alpha, Thomas Pesquet, Expedition 65/66, April 2021 to November 2021
- cosmic kiss, Matthias Maurer, Expedition 66/67, November 2021 to May 2022
- minerva, Samantha Cristoforetti, Expedition, 67/68, April to October 2022
- Huginn, Andreas Mogensen, Expedition 69/70, August 2023 to February 2024
- ATV, 2008-2015
 - ATV-1 Jules Verne, March to September 2008
 - ATV-2 Johannes Kepler, February to June 2011
 - ATV-3 Edoardo Amaldi, March to October 2012
 - ATV-4 Albert Einstein, June to November 2013
 - ATV-5 Georges Lemaître, July 2014 to February 2015

Point of Contact

German Aerospace Center (DLR)
Space Operations and Astronaut Training
Dieter Sabath
Münchener Straße 20, 82234 Weßling

Phone: + 49 8153 28 2494
E-Mail: Dieter.Sabath@dlr.de

DLR.de/RB



Shuttle Missions

- STS-9, Spacelab 1 (FSLP), 1983
- STS-61A (Spacelab D1), 1985
- STS-55 (Spacelab D2), 1993
- STS-59, X-SAR 1, 1994
- STS-99 (X-SAR/SRTM), 2000

Mir Missions

- MIR'92
- EUROMIR'95
- MOMS, 1996
- MIR'97



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Publisher

German Aerospace Center (DLR)
Spacecraft Operations and Astronaut Training
Münchener Straße 20, 82234 Weßling

Photos

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Fig. 2-1 DLR GSOC in Oberpfaffenhofen

2. Location & Assets

2.1 Building 140 & 133

Our Human Spaceflight Operations are run at the DLR site at Oberpfaffenhofen. The site is located near the A96 motorway between Munich and Lindau and is home to ten scientific institutes and currently employs approximately 1,800 people. About 100 scientists and engineers look after the European activities in the International Space Station ISS from there and represent the direct connection to space.

The Mission Control Centers are located inside the buildings of the German Space Operations Center (GSOC) at Oberpfaffenhofen (GSOC-OP) – buildings 140-1, 140-3, 140-4 and 133 (see Figure 2-2).

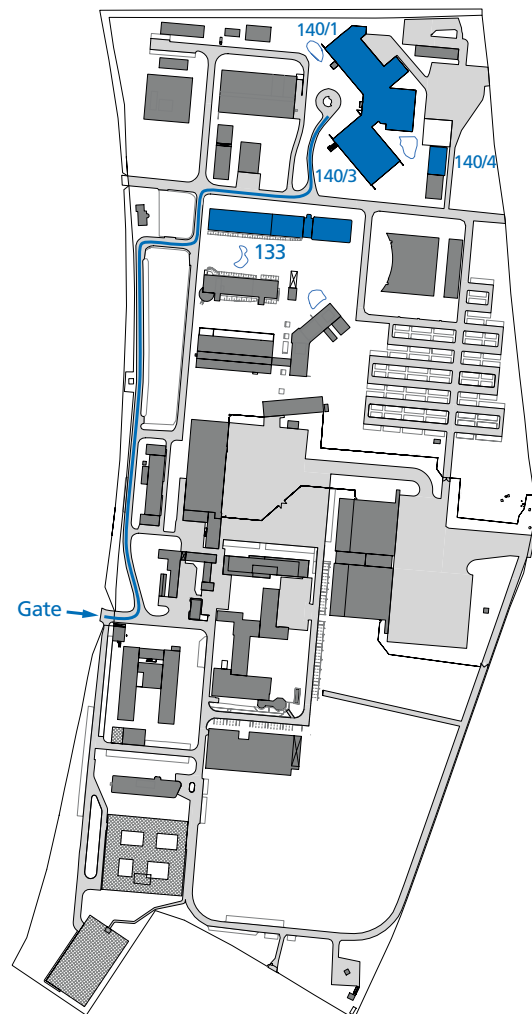


Fig. 2-2 GSOC Mission Control Centers (in blue)



2.2 Control Rooms

2.2.1 Flight Control Rooms

Control room K4



Fig. 2-4 Col-CC mission control room K4

Control room K3

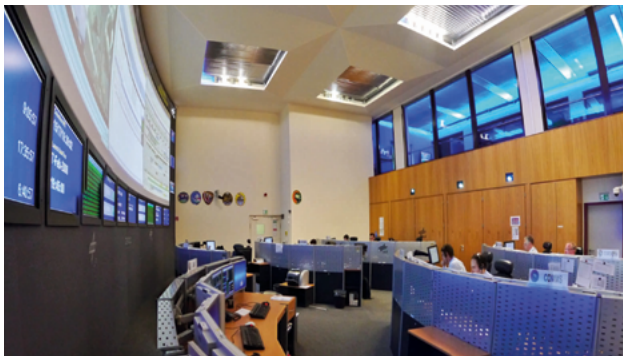


Fig. 2-5 Col-CC mission control room K3

Control room K11



Fig. 2-6 GSOC mission control room K11

▶ A detailed description of the Control Rooms can be found in the module „[Satellite Operations – GSOC Infrastructure](#)“.



2.2.2 Ground Control Rooms

Ground Operations Control Room (GoCR)



Fig. 2-7 Ground Operations Control Room (GoCR)

The backup servers of the Col-CC are (per ESA requirement) maintained in a physically separate building. This building also houses some backup components for Multi-Mission projects. The remaining backup components are accommodated in the same area as the main components.

2.2.3 Server Area

The Columbus Systems are mostly self-standing systems used solely for human spaceflight (a detailed description can be found further down below). However, the systems are integrated in the GSOC environment and networks. Software systems are virtualized to the extent possible and are hosted on the common GSOC virtual environment.

To ensure a one failure tolerance most systems are redundant with physical separation in the prime server rooms of GSOC and in the back-up system area in the separate building.



2.3 Simulation Facilities

2.3.1 Columbus Simulators

For training and operations preparation there are several simulators for Columbus or major subsystems of Columbus available:

- Columbus TQVS (Training, Qualification and Validation Subsystem) for full swing simulations with Col-CC team and European User Support and Operations Centers (USOCs)
- Desktop Trainer for in-house simulation and hands-on training
- ColKa Simulator: for training for the new Columbus Ka-Band terminal

2.3.2 Simulation Control Rooms

For the operations of the various simulators there are dedicated simulation control rooms available offering direct access to the simulator including failure introduction etc., and direct interaction with the team in training (mostly situated in one of the control rooms).

3. Team

Since beginning of 2020 the DLR Columbus Flight Control Team (Col-FCT) and the DLR Columbus Ground Support Team (Col-GST) are part of the ESA-DLR Integrated Team @ Col-CC. This new team structure has been established similarly to the ESA-DLR Integrated Team @ EAC which is existing since more than 20 years (see module "Astronaut Training"). The new combined team at Col-CC will continue the fruitful and efficient close cooperation between the ESA and the DLR team at Col-CC and make use of the new possibilities of the even closer cooperation between the two agencies. Also the cooperation between the ESA-DLR Integrated Team @ EAC and the ESA-DLR Integrated Team @ Col-CC shall be intensified, e.g. by common usage of the new "LUNA" analogue facility.

This will be especially interesting in the view of the new goals in the course of the Moon exploration, i.e. Gateway operations. The preparation of the operation of the next generation of human spacecrafts and space stations shall be performed together using all the experience and knowledge of the Integrated Team. This will ensure efficient preparation and possible future operations of, e.g. the I-HAB as one of the Gateway modules built and operation by ESA. First tasks like data distribution during Orion missions are already in preparation.

3.1 Flight Control Team

Col-CC is responsible for Columbus systems monitoring and control as well as European payload operations coordination. The Flight Control Team (FCT) located at the Col-CC has the lead responsibility for Columbus nominal and contingency/safing operations, supporting round-the-clock operations, seven days a week. The on-console teams consist of the following positions:

- Columbus Flight Director: Head of the Columbus Flight Control Team (24/7)
- STRATOS: Responsible for Columbus system commanding and monitoring (24/7)
- COMET (EPIC on console): Planning of the European complement (8/5)



Fig. 3-1 Col-CC Flight Controllers at work



3.1.1 Columbus Flight Director

The Columbus Flight Director (Col-FD) is the head of the Columbus Flight Control Team during real time operations. This position has overall authority and responsibility for the Columbus Segment. He is reporting to the ISS Flight Director and receiving overall ISS operations directions from the ISS Flight Director.

The Col-FD position is integrating following major functions in the Columbus flight control team during real time operations:

- Flight Director (Col-FD) position for overall responsibility for the Columbus module
- Direction of Columbus operations with regards to the three major objectives of
 - Crew Safety
 - Vehicle Safety
 - Mission Success
- Crew Communicator Function to the ISS crew in case of absence of the EUROCOM position
- Overall Columbus Safety Function in case of absence of the PASO position including e.g. consultancy of the eOCAD database, handling of the hazmat database and toxicity information

3.1.2 Columbus STRATOS

The STRATOS (Columbus Systems, Data Management and Communications Engineer) is the combined DMS/COMMS and SYSTEMS position. Tasks and responsibilities are described in operational documentation.

STRATOS position is integrating the following tasks during real time operations on console:

- Monitoring & Control of the Columbus EPDS System
- Monitoring & Control of the Columbus ECLSS System
- Monitoring & Control of the Columbus TCS System
- Monitoring & Control of the Columbus COMMS System
- Monitoring & Control of the Columbus Vital and Nominal DMS System
- Monitoring & Control of the Col-Ka Antenna attached to Columbus module
- Monitoring & Control of the MPCC System (commanding and telemetry via Ku-/Ka-Band)
- Coordination tasks, e.g. Load shedding, Data Flow Plan etc.
- The System to Payload Interface (SPI) towards the ESA and NASA payloads inside Columbus

3.1.3 COMET Position (EPIC on console)

The COMET Position (Columbus Operation & Mission Execution Timeline Engineer) covers the on console planning tasks of the EPIC group.

COMET is responsible for:

- **ESA near real-time planning activities (i.e., within 6 days prior to execution):**
 - Coordination of the daily E-1/3/7 day review process within the COL-CC, as well as changes to the ESA activities in the final integrated short-term plans
 - Assessment of internal requests for timeline changes via the COL-CC Flight Note System, and if approved, converts the request into a PPCR for coordination with IP planning teams. Conversely, the COMET is responsible for the approval coordination with COL-FLIGHT of externally submitted PPCR's.
 - Coordination with COL FLIGHT for the approval of all real-time replanning products (PPCR's, Execute Package, E-1/3/7 Review Flight Notes)
 - Coordination of the necessary activity replanning for upcoming days due to an off-nominal scenario during execution
- **During this timeframe, the COMET is the point of contact for:**
 - The relevant Columbus FCT positions for timeline changes impacting system and/or payload activities;
 - The remote user site planning representatives for payload activity timeline change inputs;
 - All IP planning equivalent positions for overall timeline matters. Specifically, the COMET interfaces with the following IP planning positions: OPS PLAN, RPE, LRP (MCC-H), TCO (POIC).
- **Operations of the ESA Life Support Rack (LSR) on ISS**



3.1.4 Columbus Operations Preparation and Engineering

The Columbus Off-console tasks will be performed by all team members of the Columbus Flight Director Team, the STRATOS Team, the EPIC team, and the MOS Management Support Team. The tasks sharing will be done in the first layer by MOS management delegating tasks to the dedicated team, i.e. the team lead. The team lead will then distribute the tasks among the team members of the team to achieve the optimum task sharing within the group and to assure a certain amount of off-console tasks for every team member. A proper operations preparation with experienced flight controllers is essential for a successful execution of the real time tasks. The most important tasks are:

- **Col-CC Team and System Coordination including**
 - MOS CM support
 - Shift Planning and Process/Meeting Support

- **Col-CC Console Preparation including**
 - Increment Operations
 - Mission Flight Data Base (MFDB) Products Engineering Services
 - Ops Products Engineering
 - ODF Bookcaptainship and ODF Authoring
 - Execute Level Planning (EPIC off-console)



3.2 Ground Segment and Subsystem Engineering

For the European part of the ISS operations ESA applied a decentralized operations concept. With Col-CC as the central control center as man in the middle a number of User Centers actually operate the European payloads located within the Columbus module or elsewhere in the ISS. This community is composed of a number of organizations, teams and ground segment facilities located in Europe. Each facility is interconnected with the communications network around a central node co-located with the Col-CC, with relays at the major points of data entry (Houston, Huntsville, Moscow). Col-CC acts as the central service provider to all European facilities and international partners. This is done by different Col-CC subsystems for voice, video, data distribution as well as Col-CC provides a suite of self-developed operational support tools and applications.

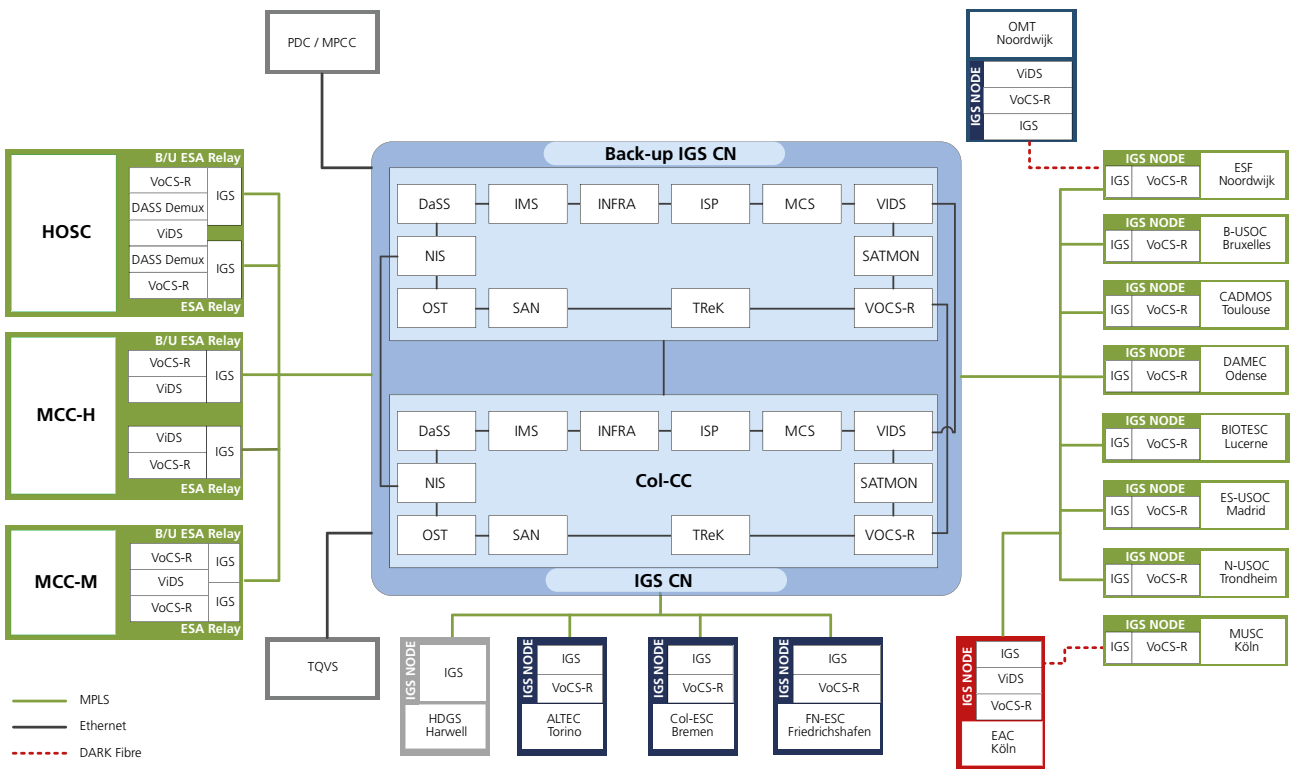


Fig. 3-2 Col-CC central service provision

The Col-CC systems are designed to be one failure tolerant.

The fast technical progress, obsolescence, and the need to improve cost effectiveness require a permanent evaluation and re-design of these systems. Nearly the whole infrastructure and all systems were replaced or totally re-designed with current technologies during on-going operations.



3.2.1 Columbus Ground Operations Team

On ground segment the following two positions are available:

- GSOC-GC: ESA ground segment operations and interface to other control centers (24/7)
- GSOC-Syscon: Responsible for internal Col-CC subsystems and networks (16/5)

The GSOC-GOP completes the ground control team. He/she is working office hours and is responsible for the ESA ground segment as well as the Col-CC internal resource and utilization planning.

The Ground Control Team (GCT) is responsible for pre-mission preparation, real-time operations including configuration, monitoring and control of the ESA Ground Segment (ESA GS) as well as the Level 1 support. In a nutshell the Ground Control Team (GCT) ensures the availability of the Ground Segment (GS) and is responsible for the proper configuration for any scheduled mission activity using the established ESA GS and communications interfaces between activated centers and International Partners and will operate it according to existing procedures.

The team is managed by the Ground Operations Manager (GOM), who also manages and coordinates the ESA Ground Segment service requirements, provision and support for all mission activities.

3.2.2 Columbus System- and Subsystem Engineering

The Subsystem Maintenance and Sustaining Engineering services refer to the complete Col-CC infrastructure at Oberpfaffenhofen including the Communications Infrastructure and wide area network.

Subsystem Maintenance and Sustaining Engineering comprises all hardware and software of the following subsystems:

Acronym	Name	Description
VIDS	Video Distribution Subsystem	Provision of video distribution and video processing, including Columbus camera.
VoCS	Voice Conferencing Subsystem	Provision of voice conferencing to all local operator consoles and designated work areas, as well as to the remote locations and International Partner centers connected via the IGS.
INFRA-SAN	Storage Area Network	Provision of a central online and offline archive for all Col-CC data, voice and video.
NIS/R&N	Network Infrastructure Subsystem	Provides all LAN network related hardware, software and services within the Col-CC.
	IGS (Interconnection Ground Sub-net) Relays and Nodes	Provides all network components at remote sites integrated in the Relays and Nodes
INFRA-GEN	General Col-CC Physical Infrastructure	Provides physical accommodation, power, air-conditioning and timing for all subsystems of Col-CC at DLR GSOC.
IGS-WAN	ESA GS Communications Infrastructure	The IGS-WAN provides all communication services for Columbus and European Payload missions.
OST	Operations Support Tools	Provision of operations support tools (incl. access to NASA tools) for both FCT and GCT.



MCS/ TQVS	Monitoring and Control Subsystem	Provides all functions related to online monitoring and control of the European Space Segment and auxiliary information.
	Training, Qualification & Validation Subsystem	Provision of Simulator for training of personnel at the Col-CC and for the validation of the Col-CC itself, either at S/S level or at system level.
DaSS	Data Services Subsystem	The DaSS provides processed data and TM packet and bitstream data distribution and routing service between all entities within the IGS.
IMS	Integrated Management Subsystem	Provision of system management within the Col-CC to ensure continuous operational availability.
MPCC	Multi Purpose Communication and Control System	The MPCC provides IP-based monitoring and control connectivity to new class 2 and class 3 payloads onboard. This system was created to provide an alternative, easy and fast implementation of new small and medium sized payloads.

3.3 Human Exploration Control Center (HECC) Operations Preparation Team

The Gateway Project is a collaboration of NASA/CSA/ESA/JAXA with the goal of establishing a crewed space station in moon orbit, including human landing on the moon. In this context DLR is providing a contribution in the area of Ops Engineering und Operations. This is established as part of the Human Exploration Control Center (HECC) in DLR/Oberpfaffenhofen, in close cooperation with ESA. The European contributions with HECC involvement are HLCS (HALO Lunar Communication System), first payloads, iHab (international Habitation Module) and ERM (Esprit Refuelling Module).

The Columbus Flight Control Team provides a central contribution of this long-term task, as part of the ESA/DLR integrated team. The following milestones are foreseen: HLCS und first payloads are part of the CMV Mission, foreseen launch in 2025, whereas iHab and ERM are launching in 2027/28.

The main technical activities are the following:

- ERSA and IDA Payloads and potential future payloads: Support preparation and cooperation during operations. This includes operational handling in HALO in close coordination with NASA.
- HLCS as part of the CMV Mission: Preparation and close cooperation during operations, also during the commissioning. Engineering support and expertise center for sustaining engineering towards NASA who operates the antenna.
- iHAB operations preparation, planning and operations of the module, in close coordination with NASA. Establish engineering expertise center.
- ERM operations preparation, planning and operations of the module and refuelling operations with NASA. Establish engineering expertise center.

