Ground System Milestones: 20 Years of Earth Observing Satellite Mission Operations

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Terra (1999) Aqua (2002) Aura (2004)

EOS Mission Goals:
Observe and document changes in the Earth system
Understand what changes are occurring and why
Improve predictions of future global change
Analyze the environmental, socioeconomic, and health consequences of global change
Support state-of-the-science assessments of global environmental change issues
Aqua/Aura Minimum Life Expectancy = 6 years, Extended life expectancy = 7.5 years
Terra Minimum Life Expectancy = 6 years, Projected decommission = 2026

Aqua, Aura, and Terra are Earth observing satellites that serve in the Earth Observing System (EOS). Each spacecraft surpassed their 6-year design life and continue to meet all mission and science requirements. As technology advances, the onboard hardware and software remain mostly the same, however, our ground system progresses. Ground system maintenance is critical for the continued operation of these Class A healthy NASA Earth Science Satellites. The mission operations systems are in active development with frequent deployments of new releases and updates of operating systems. Below is a timeline of major ground system milestones throughout these 20 years.

Mission Operations Systems

Online – Telemetry and Commanding System
- Telemetry Pages and Archiving
- Command and Procedure Executing
- Clock Correlation

MMS – Mission Management System
- Planning and Scheduling
- Command Management System
- Data Management System

ITPS – Integrated Trending and Plotting System
- Trending and Plotting
- Telemetry Archiving for Life of Mission
- Archive Playback
- Data Transmission to End Users

EMP (ESMO Modernization Plan): A tech refresh overhaul that shaped the ground system we have today. The main focus was virtualization (Towers to EsXi, Thin Clients, Zero Clients) and network robustness

Anticipated end of life of last launched EOS satellite

BEOC (Backup EOS Operations Center): Enhanced ground system for full mission operations. Week in the life (WITL)

Analysis to ITPS: In the continued efforts of EMP, Analysis was replaced with a virtual Windows OS system = ITPS

Reorganization of the Operations Center: The layout was changed to accommodate the Tri-mission position

I&T (Integration and Testing) LAN: Additional LAN to help with testing enhancements of missions systems and automation efforts

EA Enhancements

Two Man-Ops Implemented

1999-2004 | **2008** | **2010** | **2011** | **2012** | **2016** | **2017** | **2020** | **2020+**

Automation efforts: Process improvements to automate daily tasks

Controller Staff Per Mission at Launch:
1 CAC (Command Authorization Controller)
1 OC (Online Controller)
2 OE (Online Engineer)

Controller Staff Per Mission After Launch:
1 OC – 1 OE Per Mission

OCE Position:
OC & OE combined
Controller posture:
1 OCE - Aqua
1 OCE – Aura
1 OC/1 OE - Terra

Tri-mission Position:
Shift lead certified on all three missions
Controller posture:
1 OCE - Aqua
1 OCE – Aura
1 OC/1 OE - Terra

Operations Engineer Position: Position created to manage EMP and automation efforts

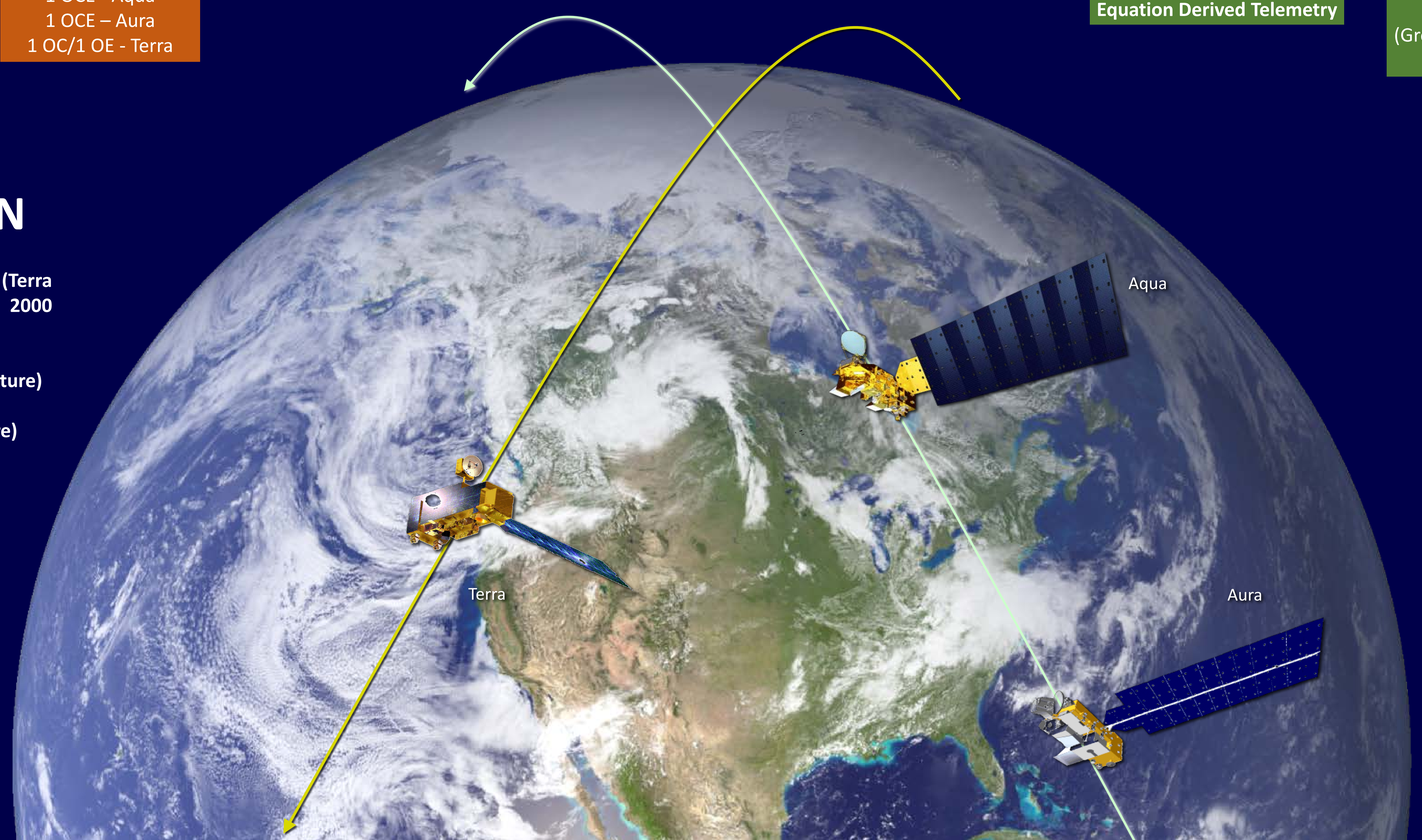
Resynching the EOS Development Lab (EDL): Automation efforts at the Ops Center needed to be reflected at the EDL. Test as you fly.

Equation Derived Telemetry

EOS Automation (EA): Consolidated alert tracking and notification leveraging the GMSEC framework. (Ground Mission Services Evolution Center)

Two Man-Ops Development

Online Python API



Operating Systems THEN

- ***Online Workstations (Windows OS)*: Windows NT (Terra launch) > Windows 98 (Aqua launch) > Windows 2000 Professional (Aura launch)**
- ***Analysis*: Sun Microsystems Solaris 2.6 (SPARQ Architecture)**
- ***MMS:* Sun Microsystems Solaris 2.6 (SPARQ Architecture)**

System Updates
New releases, operating system updates and patches contain bug fixes, enhancements and are required to maintain our IT security posture. Frequent deployments allow new technology and enhancements to be added incrementally with less risk.

Operating Systems NOW

- ***Online Workstations (Windows OS):* latest Windows**
- ***ITPS (formerly Analysis):* latest Windows**
- ***MMS:* latest RHEL**

Aqua, Aura, and Terra surpassed their design life which in itself is a huge accomplishment. With 20 years of success under our belt we continue to find new and innovative ways to evolve our ground system and improve our operating processes. In recent years, automation has been the focal point. Python and EA facilitate the ability to automate many of the tasks performed by the OCEs. The ground system has vastly changed from its origin and only continues to get better by the day. All of this occurs while a focus on NITRO (No Impact to Real-time Operations).