FUTURE VISION FOR NASA GROUND SYSTEMS

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THE PAST APPROACH

• Previously to 1996, each NASA Associate Administrator had control over the approach to operations and the facilities and capabilities that were developed with the funds from that Associate Administrator.

  • Space Science - Low Earth Orbit Flight Center
  • Space Science - Deep Space Laboratory
  • Earth Science (Mission to Planet Earth)
  • Manned Space - Vehicle Center
  • Manned Space - Science Payload Flight Center
  • Space Communications -

  ➔ Goddard Space Flight Center
  ➔ Jet Propulsion Laboratory
  ➔ GSFC
  ➔ Johnson Space Center
  ➔ Marshal Space Flight Center
  ➔ GSFC & Goddard
THE OLD ALIGNMENTS

- EARTH SCIENCE
- OFFICE SPACE COMMUNICATIONS
- PLANETARY SCIENCE
- HUMAN FLIGHT

- CONTROL CENTERS
- LOW EARTH ORBITERS NETWORKS
- DEEP SPACE NETWORKS
- CONTROL CENTERS

- GODDARD SPACE FLIGHT CENTER
- JET PROPULSION LABORATORY
- MARSHALL SPACE FLIGHT CENTER
- JOHNSON SPACE FLIGHT CENTER
- KENNEDY SPACE CENTER

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NEGATIVE ATTRIBUTES OF THE ALIGNMENTS

• Similar capabilities being developed and operated at each center.

• Agency wide solutions to common problems were not identified.

• Each Center having one or more contracts to support the development, sustaining and operations of the center capabilities supporting mission operations.

• Contractors having several contracts related to operations, with NASA at the various Centers, each managed independently.
  – Sometimes a contractor has several contracts with a single center related to mission operations support.
AN AGENCY WIDE APPROACH

• There is one Office responsible for NASA Space Operations - The Space Operations Management Office (SOMO).

• The Office is located at the Johnson Space Center.

• The Office reports to an Operations Council composed of the NASA Associate Administrators responsible for development of space missions.
AN AGENCY WIDE APPROACH

• Any new space operations assets (facilities or facility capabilities) that are required for future missions must be analyzed by the Space Operations Management Office and approved by the Space Operations Council.

  – Thus a request by Space Science to build a new polar tracking network, must be approved by the Associate Administrators for Space Flight (manned) and Mission To Planet Earth, as well as the Deputy Administrator - Technical for NASA.
Space Operations Management
National Aeronautics and Space Administration

Director of Space Operations

Engineering & Operations Manager
Commitments & Mission Services Manager
Data Services Manager

Mission Commitments & Services Manager JSC
Mission Commitments & Services Manager GSFC
Mission Commitments & Services Manager JPL
Mission Commitments & Services Manager MSFC
LEO Network Services Manager (GSFC)
Deep Space Network Services Manager (JPL)
Wide Area Network Services Manager (MSFC)

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NASA CURRENT ARCHITECTURE

Data Facilities

Mission Control Centers

Development Facilities

Space Network

Ground Network

Network Control Center

Low Earth Orbit Network

NASA Information Systems Network

Network Operations Control Center

Deep Space Network
NASA SPACE OPERATIONS SYSTEM
PRELIMINARY CONCEPT

R. P. MATHISON

SYSTEM ENGINEERING WORKING GROUP

7 JANUARY 1997
DEFINITION

The NASA Space Operations System (NSOS) is defined as the people (organization), processes, services, tools, and physical elements that do space operations for NASA Missions.
SPACE OPERATIONS MANAGEMENT
National Aeronautics and Space Administration

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CONTEXT

NASA SPACE OPERATIONS SYSTEM
INDUSTRY PROVIDED
UNIVERSITY PROVIDED
NASA MISSIONS
CONTEXT

DEEP SPACE MISSIONS DOMAIN

MANNED MISSIONS DOMAIN

EARTH ORBITING MISSIONS DOMAIN

Experiment Investigator

Project Mission Operations System (MOS)

Flight System

NASA Integrated Service Network (NISN)

Space Network (SN)/Ground Network (GN)

Service interface

Service interface

Service interface

NSOS

Data Archiving

Science Data Processing

Mission Operations & Control

Network Operations & Control

On-Board Service Element

NASA Integrated Service Network (NISN)

Space Network (SN)/Ground Network (GN)

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KEY CHARACTERISTICS

The NSOS will be established based on the concept of Integrated Space Operations Architecture. It has the following key attributes:

- The NSOS is a collection of SOMO operations system elements functionally interconnected (not just physically networked) to provide customers, i.e., project MOS and PI, seamless interface for services. By service interface, it means the request for services and provision of data as result of service execution.

- Among these operations system elements, interoperability is accomplished through a set of standard services such that any customer, i.e., project MOS or PI, can obtain different types of services from multiple operations system elements to fulfill its mission operations needs.

- Among these operations system elements, each individual service can be instantiated through replication of objects such that the identity of each operations system element can be “transcribed” to other operations system elements within the constraints of physical assets. This implies multiple instances of the same service type can be available at different operations system elements, if needed.

- Unique identities are preserved for each of these operations system elements, according to the primary mission domain it supports. Missions supported by SOMO are divided into 3 mission domains: Earth orbiting missions, manned missions, and deep space missions.

NOTE: An Operations System Element (OSE) in this context could be a tracking station, mission control center, science data processing center, or archive center.
CUSTOMER INTERFACE VIEW

FLIGHT PROJECT

Project Mission Operations System (MOS)

Flight System

Experiment Investigator

Service Management (Monitor & Control) Services:
- Resource allocation/scheduling
- Asset configuration/Control
- Frequency & spectrum management
- Service Accounting management
- Others

Mission data
- Service accountability report

Service request

Mission data
- Service accountability report

Service request

Mission data
- Service accountability report

Service request

FLIGHT PROJECT

Tracking & Navigation Services

Telecommunications Analysis Services

Experiment Product Generation Services

Mission Data Management Services

NASA SPACE OPERATIONS SYSTEM

etc.

etc.

Flight Engineering Services

Mission Control Services

Command Services

Telemetry Services

etc.
CURRENT PHYSICAL ELEMENTS

LEO NETWORK

SPACE NETWORK

SPACE NETWORK GROUND TERMINALS

SPACE NETWORK CONT CNTR

GROUND NETWORK

NASA INTEGRATED SERVICES NETWORK

FLIGHT DYNAMICS FACILITY

MISSION OPERATIONS CCS

HUNTSVILLE OPERATIONS SUP. CENT.

REMOTE EXTENSION MOSCOW

INTEGRATED PLANNING SYSTEM

MSF MISSION CONTROL CENTER

ADVANCED MULTISSION OPS. SYSTEM

DSN NETWORK OPERATIONS CC

DEEP SPACE NETWORK COMPLEXES

TO OTHER AGENCIES
DEFINITION OF TERMS

In the context of SOMO, support functions provided by SOMO to flight projects and PIs are classified into 3 categories:

- **Mission operations services:** A service is the work performed by a SOMO-funded system that produces mission and science operations results for a customer, i.e., flight project or PI.

- **Tools:**
  - Operational Tools: tools used by flight project personnel and PIs for them to perform their operational activities.
  - Development Tools: tools used by flight project personnel and PIs for them to develop their mission operations systems or system elements.

- **Engineering support:** Activities performed by SOMO to support flight projects and PIs in mission design, telecommunication link analysis, end-to-end integration and test, etc.

Distinctions between them are necessary due to their respective ramifications in cost accountability, performance accountability, and change authority.
DEFINITION OF TERMS (CONT’D)

• Standard Service: Standard service are those defined in the SOMO Service Catalog from which customers can make selection for their needed services to support their missions without the expenditure of non-recurring engineering.

• Tailored Service: A tailored service is one requested by customers for functionality different from a corresponding standard service offered in the SOMO Service Catalog and, for fulfilling this service, modification of capabilities with additional implementation effort will be needed.

• Service Family: A collection of functionally related types of services.

• Service Type: A service type is characterized by the unique function performed and the result produced by the service.

• Service Instance: An occurrence of service type.

• Service Request: Service requests specify what services are wanted by a customer. Each service request applies to a single instance of service.

• Service Accountability:
KEY ATTRIBUTES OF STANDARD SERVICES

1. CUSTOMER RELEVANCE: Services offered to the customers must be visible and meaningful to the customers. This implies hiding the level of details of the capabilities and activities from the customers, yet allowing visibility and accountability available to the customers.

2. PICK-AND-CHOOSE: The services must be selectable by SOMO customers. Subscription to a service by a customer should not require buy-in of other services which are not relevant to the customer’s needs.

3. PLUG-AND-PLAY: The use of any SOMO standard services (as distinguished from the tailored services) must be based on definitions which appear in the SOMO Services Catalog. Once a service, as it exists on the Services Catalog, is subscribed to, it must be “immediately” available for use by the customer. It should not require any implementation effort beyond interface testing, configuration setup, and parameter table updates, by the SOMO as a services provider.
KEY ATTRIBUTES OF STANDARD SERVICES (CONT’D)

4. STANDARD INTERFACES: The use of the SOMO services, in terms of control and data interfaces, by the customers will be via standard interfaces. “Standard” interfaces include those formally established by standards organizations, those widely applied by the industry as de facto standards, and those defined by SOMO as common mechanisms to all customers. No additional development effort on the SOMO or the subscriber’s system other than that required for conforming to the standard interfaces will be necessary.

5. DIRECT SERVICE CONTROL: The customers will be allowed to directly control the service (within the bounds of the system’s capabilities and safety criteria).

6. INTEROPERABILITY: Services will be standardized, whenever applicable, to enable interoperability with other service providers whenever the same service is requested.
KEY ATTRIBUTES OF STANDARD SERVICES (CONT’D)

7. PERFORMANCE ACCOUNTABILITY: Performance of each individual SOMO service subscribed to by a customer will be measurable and reportable.

8. COST ACCOUNTABILITY: Services will be provided by the SOMO to a customer on a fee schedule basis. This means all standard services will be defined, structured, and priced in such a way that customers’ recurrent costs can be tracked and reported to them.
SCHEDULE

• **Multi-center system engineering working group is current working on the NSOS Service Definitions**
  – Completed April 1997

• **NSOS consolidation options will be analyzed during the spring / summer 1997 period.**
  – NSOS recommendation to be made August 1997

• **CSOC Integrated Architecture Study Phase**
  – May 1997 - October 1997

• **Architecture and contractor selected**
  – May 1998
  – Proposal will include transition plan from current architecture to proposed architecture