



National Aeronautics and Space Administration



NASA SPACE COMMUNICATIONS AND NAVIGATION APPROACH TO CLOUD CAPABILITY IMPLEMENTATION

SCaN

Space Communications and Navigation

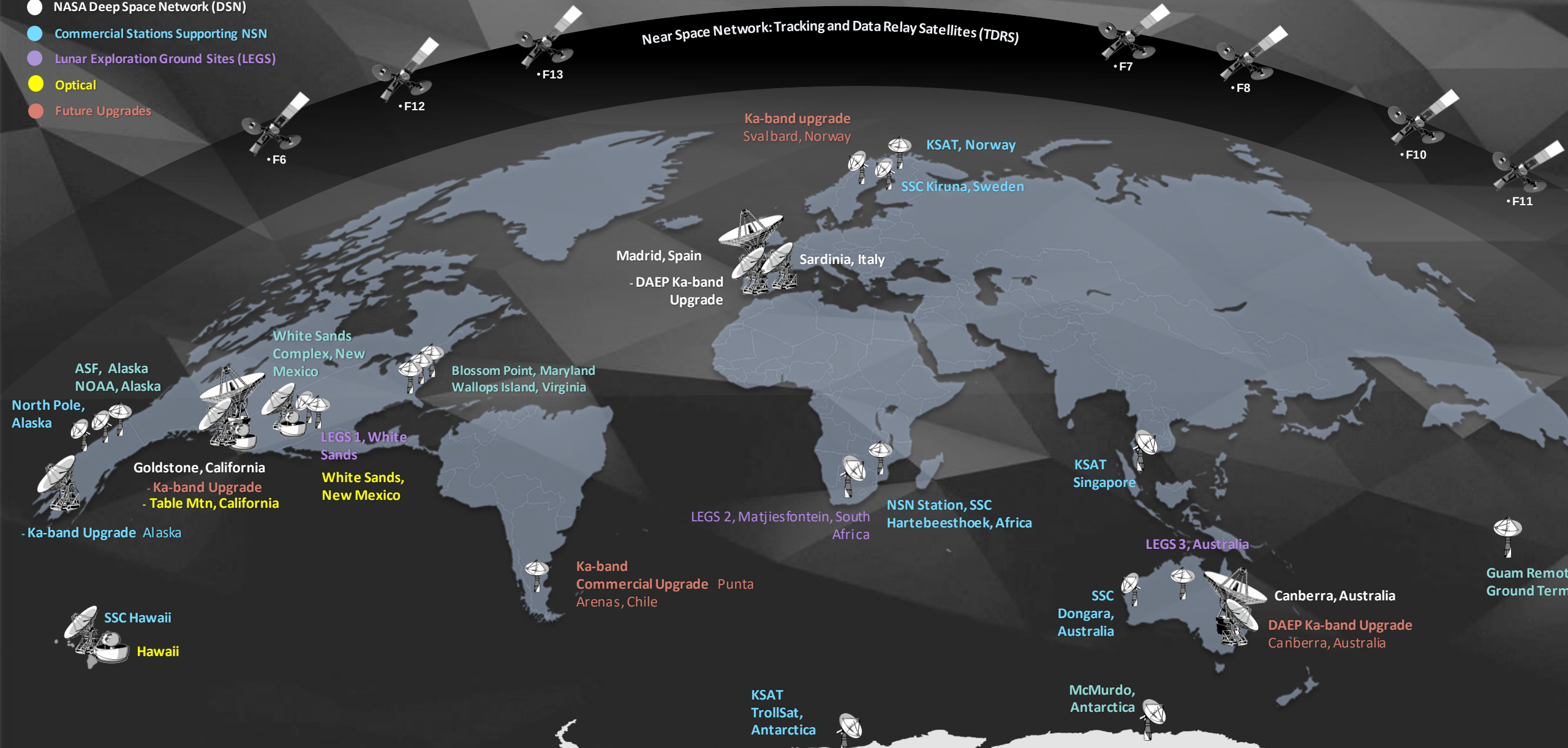
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Presented to:
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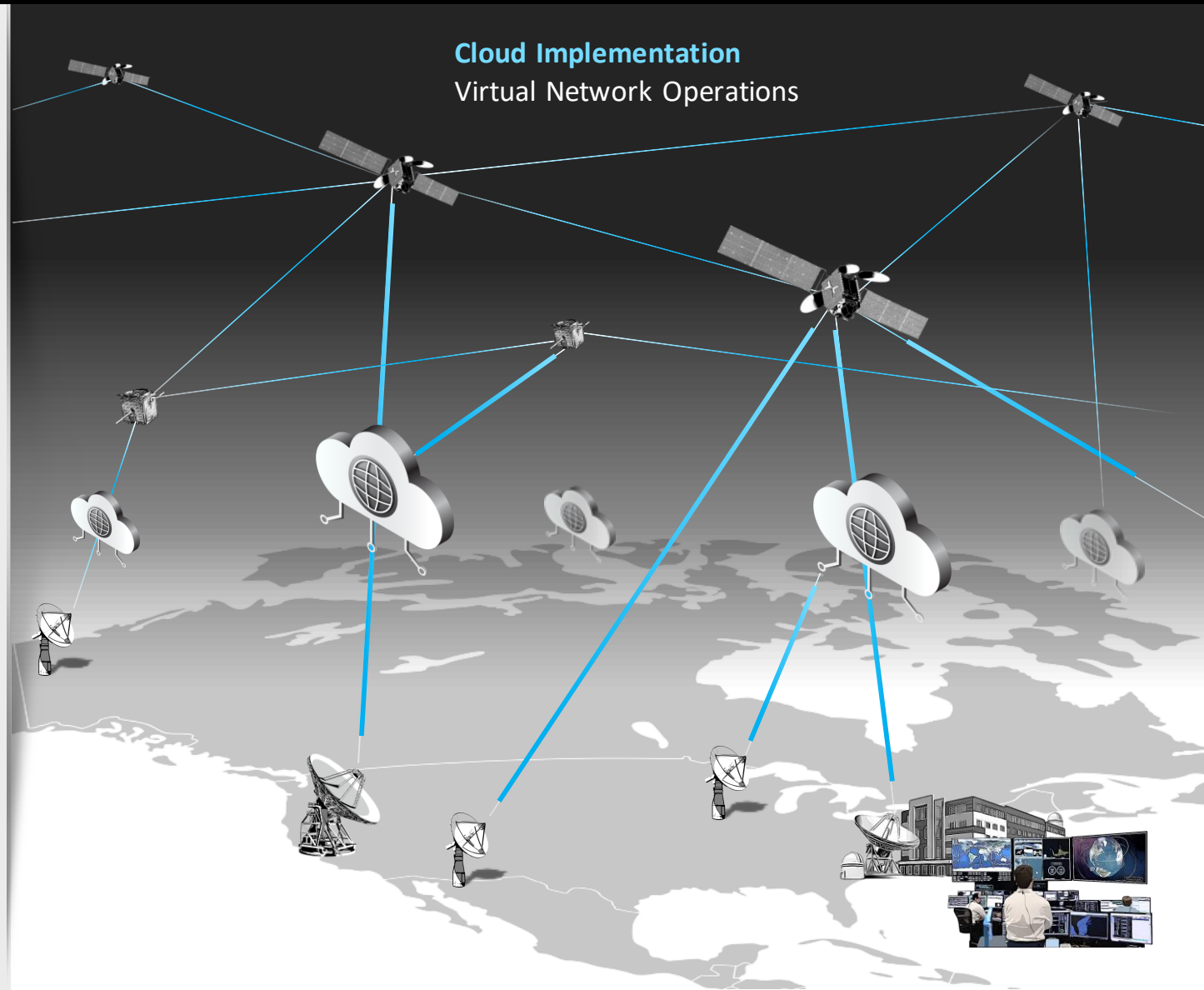
NASA's Communications Networks

- NASA Near Space Network (NSN)
- NASA Deep Space Network (DSN)
- Commercial Stations Supporting NSN
- Lunar Exploration Ground Sites (LEGS)
- Optical
- Future Upgrades



Why Cloud?

- Data delivery to virtual secure mission repositories
- Eliminates site-based mission unique equipment
- Removes barriers to scalability
- Reduces cost of operating and maintaining physical infrastructure
- Improves ability to secure the SCan infrastructure

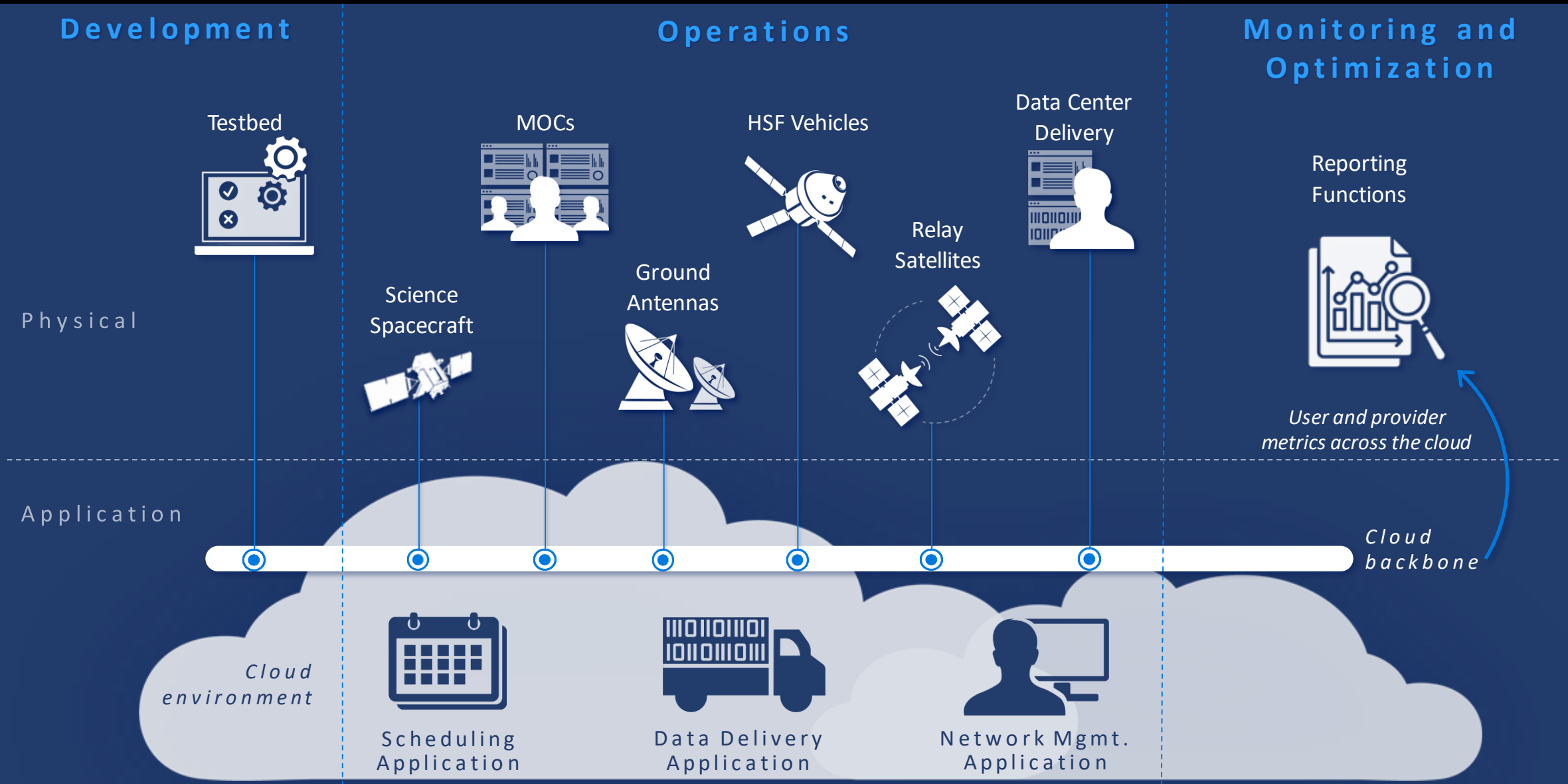


Legacy vs. Future



SPOC Vision

(SCaN Program Operation Cloud)



Conceptual Approach: Breaking Down the Challenge into Familiar IT Needs and Solutions

NASA Domain Specific Need

- Allow mission operations center users to schedule/request satellite contacts with service link providers.



Familiar Domain Independent Problem

- Provide a web user interface to view information and perform functions.
- Invoke services to retrieve information from one of many heterogeneous service providers. Implement logic and send information to providers.



Typical Cloud Solutions

AWS examples

- User front-end via serverless web application served from S3 bucket.
- APIs for all scheduling functions and expose with API Gateway.
- API service logic in Lambda functions
- AWS database service like RDS for persistence.
- Send information to service providers via provider-specific interfaces.

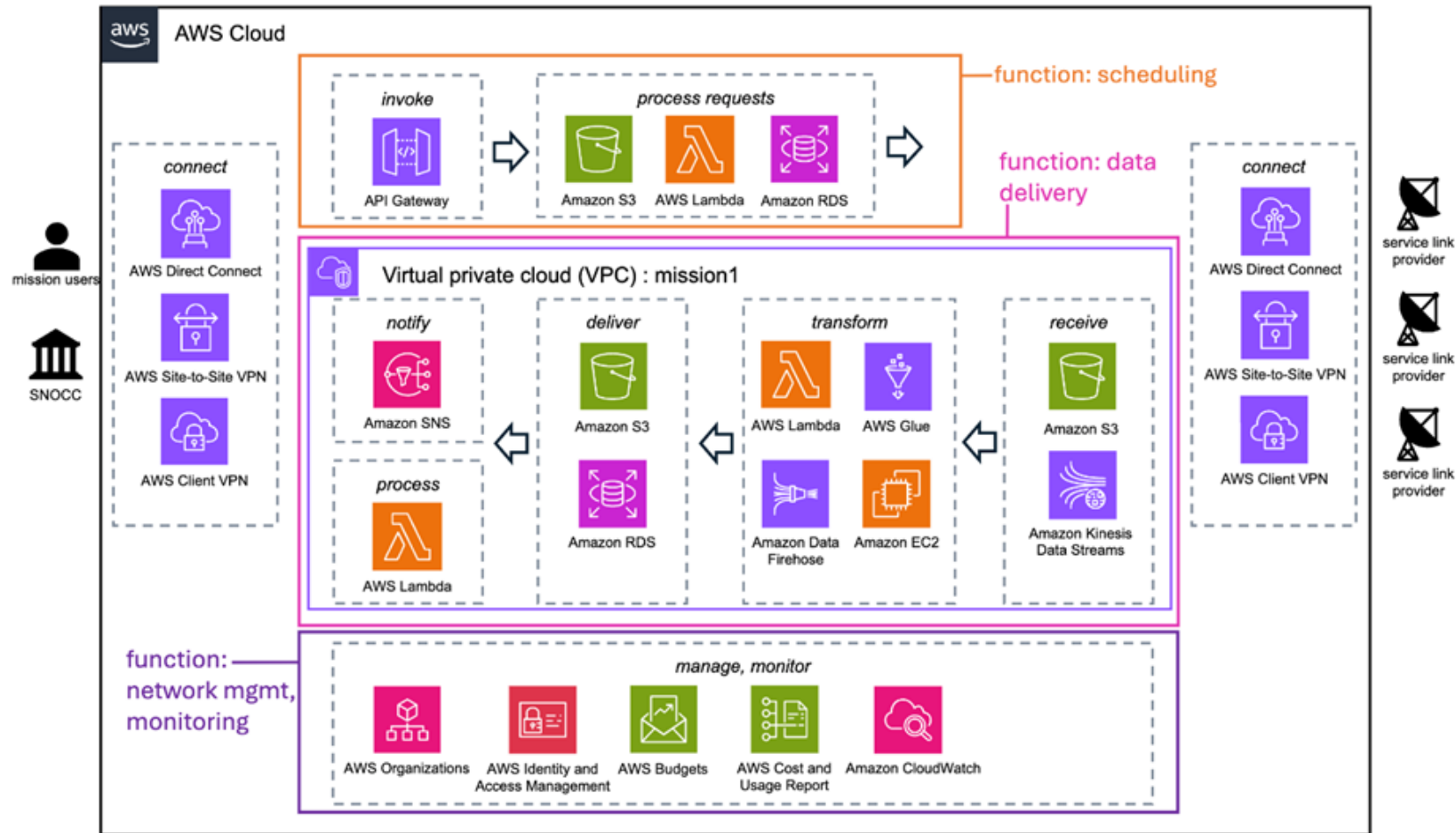
Example Mapping

Completion of this mapping exercise is forward work

Advantages of this approach:

- Mitigates risk of vendor lock-in – solutions can be pulled from a variety of vendors
- Decomposition and mapping of functions allows one to replace the solutions from one provider with the analogous services from a different cloud provider

Cloud Architecture for Virtualization of Network Ops



Example AWS implementation shown but does not reflect final architectural decisions which may incorporate a variety of vendor solutions.
The final architecture will, by necessity, address the need for additional resiliency – through regional diversity, redundancy and backups, secondary providers, and continuous monitoring.

Progress and Plans: Cloud Backbone (SPOC)

The SPOC landing zone has been established on an AWS platform

- Third party assessment completed
- Authorization to Operate anticipated in September
- Provides the foundation for all future work

Next steps:

- Begin connecting NASA mission locations to AWS using Direct Connect to the nearest point of presence (POP). Engagement with local telecom service providers is required for the "last mile" of this terrestrial connectivity
- Begin connecting a single NASA ground station location (e.g. a Wallops antenna) to the AWS cloud using either AWS Direct Connect or, more simply, AWS VPN.

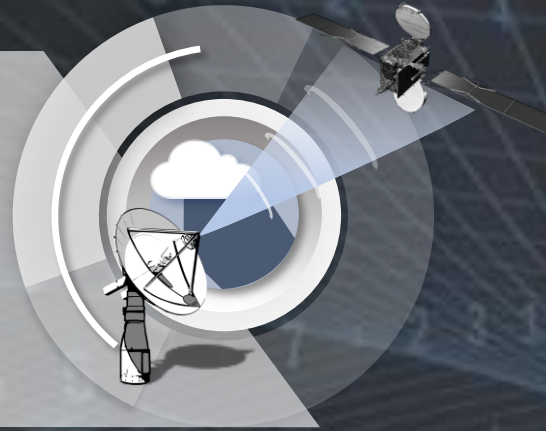


Progress And Plans

Scheduling

Proof of concept in development

- Mirror legacy network operations in the virtual environment
- Completion on track for the next year
- **Next steps:**
- Integrate the scheduling function in demo environment with a single ground station location (e.g., Wallops) to the AWS cloud



Data Delivery

Next steps:

- Identify a candidate mission for cloud implementation.
- Provision **AWS Virtual Private Cloud (VPC)** for the mission and provision users within the IAM policy
- Build data receipt, transformation, and delivery of data using the AWS services described above within the mission VPC
- Implement any mission-specific data processing using appropriate AWS services



Network Mgmt.

Next steps:

- Implement the use of **AWS CloudWatch** to provide appropriate monitoring of all AWS services and data flows
- Connect the SCan Network Operations Control Center (SNOCC) to these monitoring services



Looking Ahead – Considerations and Challenges

- ✓ **Keeping pace with industry**
- ✓ **Balance with government policy**
- ✓ **Security of data and data transfer**
- ✓ **Preparations for Human Space Flight**
- ✓ **Operational shifts - staffing and training**
- ✓ **Monitoring cloud utilization**
- ✓ **Decision-making and forward planning – maximize capability while controlling cost**



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Conceptual Approach: Breaking Down the Challenge into Familiar IT Needs and Solutions

NASA Domain-Specific Needs		Familiar Domain-Independent Problem	Typical Cloud Solutions (AWS examples)
Cloud Backbone / Adoption	Connect service link providers (SLPs) to a central location for operational needs. ...	Connect a set of heterogeneous, geographically distributed data providers to a cloud environment. ...	Direct Connect to nearest point of presence, Site-to-Site VPN or Client VPN over Internet, or PrivateLink for providers already in AWS ...
Scheduling	Allow mission operations center users to schedule/request satellite contacts with service link providers.	Provide a web user interface to view information and perform functions. Invoke services to retrieve information from one of many heterogeneous service providers. Implement logic and send information to providers.	Implement user front-end as serverless web application served from S3 bucket. Implement APIs for all scheduling functions and expose with API Gateway. Implement API service logic in Lambda functions and use AWS database service like RDS for persistence as appropriate. Send information to service providers via provider-specific interfaces.
Data Delivery	Transfer received satellite data to a central point for processing. ...	Transfer files and stream data from data providers to cloud environment. ...	S3 buckets for file storage, Kinesis for streaming data. Developers use AWS SDKs, CLI, or invoke APIs directly to transfer data into cloud environment. ...
Network Management and Monitoring	Send control directives from mission operations centers to service link providers. ...	Invoke services to send commands to one of many heterogeneous service providers. If needed, provide a web user interface. ...	Implement APIs to represent control requests/commands and expose with API Gateway. Implement logic in Lambda functions and use AWS database service like RDS for persistence. Send control info to service providers via provider-specific interfaces. User front-end can be implemented as serverless web application served from S3 bucket. ...