Operation's Concept for Deep Space Array-based Network (DSAN) for NASA

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ABSTRACT

The Deep Space Array-based Network (DSAN) is part of >1000 times increase in the downlink/telemetry capability of the Deep Space Network. The key function of the DSAN is provision of cost-effective, robust, Telemetry, Tracking and Command (TT&C) services to the space missions of NASA and its international partners.

This paper presents the architecture of DSAN and its operations philosophy. It also briefly describes customer's view of operations, operations management, logistics, anomaly analysis and reporting.

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ABSTRACT

The Deep Space Array-based Network (DSAN) will be an array-based system, part of >1000 times increase in the downlink/telemetry capability of the Deep Space Network. The key function of the DSAN is provision of cost-effective, robust Telemetry, Tracking and Command (TT&C) services to the space missions of NASA and its international partners.

This paper presents an expanded approach to the use of an array-based system. Instead of using the array as an element in the existing DSN, relying to a large extent on the DSN infrastructure, this paper explores a broader departure from the current DSN, using fewer elements of the existing DSN, and establishing a more modern Concept of Operations. For example, DSAN will have a single 24x7 M&C facility while the DSN has four 24x7 M&C facilities.

This paper gives architecture of DSAN and its operations philosophy. It also briefly describes customer's view of operations, operations management, logistics, anomaly analysis and reporting.

1.0 SYSTEM ARCHITECTURE

1.1 Introduction

The Deep Space Array-based Network (DSAN) is part of an >1000 times increase in the downlink/telemetry capability of the Deep Space Network as given in Table 1. The key function of DSAN is the provision of Telemetry, Tracking and Command (TT&C) services to the space missions of NASA and its international partners.

Source of improvement	Level of improvement	Comments
G/T due to area	X10	3 sets of 400 12m antennas, ten-fold increase in collecting area, relative to the 70m subnet
G/T due to Frequency increase	X4	Transition from X-band to Ka-band
S/C Components	X50	Move to 10m inflatable antennas
	X25	Move from tens on Watt transmitters, to few KW

Table 1 – components of the >1000 increase

DSAN will be deployed at three sites at, or near, the longitudes of the existing DSN sites. The architecture of DSAN is shown in figure 1.

DSAN Central is connected to the three Regional Array Centers (RAC's), one at each of the three longitudes. Each RAC is connected to a cluster of downlink antennas at that longitude and to one collection of uplink assets. To improve weather immunity, additional clusters may be located farther from the RAC, but the first cluster at each longitude will be collocated with the RAC. Each Cluster will include 12-m antennas for receive (downlink only, at X- and Ka-band), a total of 400 12m antennas per longitude. The cluster will also include the electronics and facilities needed to support the facility.

Uplink assets will be associated with the RAC, and support the cluster(s) in the longitude. Initially, DSAN will rely on the DSN uplink assets. Later, DSAN could use few (6-8) 12-m antennas with a to be determined [perhaps 3.5 kW] X-band transmitter on each antenna and few (2-3) larger antennas (possibly 34-m antennas). Arraying of uplink signals is not baselined in this Concept of Operations (ConOP) but may be added later, subject to technology feasibility validation and evaluation of cost-effectiveness.

The cluster(s) will occupy approximately 2-4 square miles, including the downlink antennas, processing facility, and support facilities. Uplink assets may share physical location with the cluster, or may be physically elsewhere.

Most TT&C applications will use arrays of 12-m antennas for downlink and a single 12-m or 34-m antenna for uplink. "Very high" uplink power will be used rarely, e.g. for emergencies, and could represent (due to its rarity) and exception to the "hands-off" operation.

If 34-m antennas are included to meet uplink needs, they will be equipped with limited downlink capability so that radio science observation or other non-standard science capabilities like low Allan Standard Deviation (ASD)/Phase noise performance can be supported.

The DSAN ConOp should allow for straight-forward, modular expansion of the downlink capability by adding clusters and/or antennas and/or uplink assets. Under consideration are the possible expansions:

1. Addition of Ka-band transmitters on TBD antennas

2. Addition of Solar System Radar capability on TBD antennas

3. Addition of S-band capability

4. Addition of near-earth Ka-band capability (26 GHz)

1.2 Operations Approach

1.2.1 The Link and the Pass

In this ConOP, links and passes are the basic components of DSAN support, used in a similar way to their use in the current DSN.

A pass is a continuous period of support. The support can be to a single customer, or multiple customers (the latter occurs in relay operations and in MSPA scenarios). Each pass contains periods of setup and teardown before and after the actual tracking support.

A link is defined as the logical aggregation of assets, for a pass. A link will consist of some dedicated assets (antennas, arraying equipment, transmitters, and telemetry equipment) and portions of shared assets (Frequency and Timing systems, communications lines, switching equipment). The link gets formed in the beginning of the pass, from assets in a general pool, and dissolved after the pass, returning the assets to the general pool. A link can include assets in a single cluster, multiple clusters, or even multiple regions.

When the tear-down of one pass is immediately followed by the setup of the next pass, potential efficiencies could be achieved by reducing the transition between passes. If cost-effective, DSAN will incorporate pass-combining optimization for such scenarios.

1.2.2 Antenna as an LRE (Line Replaceable Element)

DSAN will, to the extent possible, treat an antenna as the line-replaceable-element. If the antenna becomes unusable during a pass due to mechanical or electronic component (and cannot be restored quickly to service), the support will continue with the remaining antennas, if the margin allows, or another antenna will be brought into service. The fault isolation and restoration will be deferred to the next 8x5 shift. The antenna allocation process will include provision to add reserve capacity consistent with the criticality of the supported event.

1.2.3 Automation

DSAN will not be operated as a “lights-out” network – the complexity of space operations, and the uniqueness of each mission would make such a capability not cost-effective. Instead, this ConOp is based on having a small number of 24x7 personnel at DSAN central and the RACs. “Automation” will be focused on providing real-time, and non-real-time, tools that will handle, without human intervention, nominal operations and selected non-nominal failures, and free the 24x7 staff to attend to non-routine events.

Automation tools will also be provided for the non-real-time operations, to both reduce the manual/human intervention and to enable extensive data-mining in the resulting data bases.

1.2.4 Operations Philosophy

This ConOp is based on the following assumptions:

1. DSAN will maximize schedule-driven operations, and minimize human-in-the-loop intervention. Real-time operation staffing will be 24x7 only at DSAN, primarily to monitor schedule-driven operations and correct exceptions. The RACs will have 24x7 staffing for light repairs, if needed to meet Reliability/Maintainability/Availability (RMA) requirements.

2. Resource allocation will be performed on-line, based on a priority algorithm approved by NASA HQ, with minimal human intervention at the central DSAN facility.

3. Setup, start, execution, and teardown of passes will be schedule- and script- driven and not require human intervention. The customers will be responsible for providing correct Mission Parameter Files (MPFs) to drive the passes – DSAN will not plan on staff to respond to real-time verbal or e-mail updates. Note that the MPF should require little knowledge of the DSMS. It should include data on spacecrafts, modulation formats, data rates, and timeline of spacecraft events, not directions on how to configure specific DSMS assets. DSAN may provide tools (e.g. "friend of the telescope") to perform a sanity check on the input data, before the pass.

4. DSAN hardware & software will be configured based on the customer inputs, or data automatically derived from it, and not require human intervention for normal TT&C passes.

5. Output data will be automatically stored for pre-specified duration in TBD format, where authorized users can directly access their data (after proper user authentication).

6. Monitor and Control of DSAN will be via web interfaces, with access available to authorized users (customers, DSAN real-time and non-real-time staff, management, etc) through an internet connection, from any location where such a connection exists.

7. When practical, DSAN will allow easy replacement of hardware and restoration of service by employing simple interfaces and maximum use of

self-configuration of new hardware and software components ("plug-and-play").

1.3 Regional (RAC/Cluster/Uplink) Architecture

The components of the regional assets are shown in Figure 2. Each of the 12-m downlink antennas will have right circular polarization (RCP) and left circular polarization (LCP) capability at X-band (8-8.8 GHz) and RCP and LCP capability at Ka-band (31.8-38 GHz). Each antenna will produce two simultaneous IF signals, having selectable polarization and frequency band, each with up to 500 MHz bandwidth. (Option: each antenna will produce all four simultaneous IF signals). The IF signals from all antennas in a cluster will be brought together to the cluster control building for further signal processing.

The signal processing equipment for each cluster will produce up to 16 phased array signals with one antenna contributing to maximum 4 phased array beams at a time. In the initial deployment, each phased array signal would represent a (sampling) bandwidth from 125 kHz to 128 MHz, within the 500 MHz bandwidth of the antenna IF signal. Subsequently, if the mission needs justify it, the digital electronics can be upgraded to the full 500 MHz bandwidth. IF bandwidth expansion beyond 500 MHz, if required, will necessitate upgrade of the Downconverter/IF, LO electronics, and the digital electronics.

The phased array IF signals will be routed from the cluster(s) to the RAC. At the RAC, there may be further arraying of IF signal from the cluster(s)s, if inter-cluster arraying is required. The resulting IF signals will be routed to DSN-type or commercial telemetry processing equipment at the RAC to produce Consultative Committee for Space Data System (CCSDS) compatible telemetry and tracking data. The same IF signals may be routed to other special processing equipment (e.g. Very Long Baseline Interferometry for delta differential one-way ranging) at the RAC.

There will also be a correlation capability to measure autocorrelation and cross correlations between IF signals from individual antennas over any part of the signal with bandwidth ranging from 125 kHz to 512 MHz using 2-bit correlation. The correlator is required for smooth operations and calibration of the array, and may enable use of the array for emergency search for a class of "lost" spacecraft.

The uplink antennas may be physically separated from the downlink antennas to minimize RFI and regulatory concerns. In Figure 2, the uplink assets are shown as separate assets. Note that once uplink arraying is proven, the uplink capability could share antennas with the downlink capability.

When a 34-m antenna is used with the array, its receive system will be useable as part of the receive array (i.e. 34-m antenna will be one of the receive element in the array).

DSAN will include safety devices & procedures to assure that the equipment and the operations do not pose risk to the staff & equipment and to surrounding areas, including the airspace. This is in particular critical for the uplink assets of DSAN.

1.4 DSAN Central Architecture

1.4.1 Real-Time Operations

In general, the generation of TT&C products (e.g. frames for telemetry, radio-metric observables for tracking) will be script- and schedule-driven, without requirement for human intervention. The operator at DSN Central will oversee all the processing, whether done at the cluster, or at the RAC, but will intervene only during anomalies or when an override is required.

Processing at DSAN Central is required only for the cases that require participation of multiple regions, such as:

- 3-way Doppler & ranging, between regions
- Automatic acknowledgement protocols (CFDP, COP-1, etc)
- Handover between regions
- Etc

Again, the processing at DSAN central will be schedule/script-driven.

1.4.2 Non-Real-Time Operations

DSAN Central will perform several functions, in addition to overseeing the real-time operations of the assets in the three regions. Most of these functions will be controlled by software/scripts. The list identifies which functions will be performed by the 24x7 staff, and which by the 8x5 staff.

1. Priority & array Time Allocation – SW/Script driven, with overrides by the 24x7 staff

2. Resource allocation and scheduling - SW/Script driven, with overrides by the 24x7 staff

3. Validation of customer provided MPFs - SW/Script driven, with instant feedback to the customer

4. Generation of Observation Control Files (OCFs) - SW/Script driven

5. Addition of pre-pass and post-pass calibrations to OCFs, if required - SW/Script driven, with overrides by the 24x7 staff

6. Instrument calibrations and routine test observations (passes) – 8x5 staff

7. Maintenance of calibration catalogs and tables – 8x5 staff, with support of SW/Scripts

8. Maintenance planning – 8x5 staff, with support of SW/Scripts

9. Data calibration – 8x5 staff, with support of SW/Scripts

10. Data quality analysis – 8x5 staff, with support of SW/Scripts and engineering staff

1.4.3 Inter-Cluster and Inter-Region Operations

DSAN will have the following limitations on inter-cluster and inter-region operations:

1) DSAN will have the ability to array IF signals between clusters. However, DSAN will not have (in the baseline configuration) a capability for routine arraying IF signals from multiple regions.

2) DSAN will have a limited capability to array IF signals from multiple regions for delta differential one-way ranging (DDOR) type activities.

2.0 STAFFING

2.1 Approach

DSAN will have staffing at the DSAN Central, at the RACs, and at the clusters.

2.2 Roles and staffing levels (Initial Estimates)

Figure 3 shows estimated staffing levels for a full DSAN with 3x400 12m antennas and the ancillary uplink assets

DSAN central real-time will be staffed by 5 24x7 operators. The operators will monitor real-time performance, and intervene if needed. Recall that the default is for the passes to be run from the schedule, and the customers are responsible for the provision of correct inputs, via proper MPFs.

Across all assets in a longitude (RAC, clusters, uplink) there will be 8x5 staff that will perform all the maintenance on the 400 12m antennas, the uplink antennas, and the other equipment. Estimates of work-hours, from an independent reliability assessment, are under development. It will depend on the spacing between the assets, and on whether the same staff can handle all the assets, or several staffs will be needed for the various physical sites. These staff will handle the logistics, and perform the first level of failure analysis and corrective actions (see Section 6.1).

DSAN central non-real-time-operations will be staffed by TBD 8x5 positions. These staff will conduct customer interfaces, handle the logistics, and perform analysis, as needed.

DSAN central will be supported by an engineering organization that has the ultimate expertise in the details of the equipment. These staff, in addition to designing and deploying new equipment, will be available to provide support to the staff at the RAC/Clusters, and conduct the final root-cause-analysis and closure of Failure/Anomaly Reports (FARs) (Section 6.1).

At the RAC, there will be 2 24x7 rovers. The rovers will be authorized to perform light maintenance (e.g. some board replacement), as needed to keep the system operational. With experience, and better RMA data, the need for the rovers will be re-assessed.

3.0 DSAN OPERATIONS – CUSTOMER VIEW

3.1 Scheduling

Scheduling - Customers will be assigned passes and priorities on-line. The allocation process will incorporate a HQ-approved priority algorithm.

Validation - Once the pass has been allocated, the customer will submit a Mission Parameter File (MPF), in a pre-defined format (The MPF is likely to be a trimmed-out version of the DKF, limited to the parameters that the mission must define). DSAN will validate the MPF and reject any deficient MPFs, with a notification to the customer. Passes without a validated MPF will not be executed. Correctness of the parameters in the MPF is user responsibility.

The customer can update the MPF as often as needed; however, updating the MPF during the pass may result in data discontinuity and/or loss of data.

3.2 Real-Time Operations

During the pass, the customers will be able to supply modified MPFs, if needed, to be applied by the DSAN (see Section 4.2). The customers will also be able to monitor the progress, using a subset of the monitor displays available to DSAN central.

3.3 Post-pass Operations

After the pass, the customers will get a pass report, accounting for the actual performance of DSAN, as evaluated by DSAN. The customers will also be encouraged to feedback to DSAN, as soon as practical, any discrepancies they identified in the pass results. Note that some discrepancies in DSAN cannot be detected without active feedback from the customers, e.g. errors detectable only by comparing radio-metric data to the actual trajectory.

4.0 DSAN OPERATIONS – PASS MANAGEMENT

Staff at the central DSAN facility, and any authorized person with Web access, will be able to observe selected DSN monitor data and access real-time view of DSAN assets thru close circuit TV, wherever practical, and call for help in case of emergency.

4.1 Functional Modes

4.1.1 TT&C

The most common operational mode will be TT&C. DSAN will have Telemetry, Tracking (ranging, Doppler, DDOR), and Command capabilities, with largely the same functional capabilities as those of the DSN, but at significantly higher telemetry and command rates.

4.1.2 Calibration/Science

Less common operational mode will be calibration/science mode. This mode will be used for clock calibration, antenna location determination, array gain and delay calibration, direct acquisition of radio-science data, etc. DSAN will have largely the same functional capabilities as those of the DSN.

4.1.3 Maintenance & testing

Maintenance & testing will be conducted generally during times (and with assets) that are reserved on the schedule for non-operational use.

4.1.4 User-controlled mode

DSAN will allow for a set of assets to be partitioned and assigned to a user for a non-operational (or non-committed) pass. In a user-controlled pass, the user takes responsibility of operating these assets, and for the success of the pass. The DSAN operators are involved only as needed to assure the equipment and personnel safety and the compatibility with the other users during any overlaps.

4.2 Operations Scenarios

Following is an example of activities for a standard spacecraft pass.

1) A customer (user) requests a DSAN pass using a web interface. The request will be generally focused on time and capability (e.g. required G/T), not on specific assets.

2) DSAN validates the completeness of the request, and either asks for a corrected request (if an error was found) or acknowledges acceptance of the request (if the request is error-free).

3) DSAN assigns priority and commits certain capability based on HQ provided algorithm and resources available.

4) DSAN schedules the requisite allocatable resources (primarily antennas, but could also include array signal processing and telemetry equipment, Comm bandwidth, etc). These are documented in a Resource Allocation file (RAF). The RAF may contain reserve equipment, if it is a high priority pass.

5) User prepares and provides appropriate MPF in advance to DSAN Scheduling. DSAN checks the MPF and informs the user of any problem with its validity.

6) Prior to the pass, DSAN Scheduling merges the user-provided and validated MPF with the RAF containing resources allocated to the pass, and generates an OCF.

DSAN will process spacecraft emergencies in a similar manner to the DSN. The key difference is that the decision process on which allocated assets will be de-allocated, if needed, and assigned to the spacecraft in need of emergency support will include the HQ-defined priority algorithm.

DSAN will have a limited capability (TBD) to identify deviations from the spacecraft sequence (MPF) and notify affected parties. This will include events such as loss-of-signal due to safe mode. Response to these non-sequence events will require human intervention.

4.6 Weather Resilience Approach

DSAN will be designed to accommodate degradation due to weather. The following methodologies will be used:

4.6.1 Spatial diversity, Inter-Cluster Arraying

DSAN will use inter-cluster arraying to increase immunity to weather, if the clusters are spaced apart so they reside in different weather cells. Detailed methodology is to be determined.

4.7 Set-up and tear-down approach

Each pass will have a period of setup and a period of teardown. During setup the following activities will be conducted:

1. Construction of a link, i.e. assigning assets to a link
2. Creation and receipt, at the RAC and cluster, of equipment configuration data
3. Configuration of all equipment, based on the configuration data
4. Other preparations, range calibration, moving of antennas, warm-up of transmitters, etc.

During tear-down, the reverse will be conducted, as needed for the next use of equipment. The following will guide the setup/teardown:

1) Setup time will not exceed 15 minutes (5 minutes for more than 95% of the passes), plus the time to move the antennas and warm the transmitters. Teardown time will not exceed 5 minutes, plus the time to move the antennas and restore the transmitter to a standby state.

7) The link is formed, based on timed schedule, by drawing equipment from the equipment pool and the pass is conducted, including set-up and calibrations.

8) During the pass

   (a) The equipment performance and status of the pass can be checked by the customers, operators, and other interested (and authorized) parties, using monitor data accessible using the Internet.

   (b) The customer can make changes to the MPF, if needed. Any change is then sent to DSAN Central where it is automatically merged with the RAF to generate a new OCF. DSAN will be designed to minimize the adverse impact of the change, but it should be noted that at times the change will interrupt the data flow. An end-to-end change should last no more than xx (one minute?), from the time the customer submit the updated MPF, until it is applied at the cluster.

   (c) If performance falls below committed level, reserves (if available) are applied, by internal DSAN process.

9) At the end of the pass (including post-pass calibrations) the assets are released to the equipment pool.

4.3 Post-DSAN processing & feedback

To the extent practical, DSAN will conduct consistency checks on the collected data and either take automated corrective action, or report discrepancies. Examples are checking for missing telemetry blocks, or checking (and eliminating) outliers in radio-metrics data.

However, some flaws caused internal to DSAN cannot be detected internally by the DSAN. A typical case could be a flaw in the ranging/Doppler data that can be detected only when the navigators compare the ranging/Doppler data to the trajectory data. The feedback from the post-DSAN analysis will be provided through an FAR, and will be processed using by the FAR process described in Section 6.1

4.4 Definitions of event criticality

DSAN will use the same event criticality definitions as the DSN.

4.5 Non-sequence Operations, Emergencies

4.8 Demand-access and Beacon Mode Operation

In Demand-access and Beacon mode, the spacecraft will initiate an unscheduled transmission, either confirming a healthy state, or alerting the mission operations center that attention is required. The beacon, or demand-access signal, is either a tone, or a very-low-data rate signal, that can be detected with a smaller ground antenna.

DSAN will support detection of Demand-access and Beacon mode signals. The support will be provided, normally, by a single 12m antenna. Method of requesting the service is TBD. DSAN will not provide automated response – it will be the mission's responsibility to define the response and issue appropriate support requests to DSAN

5.0 DSAN OPERATIONS – LOGISTICS

5.1 Maintenance Philosophy

To the extent possible, DSAN will leverage the fact that there will be a large n umber of identical 12m antennas to simplify the maintenance process and decouple maintenance from operational commitments. (The DSN antennas tend to be more unique, thus the decoupling is more difficult). As a goal, DSAN will reserve 5% of the antennas, at any time, to be in a maintenance pool.

The technical staff at the clusters (including RAC and uplink assets) will work 8x5. However, contractual provisions will be included to facilitate presence of staff at the clusters during critical events. The key roles of the cluster staff will be the maintenance & repair of hardware and the initial disposition of the FARs.

Cluster staff will have access to monitor data, test tools, and suitable checking algorithms to support these roles. Cluster staff will also conduct array calibrations and diagnostic observations periodically, or as needed to pin point problems. There will be three levels of repair:

1) Equipment swaps and simple repairs can be performed by the 24x7 rovers. Recall that the design will incorporate redundancy to minimize the need for intervention by the rovers.

2) More complex swaps, and modest repairs will be done/coordinated by the 8x5 cluster staff, either during the regular working hours or, in rare cases, during an emergency visit to the cluster.

3) More complex repairs ("Depot level") will be done by the original vendors (or by the engineering staff), coordinated via the logistics function at DSAN Central

5.2 Shipping & Inventory

DSAN will use a methodology for shipping and inventory, similar to that used by the DSN. DSAN will investigate whether the DSN tools and processes can be adopted, as-is.

5.3 Spares management

DSAN will use a method for spares management, similar to that used by the DSN. DSAN will investigate whether the DSN tools and processes can be adopted, as-is.

5.4 Configuration Management

5.4.1 General

DSAN will use a method for configuration management, similar to that used by the DSN. DSAN will investigate whether the DSN tools and processes can be adopted, as-is.

5.4.2 Software

All configuration of the operational software will be managed centrally, and will be installed across DSAN remotely, by the central CM organization. Non-operational software may be installed locally, under TBD CM.

5.5 Non-Antenna Facilities

DSAN will handle non-antenna facilities (roads, buildings, power, etc) in a manner similar to that used by the DSN. DSAN will investigate whether the DSN processes can be adopted, as-is.

5.6 Physical Security

DSAN will handle physical security in a manner similar to that used by the DSN. DSAN will investigate whether the DSN processes can be adopted, as-is.

5.7 IT Security

DSAN will handle IT Security in a manner similar to that used by the DSN. DSAN will investigate whether the DSN processes can be adopted, as-is. However, DSAN will rely heavily on multi-layered authenticated access via the web and will deploy IT security assets, accordingly.

6.0 DSAN OPERATIONS – ANALYSIS & REPORTING

6.1 Failure/Anomaly Report (FAR) Processing

6.1.1 General

DSAN will use a single FAR processing/tracking system to capture failures, anomalies, or other issues/concerns in:

Hardware
Software
Procedures
Documentation
Data capture and delivery (Discrepancy Report)
Etc.

FARs will be tracked and closed. Closure could be via repair of hardware, or new hardware design, new software, updated procedures or documents, or by acknowledgement that the root cause is outside DSAN control (e.g. weather, RFI, or spacecraft event).

The FAR tracking system will be an on-line system, similar to AAMS, and will be accessible, world-wide, via the web.

6.1.2 Roles and Responsibilities

1. Opening FAR – all personnel in DSAN are authorized, and encouraged, to initiate FARs. The FAR system will be available to entry by user/customer representatives

2. Initial processing of FARs – Initial processing will be by the 8x5 staff at the RACs/Clusters. We estimate that 90% or more of the FAR's will be resolved by the RACs/Cluster staff.

3. Final Processing and Closure of FAR's – The final root cause analysis, and the confirmation of closure, will be conducted, at DSAN Central.

6.2 Reporting

6.2.1 Metrics

Both standard and customer reporting metrics will be created

7.0 MISCELLANEOUS

7.1 Re-use

To enable cost effective initial development and expansion DSAN will re-use elements wherever possible, for example:

1. All the 12m antennas will use the same mechanical structure, servo drive and control software. They may be modified for X-band uplink, X/X/Ka uplink/downlink, Ka-band uplink, S-band uplink/downlink, 26 GHz uplink/downlink, or other applications through the use of different feeds and electronics, but the mechanical structure and drive hardware and software will be the same.

8.0 Summary

This paper has described current ideas of architecture and operations concept for the Deep Space Array-based Network. It is at revision B level at present and will be further refined and revised version(s) will be issued as it becomes available.

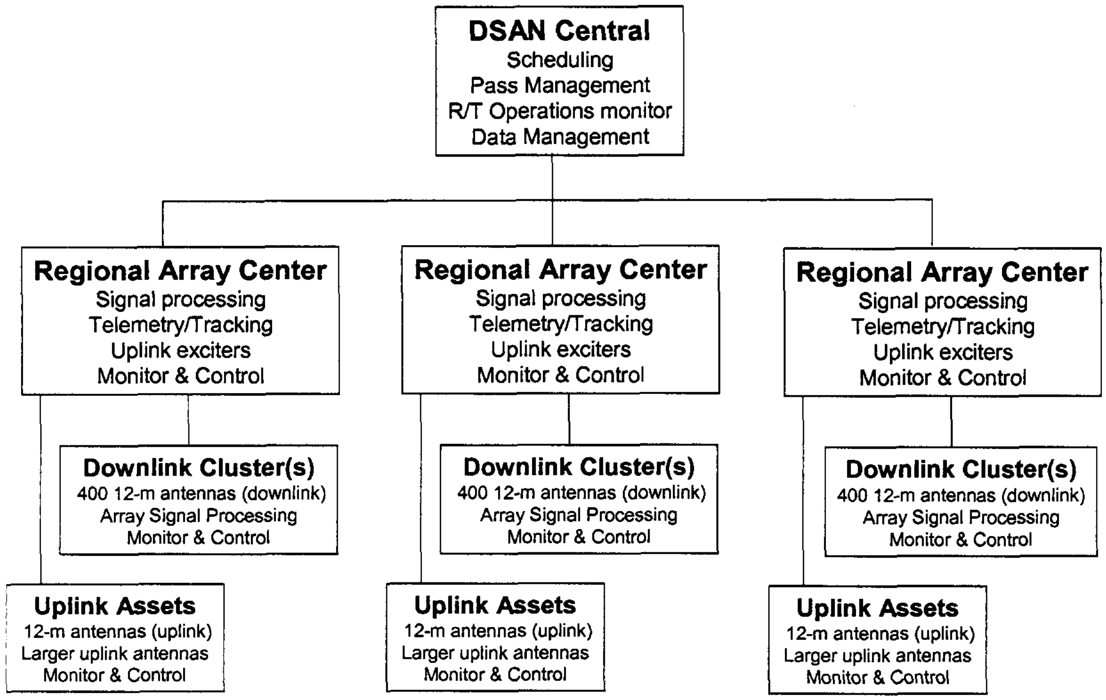


Figure 1 – Deep Space Array-based Network (DSAN) Block diagram

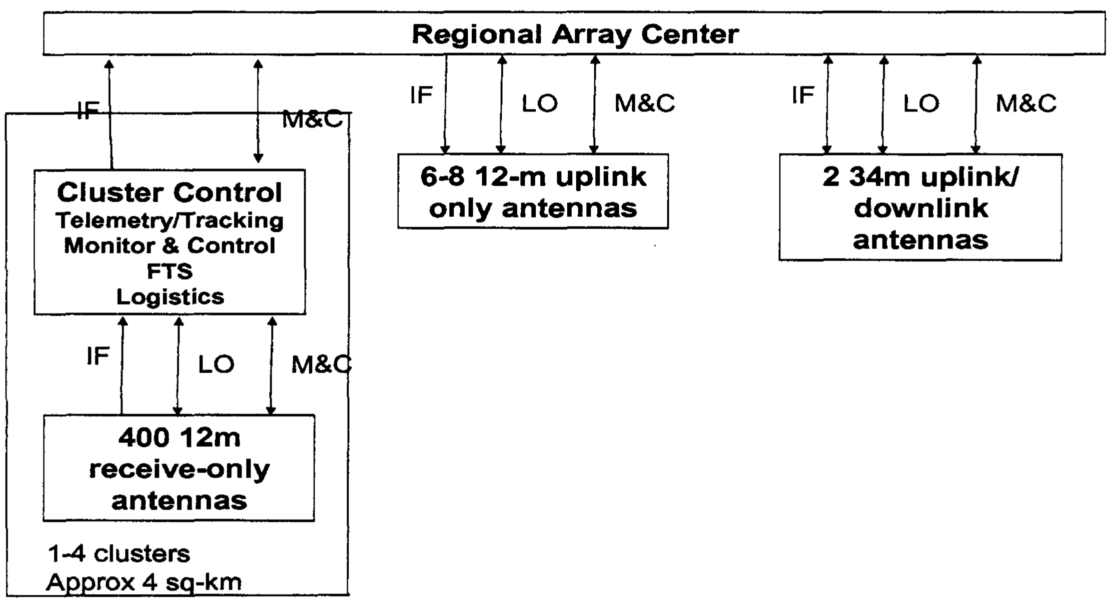


Figure 2 – DSAN Cluster Block Diagram

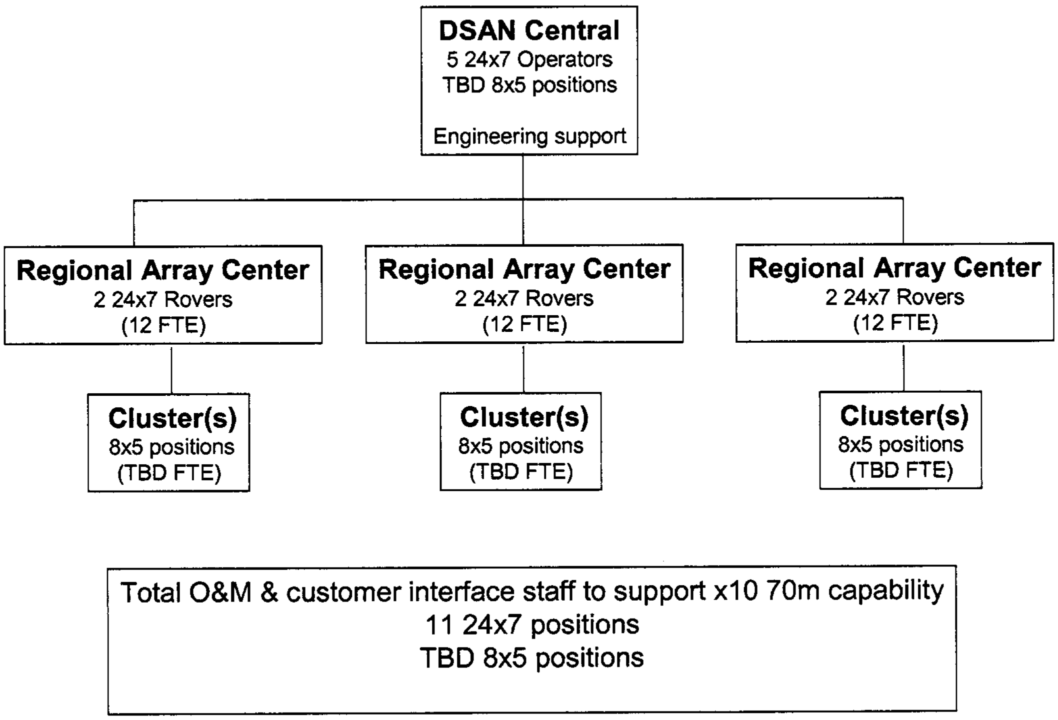
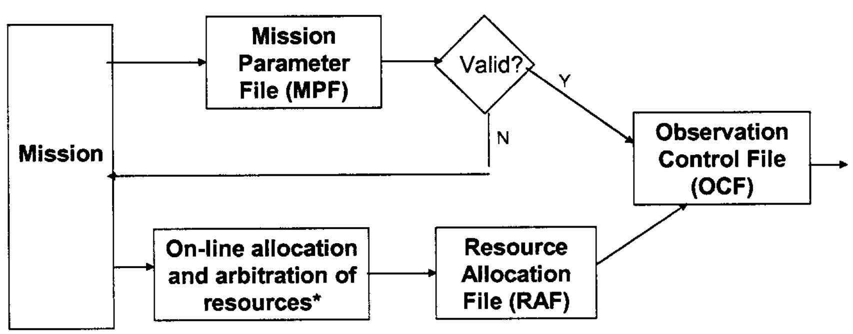


Figure 3 – Staffing levels for the DSAN



•RAF defines all the resources that require an allocation (antenna, comm capability, etc)

•MPF defines the pass parameters, that the mission must define.

•MPF & RAF can be produced long before the pass, or during the pass

•OCF is generated, just-in-time

Figure 4 – Scheduling and support product generation