Deep Space Mission System

DSN Data Delivery

Operational Concept Document

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SECTION 1

INTRODUCTION

1.1 Task Overview

Deep Space Network (DSN) Data Delivery (D^3 or DDD) upgrade task will modify the existing DSMS data capture and delivery functionality and enhance the DSMS Telemetry, Tracking, Radio Sciences, and Beacon Tone Services. The effort of this upgrade is to focus on the capture and delivery of telemetry, and to a lesser extent, tracking data. It proposes development and deployment of a new subsystem, Data Capture and Delivery (DCD) subsystem, to capture and deliver significantly increased downlink data rates. The context diagram of the D^3 task is shown in Figure 1-1.

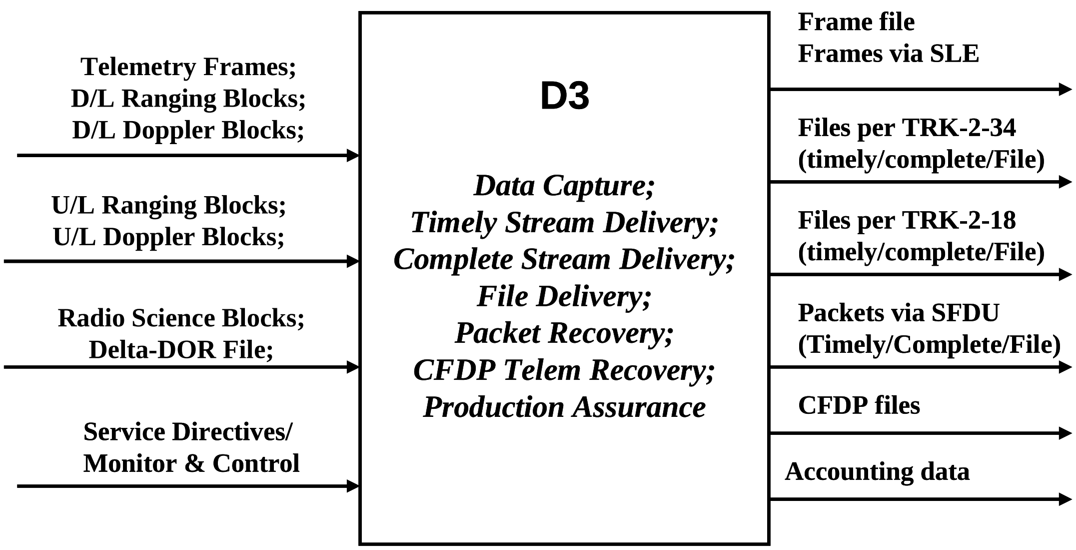

Figure 1-1 DSN Data Delivery Task Context Diagram

The goal of the D^3 upgrade task is to:

(1) Handle significantly increased downlink data rates for both deep space and near-Earth missions over the next decade.

(2) Provide low-latency accountability information that facilitates retransmission as an effective strategy for meeting demands for high degree of completeness in data return.

(3) Balance the commitments to currently subscribed missions against the long-term need to provide mission operations services to the entire set of missions in a cost-effective manner.

(4) Reduce the operational complexity of providing and using the mission operations services.

(5) Reduce the resources required to sustain DSN Data Delivery capabilities.

(6) Simplify the overall data flow path.

(7) Move 30-day archiving service to short term buffering service.

1.2 Development Phase of the D^3 Upgrade Task

D^3 upgrade task is planned to have two phases of implementation/deployment. The phases are based on the priorities as identified in the reference document [15] and requirements as specified in the reference documents [15] and [19] listed in Section 1.4.

Phase I is focused on the implementation of the DCD, the necessary interfaces with DCD, and the necessary infrastructure (e.g., messaging bus and security infrastructure).

Phase II is focused on the upgrade development work on the TTD/TFD and their interfaces with the users.

1.3 Document Overview

Section 2 of this document describes the current architectural design for the DSMS ground data capture and delivery. It describes the architectural design of the D^3 upgrade task, the components and their interaction within the D^3, and the capability/functionality of the D^3. Section 3 describes operations from customer and DSN operations perspectives for Phase I implementation. Section 4 provides major operational scenarios for Phase I implementation.

This document is planned to have a future release to cover the operational scenarios for the Phase II implementation once the detailed design is finalized.

1.4 Controlling Documents

The following documents control the operational concepts of the DSN Data Delivery Upgrade.

Reference ID	Document No	Document Title
[1]	821-102	Telemetry Service Requirements and Design; Rev. C; June 8, 2005
[2]	821-104	Tracking Service Requirements and Design; Rev. D, August 14, 2006
[3]	821-301	Service Management System Requirements and Design, Rev. A; June 13, 2002
[4]		DSMS Information Service Architecture Description (in draft version)

1.5 Applicable Documents

The following documents are referenced in this document:

Reference ID	Document No	Document Title
[5]	820-13 0161-Telecomm	Telemetry Standard Formatted Data Unit (SFDU) Interface; Rev. A (in review cycle)
[6]	820-13 0162-Telecomm	Beacon Telemetry Standard Formatted Data Unit (SFDU) Interface; July 15, 2004
[7]	820-13 0163-Telecomm	Space Link Extension Forward Link Service and Return Link Service; Rev. A; February 15, 2004
[8]	820-13 0166-Telecomm	Space Link Extension Service Instance Configuration File Interface; Rev. A; April 18, 2006
[9]	820-13 TRK-2-18	Tracking System Interfaces; Orbit Data File Interface; Rev. D (in review cycle)
[10]	820-13 TRK-2-34	DSMS Tracking System, Data Archival Format; Rev. I; September 29, 2006
[11]	820-13 OPS-6-12	Flight Project Interface to the DSN Schedule and Sequence of Events Generation; Rev. D; March 15, 2006
[12]	820-13 OPS-6-13	Flight Project Interface to the DSN for Sequence of Events Generation; Rev. D1; March 15, 2006
[13]	820-13 0168-Service_Mgmt	SPS Web Portal Services for Support Data Users; May 15, 2006
[14]	820-13 0196-Data_Management	DSMS Messaging Service Interface (in review cycle)
[15]	827-204	DSN Data Delivery Upgrade Requirements and Design (in review cycle)
[16]	828-011	Deep Space Network Requirements on NASA Integrated Services Network; System Requirements; Rev. A; January 4, 2006
[17]	834-072	Network Monitor and Control Subsystem (NMC), Subsystem Functional Requirements; March 23, 1999

[18]	834-080	Service Preparation Subsystem (SPS), Functional Requirements Document; Rev. A; September 24, 2002
[19]	834-148	Data Capture and Delivery Subsystem Functional Requirements Document (in signature collection cycle)
[20]	834-151	Service Quality Assessment (SQA) Subsystem; Functional Requirements Document; August 23, 2005
[21]	CCSDS 102-B-5	CCSDS Packet Telemetry; Blue Book; Issue 5; November 2000
[22]	CCSDS 620.0-B-2	CCSDS Standard Formatted Data Unit Structure & Construction Rules; Blue Book; Issue 2; dated May 1992

SECTION 2

System Design

2.1 Key Characteristics of the D^3 Task System Design

The D^3 task provides data handling and management for DSN produced telemetry and tracking stream data. The system design of the D^3 task has the following key characteristics:

(1) Provide automated capture, data handling and management of received DSN produced telemetry and tracking datasets. (Upgrade existing capability)

(2) Provide data capture and delivery protocols for the acquisition and delivery of the DSN produced datasets and associated files containing production configuration and operational metadata. (Upgrade existing capability)

(3) Provide transfer acknowledgements such that automated custody transfer can be accomplished and delivered data can be routinely deleted from its DSCC stores. (New capability)

(4) Delivery services include capability to assign (per service instance configuration) priorities to delivery of mission datasets. (New capability)

(5) Provide four user-selectable delivery mechanisms (e.g., timely, complete, and file) for delivery of mission data. (New and modification to current capability)

(6) Provide file delivery protocol to deliver produced datasets with their production and transport metadata. (Upgrade existing capability)

(7) Provide stream delivery services for DSN produced datasets by utilizing CCSDS SLE Protocols. (Upgrade existing capability)

(8) Provide direct SLE frame delivery from a DSCC to a mission (including JPL and non-JPL missions). (New capability)

(9) Provide Packet extraction and delivery from received frames. (Unchanged existing capability)

(10) Provide CFDP service to assemble files transmitted from a spacecraft in telemetry using the CFDP at JPL. This service will provide the users and DSMS Operations with continuous status for each open transaction along with its accounting. Early delivery of incomplete files is available using automated and manual controls. (Unchanged existing capability)

(11) Provide adequate storage so that verified delivery and custody transfer of datasets can be accomplished within a pre-determined period of time of receipt (i.e., 7 days). (New capability)

(12) Provide DSCC operations with visual monitoring of the system's operational and performance status and alert the operator when operator intervention is required. Human interaction is limited to exception handling. (New and upgrade)

(13) Provide periodic accounting information associated with each data capture and delivery activity via DSMS messaging bus. (New capability)

2.2 Existing DSMS Ground Data Capture and Delivery Design

The current DSMS design for performing ground data capture and delivery is depicted in Figure 2-1. The existing DSMS data capture and delivery functionality relies on components of the Telemetry, Tracking, and Command (TT&C) and Ground Data Delivery (GDD) system. The existing design receives telemetry and tracking data from DSN Front-End Service Providers. The existing design also uses the DSMS infrastructure (e.g., network) for communication.

It is assumed that 26M service will be phased out within the D3 development window. If not, additional legacy front-end producers and providers will need to be developed.

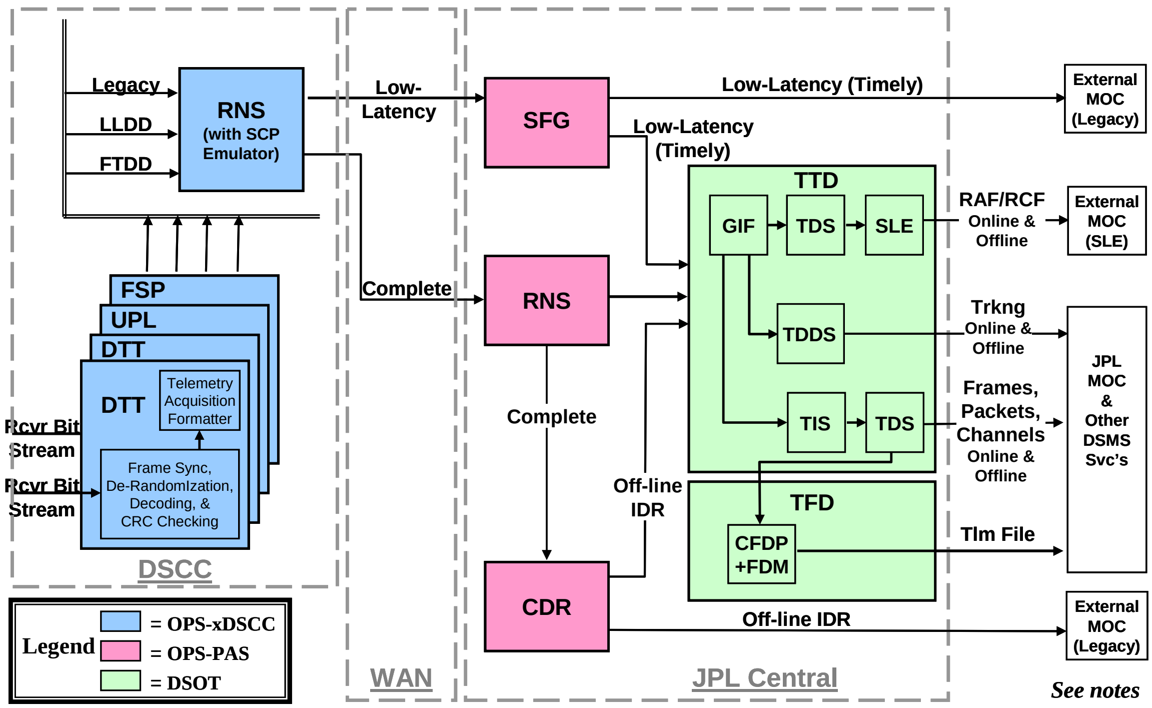

Figure 2-1 Current DSMS Ground Data Capture and Delivery Design

2.2.1 Key Components of the Existing Ground Data Capture and Delivery Design

The key components/features of the current design used to perform the ground data capture and delivery functionality are briefly described as follows.

Data capture, delivery, and storage components: These components are planned to be replaced by the new DCD subsystem from the D^3 task.		
(1)	Reliable Network Server (RNS)	The RNS is a redundant system responsible for reliable transfer of data between the complexes and JPL. RNS assemblies are deployed both at the DSCC's and at JPL Central. The RNS is part of the GDD system.
(2)	Special Function Gateway (SFG)	The SFG comprises a pair of assemblies (hardware & software) within the GDD subsystem. It implements the interface to the external missions for real time data flows (e.g., Low Latency Data Delivery (LLDD), monitor data, tracking data broadcast). Note: • Only the telemetry data flow that is currently supported by the SFG is replaced by DCD subsystem SFG will continue to be used to flow non-SLE telemetry data, tracking data (for Goddard and APL missions), and monitor data.
(3)	Central Data Recorder (CDR)	The Central Data Recording group is a major assembly within the GDD system. It is the repository of all data delivered via the RNS. Data is typically stored for 30 days.
(4)	GDD Monitor Processor (GMP)	The GMP collects and aggregates accountability data into condensed and compressed accountability records. The GMP function of monitoring RNS data traffic will be replaced by DCD.

Data processing components: These components will remain the same except any needed interface modification to accommodate the new DCD subsystem and needed upgrade to support new protocols.		
(1)	Telemetry & Tracking Data (TTD) Subsystem	The TTD performs higher-level processing of tracking and telemetry data at JPL-Central. It also conveys downlink data to subsequent DSMS service stages (e.g. Long-term Repository Service, Experiment Product Delivery service, Validated Radio Metric data service) as well as to individual flight project end-users. TTD currently contains the following elements: • Ground Communications Facility (GCF) Interface Subsystem (GIF) • Telemetry Delivery Subsystem (TDS) • Telemetry Input Subsystem (TIS) • Telemetry Space Link Extension (SLE) • Tracking Data Delivery Subsystem (TDDS)

(2)	TTC File Delivery (TFD) Subsystem	The TFD performs CFDP transaction processing and management. TFD consists of multiple elements: • CCSDS File Delivery Protocol (CFDP) element • File Delivery Manager (FDM) element

2.2.2 DSN Subsystems Interact with the Existing Ground Data Capture and Delivery Design

Front-end service producers:

There are several DSN front-end service producers, each with their own data types and interfaces. Those front-end service producers are expected to remain the same other than the needed interface modifications in order to interact with the new DCD subsystem.

(1)	Downlink Tracking and Telemetry (DTT) subsystem	DTT is the downlink front-end that demodulates the received signal from the antenna into a quantized bit stream and extracts frames from that bit stream. It also generates downlink tracking data in the form of ranging and Doppler blocks.
(2)	Uplink Tracking and Command (UPL) subsystem	UPL primarily handles data processing for the uplink communications with spacecraft. However, it also generates uplink tracking data in the form of ranging and Doppler blocks.
(3)	Full Spectrum Processing (FSP) subsystem	FSP supports radio science investigation, VLBI investigation including Delta-DOR measurement for navigation purposes, and array processing that enhances telemetry and tracking performance.
(4)	Service Preparation Subsystem (SPS)	SPS performs support data preparation, generation, and distribution for DSN tracking support. See Section 2.3.2.2 for more information.
(5)	Network Monitor and Control Subsystem (NMC)	NMC performs link configuration. See Section 2.3.2.4 for more information.

2.2.3 Supporting DSMS Components to the Existing Ground Data Capture and Delivery Design

DSMS Infrastructure Components

The communication within the existing data capture and delivery design relies on the DSMS infrastructure. Those infrastructure components are planned to remain the same. Some network enhancements on those components are expected but is beyond the scope of the D^3 upgrade task.

(1)	Ground Networks (GNW) subsystem *[not shown in Figure 2-1]*	The GNW provides the local area network (LAN) environments of each DSCC, of JPL Central, and of JPL flight operations.
(2)	Wide Area Network (WAN):	The communication between a DSCC and JPL is via WAN.

2.3 DSN Data Delivery Upgrade Task Design

The system design for the D^3 upgrade task is illustrated in Figure 2-2.

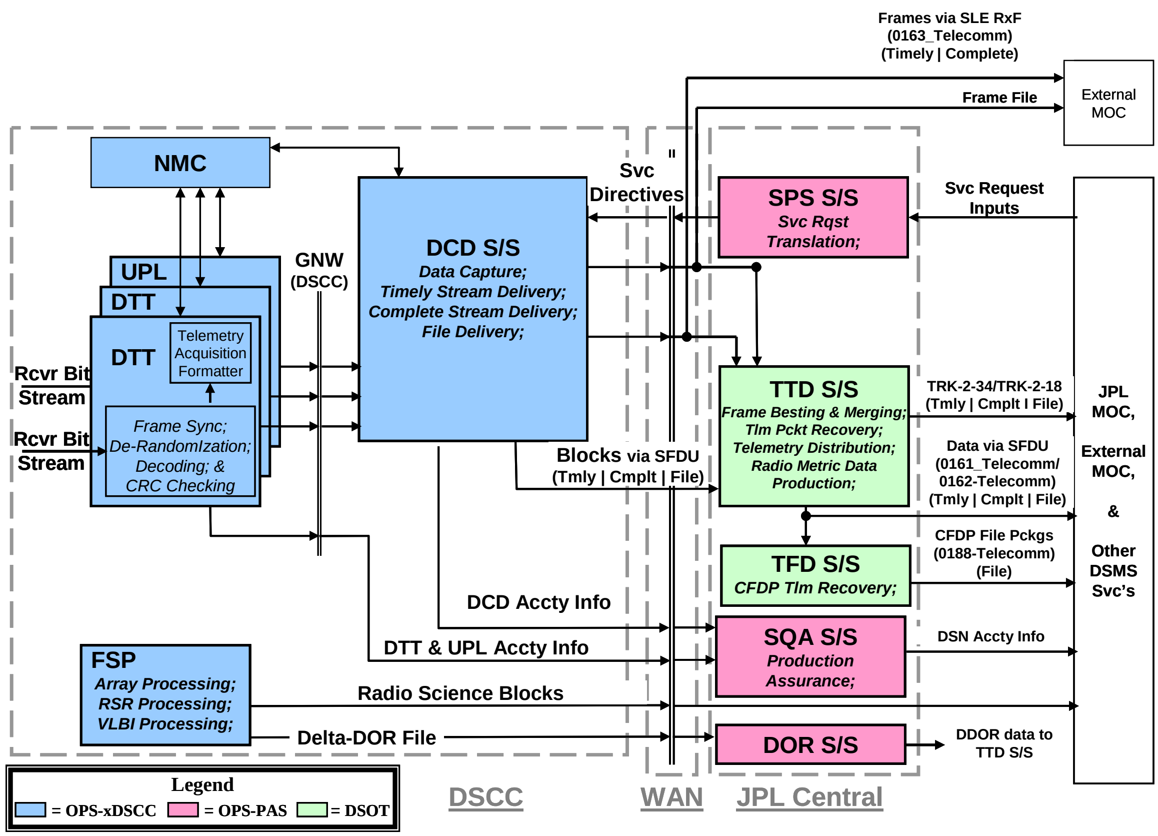

Figure 2-2 D^3 Task System Design Diagram

After the upgrade, the D^3 is able to capture the various data streams produced by relevant DSMS subsystems located at each station in a Deep Space Communications Complex (DSCC) with increased reliability and efficiency. D^3 is mainly composed of a new subsystem (DCD) and two existing subsystems (TTD and TFD). The telemetry data captured by the DCD not only can be delivered to JPL for further data processing, but to flight projects directly.

The DCD subsystem is where most of the new implementation of the DSN Data Delivery Upgrade task will take place. Some interface modifications to DTT, UPL, and TTD are expected to interact with the new DCD. However, there is no plan to change the interface between the TTD/TFD and data recipients/users. How TTD and TFD deliver their output data to the data recipient and how user's query is expected to remain the same (except the SLE RAF/RCF frames).

The D^3 task is composed of the following major components:

- Data Capture & Delivery Subsystem (a new subsystem)
- Telemetry and Tracking Data Subsystem (an existing subsystem)
- TTC File Delivery Subsystem (an existing subsystem)

The D^3 task interfaces with the following DSMS components:

- DSN front-end service producers (e.g., UPL, DTT, etc)
- Service Preparation Subsystem
- Service Quality Assessment Subsystem (SQA)
- Network Monitor & Control Subsystem
- DSMS Information Services Architecture (DISA) *[not shown in Figure 2-2]*

The D^3 task utilizes the following DSMS infrastructure.

- Ground Network Subsystem (GNW)
- Wide Area Network (WAN)

2.3.1 Major Subsystems of the D^3 Task

2.3.1.1 Data Capture & Delivery Subsystem

DCD is a new DSN subsystem which is responsible for telemetry and radiometric data capture and delivery.

The DCD is located at each DSCC and provides the capability to deliver DSN produced datasets directly to a Flight Project Mission Operations Center (MOC). It also forwards captured data to other DSMS elements located at JPL (e.g., TTD and TFD) for further processing and/or distribution. The DCD employs common stream [i.e. Consultative Committee on Space Data Systems (CCSDS) Space Link Extension (SLE)] and file delivery protocols. A DCD context diagram is shown in Figure 2-3.

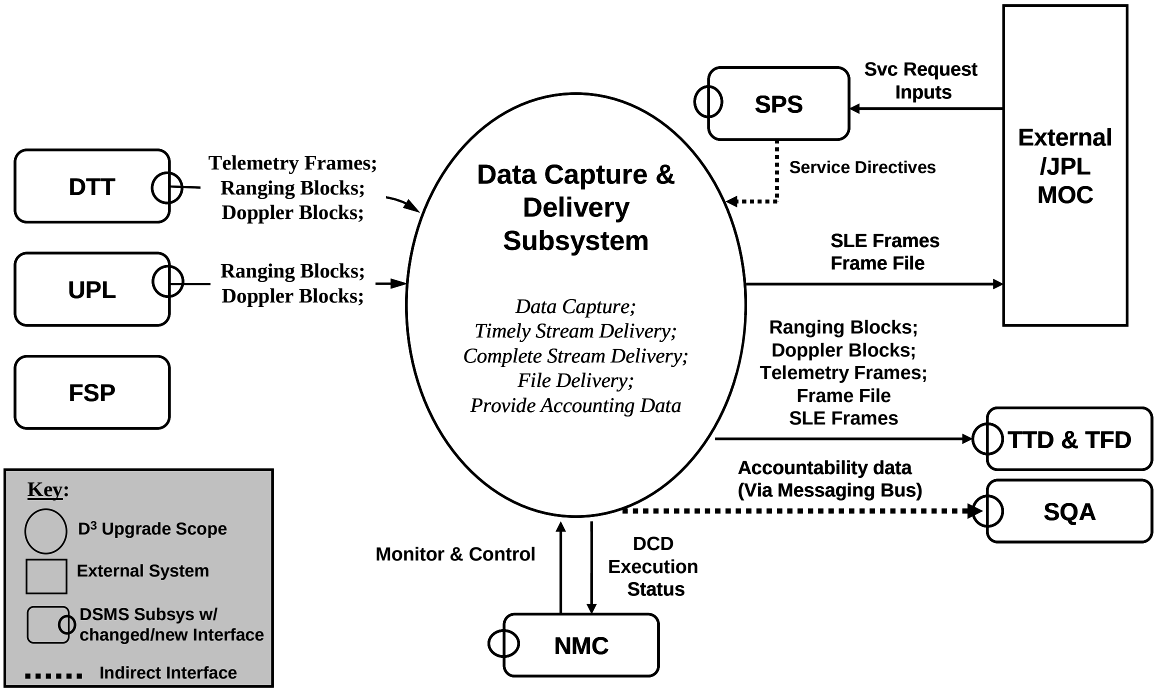

Figure 2-3 DCD Context Diagram

The main functionalities/capabilities provided by the DCD are listed below:

(1) Capturing mission telemetry and tracking data that are acquired by DSN equipment.
(2) Buffering the data to accommodate the bandwidth constraint or outages in the wide area network prior to successful custody transfer.
(3) Cataloging data to enable query and data accounting.
(4) Managing data delivery to Mission Operations Centers and Telemetry Tracking Delivery subsystem (TTD), per priority subscription.
(5) Delivering tracking data to the Telemetry Tracking Delivery (TTD) Subsystem for computation of Doppler and ranging observables.
(6) Delivering SLE frames to Mission Operations Centers directly.
(7) Generating DCD-specific data accountability to enable Service Quality Assessment (SQA) subsystem to account service-level performance.
(8) Provide the following data delivery modes:
   - Timely stream delivery for telemetry frames, candidate (arbitrary data records that could not be successfully synchronized or decoded) frames, beacon telemetry data, and tracking data.
   - Complete stream delivery for telemetry frames, candidate frames, beacon telemetry data, and tracking data.

- File delivery for telemetry frames, candidate frames, beacon telemetry data, and tracking blocks.

2.3.1.2 TTD Subsystem

TTD subsystem performs high level processing of tracking and telemetry data at JPL-central. It also conveys downlink data to subsequent DSMS service stages (e.g. Long-term Repository Service, Experiment Product Delivery service, Validated Radio Metric data service) as well as to individual flight project end-users. The main internal functionalities/capabilities provided by the TTD subsystem are listed below:

(1) Provide frame besting & merging

(2) Provide telemetry packet recovery

(3) Perform telemetry distribution

TTD receives telemetry frames and tracking data from the DCD. TTD delivers telemetry packets, telemetry files, and validated/corrected radio metric data to each subscriber in accordance with the user-requested delivery grades/priorities.

(4) Perform radio metric data production

(5) Produce domain-specific accountability metrics

TTD is an existing DSN subsystem. While its principle responsibilities remain largely unaltered by DSN Data Delivery Upgrade system design, there are numerous interface changes.

2.3.1.3 TFD Subsystem

TFD subsystem performs CFDP application at JPL-central. The main internal functionalities/capabilities provided by TFD are listed below:

(1) Provide CFDP telemetry recovery

(2) Perform telemetry distribution

TFD receives packet streams from TTD. TFD delivers recovered telemetry package to each subscriber in accordance with the user-requested delivery grades/priorities.

(3) Produce domain-specific accountability metrics

TFD is an existing DSN subsystem. While its principle responsibilities remain largely unaltered by DSN Data Delivery Upgrade system design, some interface changes are required.

2.3.2 DSN Subsystems Interaction with the D^3 Task

2.3.2.1 DSN Front-End Service Producers

DTT and UPL subsystems are the producers of the data to be captured and delivered by the DCD Subsystem. The DTT produces telemetry frames and tracking data associated with the return link. The UPL produces tracking data associated with the forward link.

2.3.2.2 Service Preparation Subsystem (SPS)

SPS is a major component of the Service Management System (SMS). The SPS provides all short term scheduling and preparation of requests for DSMS services prior to actual service execution. The SPS is responsible for generating support data to DSN subsystems in response to user requests for standard DSMS services. The support data are generated by using flight project provided inputs which include service requests, DSN tracking schedules (7-day operational schedules), trajectory files, DSN keyword files, Service Instance ConFiguration (SICF) file, etc. The support data generated by the SPS include predicts (antenna pointing, downlink frequency, uplink, telemetry, and delay), Service Directives[1] (e.g., DSN subsystem specific configuration files), antenna specific configuration files, pass sequence of events file, etc. Only Service Directives are needed by the DCD subsystem. The other types of support data generated by the SPS are for the other DSN subsystems (e.g., DSN Front-End Service providers, etc).

2.3.2.3 Service Quality Assessment Subsystem (SQA)

SQA currently does not exist and is a major component of the Service Management System (SMS). The SQA will assess the performance and the quality of services based on the information provided by the relevant DSMS components. DSMS components can publish their domain specific accounting information to the messaging bus where SQA can subscribe the needed accounting information from. The publication and subscription of the accounting information is expected to be based on the DSMS Information Service Architecture. The SQA will monitor the end-to-end performance of the DSMS from the time a customer enters a service request until the service is executed by the DSMS and service products are returned to the customer. The SQA will capture and store DSMS performance and service quality metrics; will assess the quality of the services provided by the DSMS; and will provide service accountability to the customer.

SQA will not interact with the DCD directly. SQA will subscribe the accounting data published by the DCD via the messaging bus as it will for other subsystems. The D3 upgrade task will not rely on the implementation of SQA as described by the SQA FRD. It will only require that some application will be available to provide data delivery accountability information for quality assessment and production assurance purpose.

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[1] A Service Directive is a set of instructions for a specific instance of a particular internal service or process. It can be in a file format or other kinds of format pending on the Service Management design.

2.3.2.4 Network Monitor & Control subsystem (NMC)

NMC is a major component of the Service Management System (SMS). The NMC is responsible for monitor and control of DSN subsystems, as well as for generation of externally deliverable monitor data. It contains the means whereby subsystems are assigned to a connection to form a virtual network of ground equipment for the duration of a spacecraft pass, as well as interfaces for collecting, displaying, and disseminating monitor data. The NMC is an existing subsystem. NMC will provide direct operator control of and visibility into the operation of the DCD.

2.3.2.5 DSMS Information Services Architecture

D^3 upgrade task requires the DISA capabilities/services available at DSCCs. DISA is based on the services provided by the DSMS Common Information Services Components (DCISC) subsystem. The following DISA provided institutional capabilities are expected to be used by the DSN Data Delivery Upgrade.

(1) The DSMS messaging bus and attendant messaging service

DCD is planned to publish domain specific accounting data to the DSMS messaging bus.

(2) Registry service, both for service registry and data registry capability

SPS is expected to disseminate the Service Directives to the relevant service providers as specified in the Service Registry. By addressing Service Directives to the registered service provider, rather than directly to the DCD or TTD or TFD subsystems, it provides significant degree of deployment, migration, and test flexibility

(3) A common security service providing basic authentication, authorization, and integrity assurance mechanisms

All user interactions with the D^3 upgrade task (e.g., data query, SLE service binding, etc) are required to comply with the DSMS security standard or use the DSMS common security service.

2.3.3 Supporting DSMS Components to the D^3 Task

2.3.3.1 Ground Network Subsystem

The GNW provides the LAN environments of each DSCC, of JPL Central, and of JPL flight operations. A separate subsystem, the AMMOS Ground Network subsystem (AGNW), provides the LAN environment for AMMOS deployments at JPL Central.

2.3.3.2 Wide Area Network

Wide area network communications service between the DSCC's and JPL Central is provided by a combination of functionality from the Ground Transmission Subsystem (GTX), the

Ground Networks Subsystem (GNW), and from the NASA Integrated Services Network (NISN).

2.4 Capabilities of the D^3 Task

The capabilities provided by the DSN Data Delivery Upgrade are described below.

2.4.1 Stream Data Capture

The DCD subsystem captures stream data produced by the DSN Front-End Service Producers (e.g., DTT, UPL, etc). The protocol for data interfaces between the DSN Front-End Service Producers and the DCD subsystem may need to be changed, pending future trade analysis. A Service Directive will be used to provide the DCD the configuration information to formulate the named dataset(s) for each received data stream. The DCD will open a dataset repository for each produced data stream. The stream is identified by its unique identifiers (e.g., Stream ID, etc). A series of datasets will be created for a stream, each limited in size by a time period and/or volume defined by a configuration parameter. The DCD will also capture the metadata associated with each stream in a metadata log file. In addition to the information being recorded in a metadata log file, domain-specific accountability data for all the data units captured within a defined time period will be published periodically to the DISA messaging bus. The DCD monitor data may also be published to the DSCC operations via MON-2 protocol (or other type of protocols) for monitoring DCD operations.

2.4.2 Delivery Prioritization

Data can be delivered based on customer-specified priorities. Priorities only control the relative rate of delivery within a specific mission's data (e.g., based on virtual channel). A flight project needs to provide the applicable delivery prioritization rules as part of the service request inputs.

2.4.3 Data Delivery Mode

The data delivery can be performed by using different delivery methods (stream and file) and different modes (online/offline and Complete/Timely) and applicable delivery prioritizations. Projects can apply different delivery methods to different virtual channels.

Any particular virtual channel can only be delivered using one mode and method. For example virtual channel 0, if scheduled for Timely service can not also be delivered using Complete service.

2.4.3.1 Stream Delivery

Stream delivery service provides the capability to deliver stream-oriented data from a Front-End Service Provider (e.g., DTT, UPL, etc) to recipients (Flight Project End Users and TTD and TFD subsystems). Telemetry and tracking data are delivered to the DCD subsystem as stream input.

Stream delivery can be either Timely or Complete.

If a Timely or a Complete stream delivery is scheduled, the service request inputs indicate what data sets to deliver, and configuration information sufficient to enable binding to the receiving application. The same information is provided via a query for offline Complete delivery or the gap delivery of an Extended Timely service.

2.4.3.1.1 Timely Stream Delivery

There are two kinds of Timely stream delivery:

(1) Timely (Standard Timely): A Timely delivery is one in which there may (or may not be gaps) and the system takes no action to either monitor or keep track of which data was successfully transferred. The data units that cannot be delivered within the allotted latency are dropped (oldest first).

Timely stream delivery is always scheduled and is an on-line service. Timely stream is a limited service due to bandwidth constraints. This type of delivery should be pre-agreed between a flight project and the DSMS.

(2) “Extended Timely”: An Extended Timely delivery has components of both the Timely and Complete:

- The 'real-time' data stream may have gaps, but the system keeps track of the untransferred (or 'gapped') data. The Timely component is scheduled and on-line.
- The delivery of the gap data is ONLY off-line and unscheduled (and thus necessarily on via query).

Note:

- “Extended Timely” is not a CCSDS standard service.

Data delivery is initiated immediately upon ingestion, and the data delivery rate is equal to the data ingest rate throughout the duration of the service instance. For a Timely delivery, data units will be skipped due to the following reasons:

- DSN can not keep up with the data rate due to WAN degradation or outage. If the service cannot keep up the data rate, data units will be skipped and the most recent data will always be delivered within the time constraint.
- Recipient can not keep up with the data rate: The data units couldn't be delivered because the custody transfer wasn't completed.

2.4.3.1.2 Complete Stream Delivery

Complete stream delivery delivers streams of telemetry and tracking data that have been previously captured.

There are two kinds of Complete Stream delivery:

(1) Complete on-line stream delivery.

Complete on-line stream delivery is scheduled.

(2) Complete off-line stream delivery

Complete off-line stream delivery can either be in response to end-user queries or be scheduled. A user query for a complete stream delivery can be requested after a tracking pass has been completed and before the requested datasets are removed from the data repository.

2.4.3.1.3 SLE Stream Delivery

The received telemetry data can be delivered to the Flight Project End Users by the DCD using the CCSDS Space Link Extension (SLE) protocol. Two types of SLE deliveries are supported:

(1) SLE telemetry Return All Frames (RAF)
(2) SLE telemetry Return Channel Frames (RCF)

SLE RAF and RCF services support both online and offline delivery modes. In essence, online delivery mode refers to telemetry that is delivered to a flight project during the tracking pass. The offline delivery mode refers to telemetry that is delivered post-pass. Both offline and online deliveries are used to deliver telemetry data directly from the DCD at a DSCC to a flight project.

SLE stream delivery requires binding before frames can be delivered to the recipients regardless if the delivery is scheduled or is in response to a query. The binding is to establish TCP association between the service provider (e.g., DCD subsystem) and service users (e.g., flight project users, etc). The authentication is required before the binding can be established.

2.4.3.2 File Delivery

The function of file delivery provision represents the reliable file delivery of previously captured telemetry and tracking data to users or DSMS-internal clients, either on a subscription basis or in response to ad hoc queries. File Delivery service is guaranteed to be complete even in circumstances of temporary communications interruption.

A user can elect to receive a captured dataset as a file containing all or a subset of the captured telemetry and tracking data stream. The delivery of subsets of a file will require the DSN Data Delivery Upgrade to use user specified configuration parameters to select the desired data units and create a product for delivery. This product will be accompanied by a metadata log file for the subset product.

File delivery service can be either scheduled or be performed in response to user request from a provided catalog.

File delivery is provided off-line.

File delivery is only provided for datasets that have been closed.

2.4.4 Packet Service

Packet services will be provided at JPL Central and not at a DSCC. Packet Service includes the extraction of packets from the telemetry frames contained in the designated frame stream or frame dataset. These packets are extracted from a virtual channel and delivered to the designated destination. The offline portion of this service relies on a multi-stream frame merging capability that creates a single integrated stream of frames from which the packets are extracted.

Telemetry packet recovery service can be either scheduled or be in response to a query.

Telemetry packet recovery service can be either online or off-line. An off-line telemetry packet recovery service is in response to end-user queries.

Note: CCSDS Space Packets have Application Identifiers (APIDs) that are mission defined and thus the delivery of these packets is table driven using packet information provided by a flight project.

2.4.5 CFDP Production and Delivery

This application process will extract CFDP Protocol Data Units (PDUs) from selected Virtual Channels within a stream and perform the CFDP production. The CFDP application would subscribe to the TFD subsystem (a scheduled SLE service to the CFDP application) for the specific mission’s Virtual Channel data frames that are to be processed. This application process is always running and springs into action when the specific data is made available. An instance of the CFDP application will result in the creation of user file products and associated metadata products which will be cataloged and delivered to the flight projects.

CFDP telemetry recovery service can be either scheduled or be in response to delivered packets.

CFDP telemetry recovery service can be either on-line or offline.

2.4.6 Radio Metric Data Production

DSN Data Delivery Upgrade provides the following tracking services:

- Raw radio metric measurements service
- Validated Radio Metric Data service

Tracking Data Delivery Subsystem (TDDS) is used to produce validated radio metric data service. TDDS is an existing DSN capability, provides real-time capabilities for receiving, validating, and correcting radio metric data, and generating observables from the received tracking data. In addition, it provides near-real-time capabilities for generating tracking data products, as well as non-real-time capabilities to process tracking data.

2.4.7 Production Assurance

The production assurance function provides periodic accounting reports to flight project users, operation personnel, and/or application software. The accounting reports are regarding the flow of data supported by the D^3 upgrade task. The accounting reports are generated based on user specified rules and criteria. The accounting reports report the flow of data through DCD. The reports provide information regarding data received in the capture process as well as data delivered to users. The information captured in an accounting report includes what data streams have come in and what have been delivered, which segment still not custody transferred, where the data gaps are, etc.

The DCD is expected to publish its domain specific accounting information to the messaging bus so that the accounting reports can be generated by the SQA.

2.4.8 Data Catalog

A data catalog produced by the D^3 task should have the capability to contain all datasets which have been or are in the process of being captured, but have not yet been relinquished (i.e. removed from the repository post successful custody transfer).

A DCD directory/catalog entry is created for each created dataset. Since a dataset name reflects the service type and instance, the user (mission), and the start time, this information of a dataset name will be co-opted for use in the catalog and for querying. The query can be for data discovery (identifying what is available in the catalog) or a specific request for certain data set.

2.4.9 Data Retention

The data retention capability of the D^3 upgrade task will reliably store each captured dataset until relinquishing criteria (defined below) are met. Once the data is custody transferred to users, DSN does not have the responsibility to store data. The long-term data storage service is not provided by the DSN.

The DCD subsystem may relinquish (i.e. delete from both storage and catalog) any captured dataset or file whenever either of the following criteria are met:

- Custody has been transferred to a recipient;
- The specified retention window (maximum 3 days) has expired.

Note: Custody transfer is supposed to occur within the specified retention window. Customers are repeatly notified until a custody transfer takes place. Data are marked for relinquishment after the specified retention window regardless whether the custody transfer has occurred; however, the data may be stored in the repository for another specified backup retention period. The backup retention period is configurable and determined by the DSN and is strictly for DSN internal usage.

2.4.10 Metadata

One capability provided by the D^3 task is to construct metadata for the captured/delivery data streams. Metadata is structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage the data generated by the DCD. Metadata provides information regarding how and when the data was created, file type (SLE, etc) and other technical information (e.g., DSN Pass ID, Mission ID, stream ID, frequency band, start time, etc), and who can access it. The metadata for each dataset will be transferred to the recipient as part of the custody transfer.

2.5 Scope of the D^3 Task for Phase I Implementation

The scope of the D^3 task contains the following items:

(1) Implement a new subsystem, DCD replacing the existing GDD.

(2) Make modifications to the existing telemetry/tracking data processing subsystem, TTD. The modifications are limited to the interfaces between TTD and DCD to support new protocols. These TBD new protocols are used to deliver data from DCD to TTD and any necessary information exchange between DCD and TTD. Additionally, the SLE interface to external Mission Operations Centers (MOCs) shall be moved form JPL central to the DSCCs.

(3) Make modifications to the existing front end service providers, DTT and UPL, to interface with DCD.

(4) Implement DSMS messaging and security services.

(5) Extend the DSN service management capabilities to provide monitor, control, and accountability for data capture and delivery capabilities. Specifically:

- Extend the existing SPS subsystem to generate the requisite Service Directives (e.g., configuration files or other forms) from customer inputs and disseminate them to the affected subsystems.
- Make modifications to the existing NMC subsystem to monitor and control DCD. The modification is limited to the update on the NMC equipment configuration files. This update will allow the NMC to handle new DSN equipment. No software modification to the NMC is expected.
- Partial implement of quality assurance (e.g., SQA) to provide data accountability information.

(6) Introduce new protocols which are used for:

- Data Capture Protocol: A stream-oriented, application/transport layer protocol used for transferring data capture units from front-end producers over a local-area network. DTT and UPL subsystems will be modified to support this protocol.

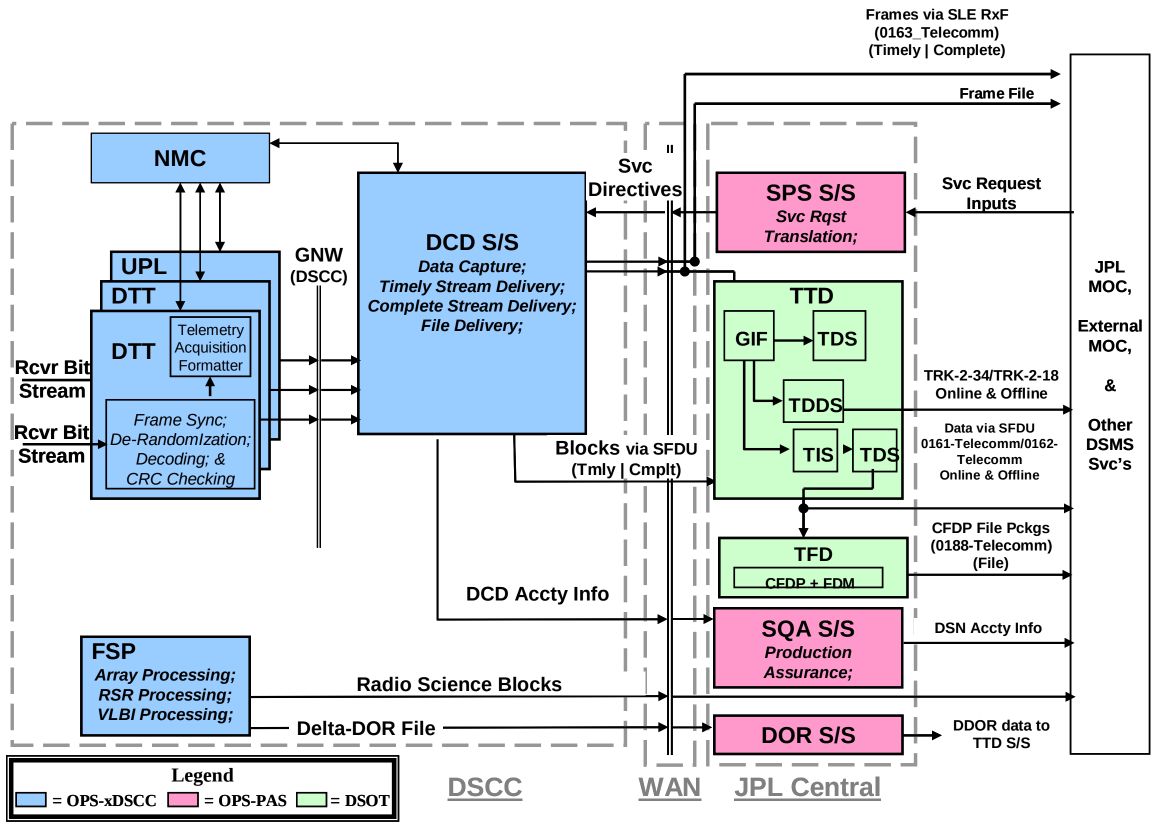
- File Exchange Protocol: An application/transport layer protocol used for delivering files with attendant meta-data over local or wide-area networks. TTD and TFD subsystems will be modified to support this protocol.
- Stream Delivery Protocol: An application/transport layer protocol used for delivering data streams with attendant meta-data over local or wide-area networks. TTD and TFD subsystems will be modified to support this protocol.
- Delivery Request and Catalog Request Query Protocols: Application/transport layer protocols used for requesting data delivery or catalog information over local or wide area networks.

SECTION 3

OPERATIONS FOR D³ PHASE I IMPLEMENTATION

3.1 D³ Phase I Implementation

The system design for the phase I implementation of the D³ upgrade task is illustrated in Figure 3-1.



* The existing GIF may not be valid for the actual design/interface.

Figure 3-1 D³ Task Phase I System Design Diagram

3.2 Overview of the DCD Operations

Configuration and operation of the DCD is initiated by service requests[2]. Service requests identify the "what" of the DSMS mission operations services are needed for a tracking pass. The service request from a flight project includes information related to the trajectory and telecommunications configuration onboard the spacecraft in question. DSMS Service Management (e.g., SPS, etc) interprets the input from the service request and determines which internal services (telemetry service, tracking service, command service, etc) are required to fulfill the customer's request. The SPS expands and translates the inputs associated with the service request, such as spacecraft events, trajectory data, requested telemetry/tracking services, etc into Service Directives relevant to the DSN ground equipment (e.g., DTT, UPL, FSP, DCD, etc). Service directives are generated for the DSN equipments that require them.

DCD configures itself based on the information in a Service Directive. The DCD's capture process is required to be highly reliable so that data received from the DSN Front-End Service Providers (e.g., DTT, UPL, etc) are very rarely lost. The capture and delivery of the DCD received data streams are scheduled to instantiate each stream capture and the requested delivery services. For nominal operation scenarios, DCD automatically configures and executes its functionality without human intervention. The DCD may detect and resolve anomalous behavior and automatically execute corrective actions. It is required to publish data (e.g., monitor data, event messages, operator directive responses, etc) to be displayed by the NMC operational tools. The displayed data allow the DSCC operations to view the operational status and performance and to provide for rapid detection and identification of problems. Controls are provided to enable DSCC operator intervention for recovery from both capture and delivery problems.

The DCD will create one or more named stored datasets for each received data stream. Metadata will be created for each dataset. Users can use metadata for resource discovery. A catalog of the captured datasets and their associated metadata is maintained by the DCD and users can query for specific datasets. This catalog is searchable by identify relevant criteria contain in the metadata (e.g., e.g., find datasets created for MRO, for DOY 123, start time 11:00 UTC, etc. This is pending on actual design). Metadata along with catalog service allow users to locate proper datasets easily. The DCD can perform data deliveries in response to end-user queries.

3.3 Overview of the TTD/TFD Operations

The telemetry and radio metric data are transmitted to TTD for further processing. The operation of the TTD/TFD is expected to remain the same. Users are expected to access and

[2] As used herein, "service request inputs" refers generically to the set of external inputs provided by customers that allow the DSN to ascertain the characteristics of specific data service instances. The term is used to include the current legacy set of schedules, keyword files, trajectory data files, etc., It also includes the proposed "Service Request", which would replace the legacy files with a more coherent, service-oriented interface. The latter is allowed for but not assumed by this specification.

receive data from the TTD/TFD using the current mechanism (except for the SLE RAF/RCF delivery which will no longer be available via TTD processing).

3.4 Service Directives

Two kinds of service directives exist - the Pass-specific Service Directive and the Default Service Directive. For normal operations scenarios, there should be one pass-specific service directive per service instance for each item of DSN equipment that requires one. The default service directive is used by the equipment when no pass-specific directive is received. Service Directives used to configure/operate the DSN ground equipment are disseminated to those equipments via a pre-agreed upon mechanism. A Service Directive is delivered to each item of the DSN ground equipments as part of a Support Data Package[3] (SDP). A support data package contains all information (e.g., predictions, antenna specific configuration tables, Service Directives, etc) that a DSN equipment needed to support a tracking pass.

Each DSN-supported mission is expected to have a default Service Directives file for the DCD. A default Service Directive can have time-window specificity. The default Service Directive is only used as a backup when a pass-specific Service Directive is not available. The default Service Directive contains all needed information (Timely/Complete, SLE binding information, etc) to capture and deliver data to meet a flight project's need for a long period of time. A default Service Directives file is delivered to the DCD as part of a support data package once and remains the default until it is replaced.

A pass-specific Service Directive should be available to support a tracking pass for most of the operational scenarios. A pass-specific Service Directive is generated by the SPS and is delivered to the DCD as part of a support data package. The DCD expects to receive a support data package from the SPS on pass basis. A pass-specific Service Directive overrides the default and contains information such as pass start time, stop time, requested production and online and/or offline delivery configurations for telemetry data (e.g., frame, packet, file, etc) and tracking data (raw radio metric, validated radio metric, etc), etc.

3.5 User Classes and Other Involved Personnel

The following classes of personnel are involved in DSN Data Delivery Upgrade activities.

(1) DSCC Real-Time Operations Teams (DSCC Operations)

The DSCC Operations is responsible for the on-site operations, maintenance and troubleshooting of the DCD subsystem as well as the other DSN components at their site. For nominal operation scenarios, DCD automatically configures and executes its functionality based on the information specified in the Service Directives without human intervention. The DCD detects, notifies, and resolves (if possible) failures automatically.

[3] A support data package is an XML file generated by the SPS that contains all support data products needed to support a scheduled activity. A scheduled activity can contain multiple passes (Multiple Spacecrafts Per Antenna (MSPA), ARRAY, DDOR). Support data products encompass predicts, various configuration tables, Service Directives.

DSCC Operations can override the automatic execution process of the DCD to correct faulty conditions or for anomalous un-scheduled spacecraft activity, if needed.

(2) Pasadena Operations Team

In addition to the existing assigned responsibility, the Pasadena Operations Team shall exercise operational oversight and perform off-nominal control when required for the Production Assurance process. In particular, notify DSMS engineering support staff and customers of discrepancies in service provision or data flow as indicated by the accountability information provided by the DCD.

(3) Data System Operations Team (DSOT)

The responsibility assigned to DSOT for day-to-day operation of the TTD and TFD subsystems remains the same.

(4) Flight Project Users

Flight projects users are those who perform the following activities:

- Submit service requests to request DSN telemetry/tracking data as well as command, radio science, and other services.

  The information embedded in a service request allows the DSN to identify the characteristics (e.g., delivery grade, delivery type/mode, destinations, etc) of specific data service types. The information is used to initiate data capture and delivery services.

- Request data via query service provided by DCD or TTD subsystem

  The query can be for data discovery (identifying what is available in the catalog) or a specific request for certain data set.

- Receive telemetry and/or tracking data from the DCD, TTD, or TFD subsystems.

The user who submits the service request inputs to the DSN is not necessarily the one to receive the data. It is permissible to have multiple recipients for various kinds of data (for example, science data can be delivered to a designated principle investigator, telemetry data can be delivered to a MOC, etc). It is not permissible to have multiple recipients for a same data stream.

3.6 User Interfaces

All project provided inputs for DSN tracking support are required to be entered via the SPS Portal (see reference [13]).

All existing user interfaces to the TTD and TFD will remain the same except the SLE service. All user interfaces used to retrieve data or access data from TTD and TFD will remain the same.

The DCD will provide an interface to accept DCD configuration information (e.g., via Service Directives) provided by the SPS.

The DCD will provide a user interface to the DSCC Operations Team for entering commands (e.g., Operator Directives, etc.) to override the system configuration or to handle exceptional conditions.

The DCD will provide a user interface to access to the DCD's data repository catalog and query for data delivery.

The DCD will provide the required configuration, operational status, and performance information to the DSCC Operations.

The DCD will provide a user interface to the DSCC Operations for monitoring the performance of the DCD.

The DCD will provide visibility to the DSCC Operations on any action taken by the DCD.

The DCD will provide a user interface to the DSCC Operations for providing visibility into all faulty conditions of the DCD.

The DCD will provide accountability information regarding data production, capture, processing, transfer, and delivery of data (e.g., telemetry and tracking data, etc) to the DSMS messaging bus per reference [14].

3.7 Operational Timeline

A flight project is required to select and plan for the data production types (e.g., virtual streams, all streams, etc.) and data delivery mechanisms (e.g., Timely, Complete, or File) that can be supported by the DSMS. These data production and data delivery plans are developed in the early phases of a mission. The DSMS supports these plans based on user-provided inputs and the inputs are provided into the DSMS via the pre-agreed upon mechanism. A project provides service request inputs from weeks to minutes prior to a tracking pass to formulate the configuration information. The configuration information that is contained in a Service Directive is required for the data production, data capture and the stream delivery services associated with each tracking pass.

The flight project user will be notified of the availability of each stored dataset for that project. Depending on the established delivery scenario for a flight project as specified in user-provided service request inputs, the delivery of stored datasets and their associated metadata files will be pushed to the user using the pre-agreed upon product delivery protocols or the delivery can be initiated by the flight project user after receipt of notification of its availability from the DSCC.

Figure 3-1 illustrates the basic activity timeline for a service instance for a DSN supported tracking pass.

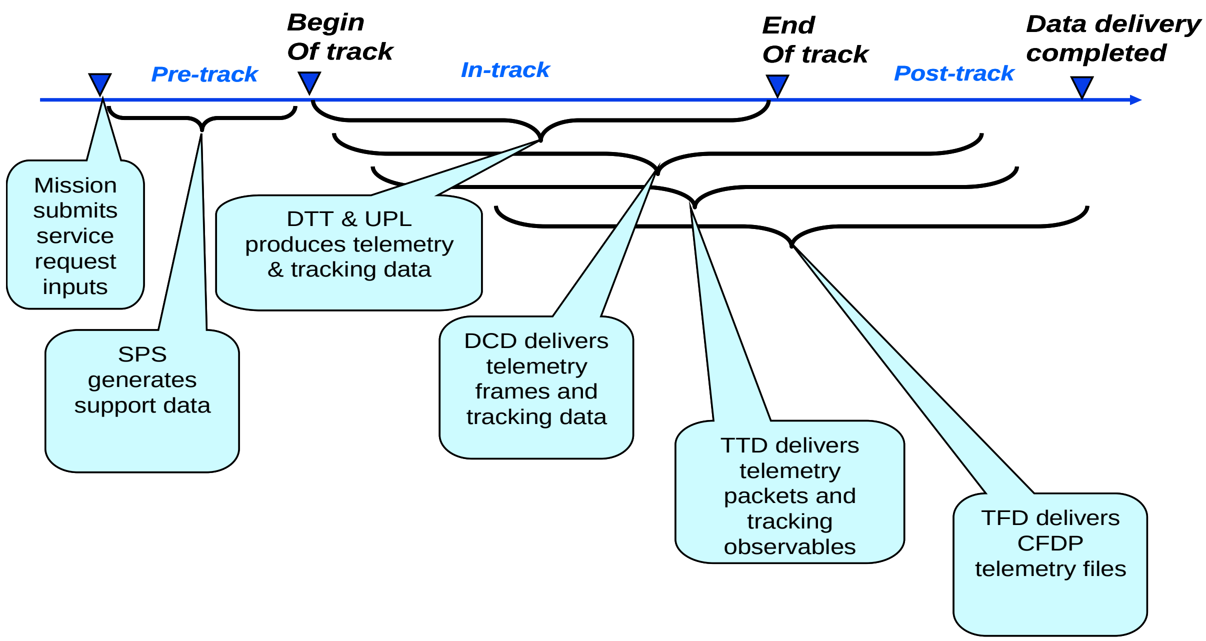


Figure 3-2 Basic Activity Timeline

(1) Service instance timeline starts when Flight Project Users submit service request inputs for a tracking pass.

(2) SPS generates support data based on agreed-upon scenarios and user-provided inputs before the scheduled beginning of track time.

(3) DSN Front-end Service Equipments start producing telemetry and tracking data based on the configuration information of Service Directives at the beginning of the scheduled track time.

(4) Online Timely and scheduled Complete delivery services are performed by DCD, TTD, and TFD during "in track".

(5) The activities for Complete delivery service in response to end-user queries and File delivery service in response to either scheduling or end-user queries can continue post track.

(6) Once all activities for the requested data capture and delivery services are performed and have received custody delivery confirmation, the datasets are removed from the DCD or TTD/TFD repository. The data deletion from a data repository ends one service instance.

(7) The following data management activities accompany data capture and delivery services:

- Users are notified on availability of each stored dataset
- Datasets are custody transferred within a limited window and they are held at the DCD for a negotiated period after custody transfer.

- Users are alerted daily (via e-mail notification or other mechanism) on data segments that have not had custody transfer confirmed.

3.8 Interaction of DSN Data Delivery Upgrade Operational Activities

Figure 3-2 illustrates the interaction of high-level end-to-end operational activities within the DSN Data Delivery upgrade task.

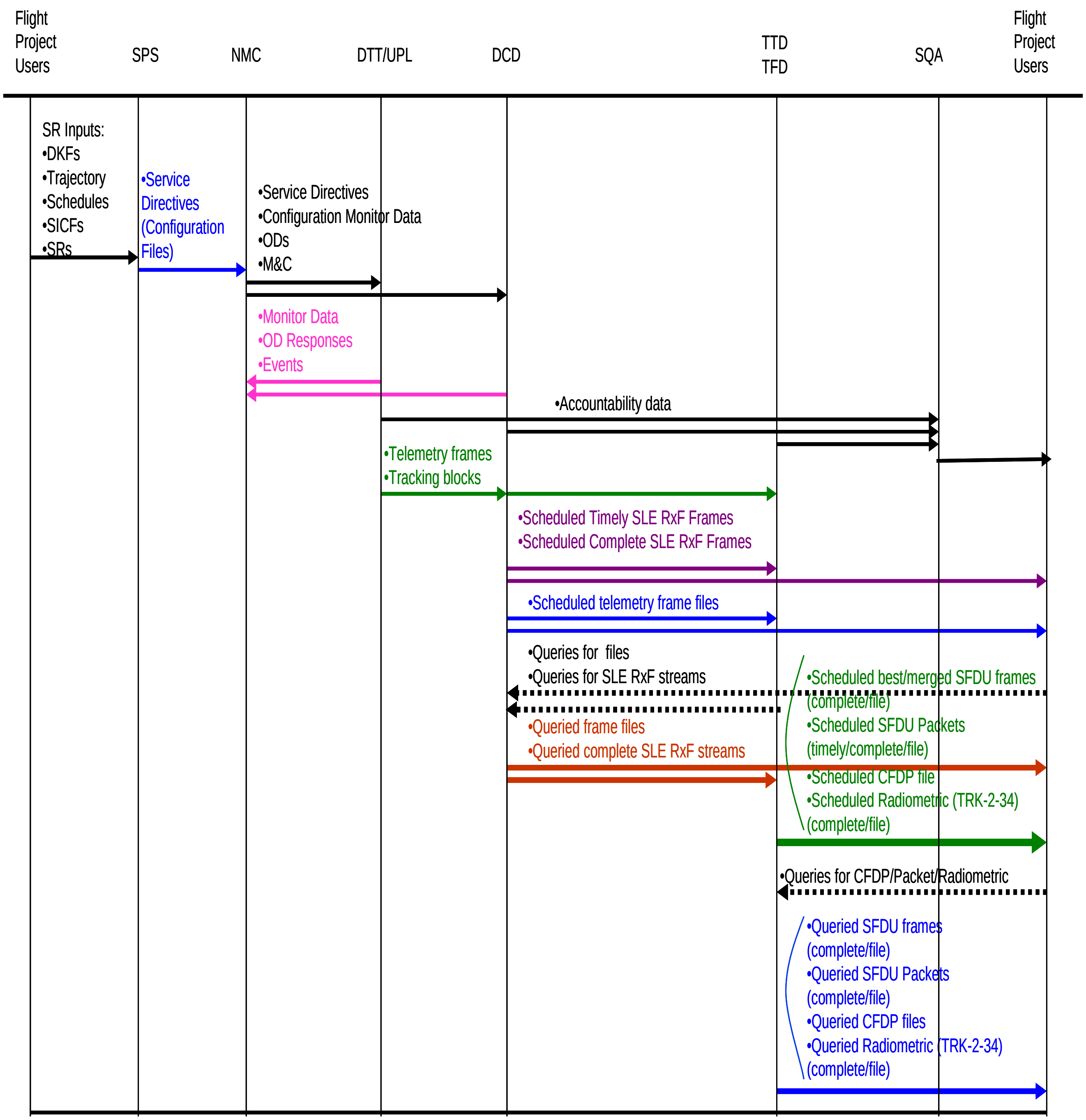


Figure 3-3 Interaction for the Operational Activities within the D^3

(Note that the colors shown in the Figure 2-1 are simply used to make the figure more readable.)

3.9 Views of DSN D^3 Task Operations

3.9.1 Customer perspective

3.9.1.1 Prerequisites

DSMS Services are only provided to Flight Project Users that have a committed service agreement with DSMS. This agreement is typically negotiated and signed during the early development phases of a flight project. This agreement outlines the types and performance of services required by a flight project and authorizes the creation of credentials for the Flight Project Users to interact with the DSMS.

3.9.1.1.1 Comparison of Prerequisites

Table 3-1 Comparison of Prerequisites

Step/ Activity	Existing Operations	D^3 Operations
(1)	Document the agreed/committed services/requirements into Detail Mission Requirements (DMR) or DSMS Service Agreement (DSA) documents. The following services relevant to the data capture and delivery provided by the DSMS are identified in a DMR/DSA: • Data production type (e.g., SLE, CFDP file, etc.) • Data delivery mechanism (real time, complete, file, etc) • Various data interfaces (e.g., 0161-Telecom, 0163-Telecom, TLM-3-10A, TLM-3-14, TLM-3-23, etc) • Data latency • Data retention	Same with the following exception: • Shorten the retention duration via data custody transfer plan (i.e. data retention limited to < 1 week).

3.9.1.2 Preoperational Activities

Flight Project Users will participate in the DSMS scheduling process to request station tracking time and will provide service request inputs including DSN Keyword Files (DKFs), trajectory files, and SLE service configuration information that is typically provided as Service Instance ConFiguration[4] files, etc. within weeks/days before the scheduled tracking pass. Service request inputs contain the configuration information (e.g., service user, service provider, IP address, port number, binding initiator, etc) required for the SLE stream delivery services. Service request inputs also contain user selected data types and delivery mechanisms (Timely/Complete, stream/file, etc.).

3.9.1.2.1 Comparison of Preoperational Activities

The following table shows a comparison of the current and D^3 pre-operational activities.

Table 3-2 Comparison of Preoperational Activities

Step/ Activity	Existing Operations	D^3 Operations
(1)	Flight project users provide the following inputs to the DSN via the SPS portal • DKF/Nominal SOE (Note that Nominal SOEs are normally loaded to the SPS Database by NOPEs directly.) • Trajectory file • Optional override SICF files (for RAF/RCF/CLTU services) Note: Default SICF files are delivered to the NOPEs. • DSN tracking schedules (7-day operation schedule)	Flight projects provide the following inputs to the DSN via the SPS portal: Same as the existing operations plus the following: • *A new Service Request format which can be used by users to provide all needed user inputs for a tracking pass (pending on the Service Management design).* • *Both default and override SICF files can be submitted to the DSN via the SPS portal.*
(2)	SPS generates needed support data based on user provided inputs.	same
(3)	SPS transmits support data from JPL to DSCC	same
(4)	SPS distributes support data to DSN asserts.	same
(5)	DSN assets configure themselves based on the support data provided by the SPS.	same

[4] All service management/configuration information that the DSMS needs in order to provide SLE services to a mission should be specified in a pre-agreed upon format. The information can be conveyed by a flight project to the DSMS by means of SICF files; however, SICF files are not the only means by which that information can be conveyed. SICF files can be provided as part of service request inputs from a flight project to the DSMS if CCSDS SLE RAF/RCF services are requested. DCD can allow flight projects to specify such information in response to queries for offline delivery mode. DSN Data Delivery Upgrade task can also choose to replace SICF files with the other formats and design. A Service Directive generated by the SPS for the DCD subsystem will contain such configuration information for SLE services.

3.9.1.3 SLE Operational Activities

A Flight Project User (e.g., external/JPL MOC) normally initiates the binding to the DCD for a SLE service instance based on the SLE service configuration information. The binding information (e.g., IP addresses for the DCDs, etc) should make available to the flight project users via a pre-agreed upon mechanism. The SLE configuration information is provided by a flight project to the DSMS via a pre-agreed upon mechanism. The user needs to bind to the service before the start of the space link session. DSCC Operations is expected to have visibility regarding the binding status. Once binding is completed the stream delivery service will commence per the SLE protocol configured. The stream delivery services will selectively extract data from the stream of data units produced using the provided parameters in the Service Directive. Note that the difference between Timely service and Complete service is the allowed latency for delivery of the data units. Timely stream service can result in the loss of data due to WAN and local latencies with the DCD or user's system(s).

Both offline and online SLE deliveries are used to deliver telemetry data directly from the DCD at a DSCC to a flight project. The DCD has a capability to record all telemetry acquired during a tracking pass and deliver the complete recording (or portions thereof) to a flight project post-pass via the SLE offline delivery mode.

3.9.1.3.1 Comparison of SLE Operations

The following table shows a comparison of the current SLE operations with the D^3 operations.

Table 3-3 Comparison of SLE Operations

Step/ Activity	Existing Operations	D^3 Operations
(1)	See step (1) of Table 3-2.	See step (1) of Table 3-2.
(2)	A flight project user initiates the binding between the SLE service provider (SLE/TTC&DM at JPL) and the SLE service user (external/JPL MOC) for a SLE RAF/RCF service instance(s) based on the information from a SICF file and 7-day schedule.	Same except *that the binding is established by a flight project user to DCD, not to SLE/TTC&DM.* *Note: Since the DCD is located at each of the DSCCs (not at JPL), a flight project user is required to bind to the DCD at the appropriate DSCC which provide the data production and provision services (based on the 7-day schedule).* .

Step/ Activity	Existing Operations	D^3 Operations
(3)	A support data package is generated by the SPS and is delivered to DTT. The support data package provided to the DTT does not contain any SICF file.	A support data package is delivered to DTT and *DCD.* The support data package provided to the DTT does not contain any SICF file. *The support data package provided to the DCD contains a Service Directive. The information of an override (or default) SICF file is expected to be embedded in a pass-specific (or default) Service Directive. (This is pending on Service Management design.)*
(4)	DSN front-end service provider (DTT) produces telemetry data based on the information identified in the mission-specific tables (SCAP or telemetry configuration table). DTT puts data into a default stream (not virtual streams) for those missions which use SLE service.	Same
(5)	Telemetry data are transmitted from the DTT to RNS/DSCC.	Telemetry data are transmitted from DTT *to the DCD located at a DSCC.*
(6)	(a) For SLE RAF/RCF LLDD delivery: The captured telemetry data for LLDD delivery are transferred from the RNS/DSCC to SFG, to GIF, to TDS, and then to SLE. (b) For SLE RAF/RCF FTDD delivery: The FTDD telemetry data are transferred from RNS/DSCC to RNS/JPL, to GIF, to TDS, to SLE.	SLE stream data is flowed to TTD for further packet and CFDP processing.
(7)	Assuming step (2) has been performed, SLE of TTC&DM delivers the SLE RAF/RCF telemetry streams to the external MOC (SLE service users) based on the information from a SICF file and 7-day schedule.	Assuming step (2) has been performed, DCD delivers the SLE RAF/RCF telemetry streams to SLE service users (external/JPL MOC) based on the configuration information (Timely or Complete, online or offline, etc.) from a Service Directive. If a Extended Timlydelivery is scheduled, the stream gaps resulted from a standard Timely delivery will be delivered offline via a query. If a Complete delivery is not scheduled, a user can query for an offline Complete delivery.
(8)	None	DCD deletes the data from its storage (or marks the data for deletion) after the custody transfer is confirmed or the retention time is expired.

3.9.1.4 File Delivery Operations

Flight Project Users will be provided access to the DSN Data Delivery Upgrade's data repository catalogs. The DCD catalogs will be searchable by various attributes (e.g., mission name, start time, antenna number, etc). The "desirement" is to only allow delivery of the data from the DCD once, allowing the service to either push the file products to the specified user or allowing the user to pull the released data products (e.g., files and metadata logs) after DSMS has notified the user that the products are ready. The file delivery protocol will only deliver files after they are closed. A series of datasets can be created from a single telemetry stream based on total dataset size or time constraints. These products can be preset by size or time period by agreement with flight projects. Flight project users can request a file delivery containing a subset of these datasets. The DSN Data Delivery Upgrade will produce these subset files for delivery and then notify the user that they are available. Flight project users can request that subset files be routinely created and cataloged for delivery.

A custody transfer protocol will be used to assure that a fight project user has received all the captured data before they are deleted from the repository. The protocol used for file exchanges must validate that the user received all the captured data before it is deleted from storage. A successful transfer of a subset of data does not trigger the data deletion from the data repository until the complete set of data is custody transferred. Data in the repository is removed (or is marked for deletion) once the custody transfer is confirmed or the specified retention window has expired without custody transfer.

File delivery protocol is currently provided by the TFD but not by the TTD. The data catalog service and data delivery mechanism TTD/TFD are expected to remain the same for D^3 Phase I implementation. There will be no upgrade to the TTD/TFD data catalog and will be no custody transfer until Phase II. New file delivery protocol will not be supported by the TTD and TFD until Phase II.

3.9.1.4.1 Comparison of File Delivery Operations

Table 3-4 Comparison of DCD File Delivery Operations

Step/ Activity	Existing Operations	D^3 Operations
(1)	The RNS/DSCC captures outputs from DSN Front-End service providers	The DCD/DSCC captures outputs from DSN Front-End service providers
(2)	The captured data is transmitted from the RNS/DSCC to the RNS/JPL.	None
(3)	All data recorded to the CDR is delivered by the RNS/JPL (i.e., NOCC). The CDR records and segregates the data blocks into Intermediate Data Records (IDRs) based on stream definition (includes source/destination address, S/C ID, data type). There is a master CDR table that defines what data should be written to IDR files. The table includes spacecraft ID, DSS number, etc. Data blocks in an IDR are time-ordered by the ERT of the block. As data is received at the CDR, it is "immediately" written to the IDR file.	The DCD constructs datasets (including transaction logs and metadata) consisting of ordered data blocks which matches the construction criteria as specified in "Service Directives". The DCD maintains a catalog of all datasets which have been or are in the process of being captured, but have not yet been relinquished (i.e. removed from the repository post successful custody transfer).

(4)	Frame files delivery service is available via: (a) Users can query for IDRs via the CDR/IDR website. IDRs are delivered to the users via FTP based on the queries. Users query IDR files by spacecraft number, date and data type. The requested files are FTPed to the requester. (b) The flight projects can set up automatic ftp requests to pull this data from the CDR. IDR files can be FTPed to any mission automatically based on the agreement. This means that the IDRs are distributed to users directly via FTP. Note: IDRs which are sent to Goddard missions are via SFG.	Frame files delivery service is available via: (a) File delivery can be scheduled. (b) Users access data repository catalog and query for file delivery. The DCD can either push the requested files to the users or notify the users once the requested datasets are available so that users can download the datasets/files from the DCD repository.
(5)	The CDR delivers IDR files to external MOCs and to the GIF.	Files are delivered to external/JPL MOCs and other users. (Note: The DCD has the capability to deliver files to external/JPL MOCs as well as to the TTD. However, the TTD is not expected to receive new file protocol until Phase II.)
(6)	Data are stored in the CDR until the pre-agreed retention time is expired (e.g., 30 days).	The DCD stores each captured dataset or file until it is relinquished. The DCD remove stored datasets once they are custody transferred.

Table 3-5 Comparison of CFDP File Delivery Operation

Step/ Activity	Existing Operations	D^3 Operations
(1)	CFDP files generated by the CFDP/TFD are stored into the DOM. User can query for CFDP file delivery.	Same

3.9.2 DSN Operations perspective

Note: The process to reach a DSMS service agreement between a flight project and the DSMS is not discussed here. It assumes a starting point of an approved service request and an approved tracking schedule.

3.9.2.1 Support Data Generation and Distribution

SPS generates all required support data (predicts, subsystem Service Directives[5], etc) based on user-provided service request inputs. "Service request inputs" refers generically to the set of external inputs provided by flight project users that allow the DSN to ascertain the characteristics of specific data service instances. This term is used to include DSN Keyword Files, trajectory files, 7-day schedules, SICF files, service requests in TBD new format, etc. The support data generated by the SPS are in relation to equipment types within the production processes. The support data generated by the SPS include predicts, Service Directives (e.g., configuration files), etc. One or more Service Directives are generated by the SPS for each of the DSN equipment assigned to support a tracking pass, if needed.

SPS starts the process to generate all the required support data when all the required user-provided service request inputs are available. The required support data are generated and managed at the Service Preparation Subsystem (SPS) JPL central processors (SPS-NOCC) and transferred to the SPS computers in each DSCC. The support data generation process normally starts at a configurable delta time prior to the scheduled tracking activities based on the DSN 7-day schedules. The generated support data are transmitted to a DSCC from the JPL-central.

Monitored and controlled by the NMC, the SPS distributes support data to the proper DSMS equipment prior to the scheduled start time of a spacecraft tracking pass.

DCD uses the information (e.g. services modes, destinations, prioritization, etc.) from a Service Directive to instantiate data capture and delivery services.

3.9.2.1.1 Comparison of Support Data Generation and Distribution

Table 3-6 Comparison of Support Data Generation and Distribution

Step/ Activity	Existing Operations	D^3 Operations
(1)	See step (1) of Table 3-2.	See step (1) of Table 3-2.
(2)	For RAF/RCF data delivery service: Override SICF: Once receiving the override SICF files, SPS delivers the files to the Space Link Extension (SLE) service provider element within the TTC&DM Telemetry and Tracking Subsystem. Override SICF files are delivered from SPS to TTC&DM by means of the SPS remote copy utility, named "rsync," operating over a Secure Shell (SSH)	None

[5] A SICF file is used to specify the initial values of the SLE instance parameters for SLE service instances. SICF files are generated by a mission to obtain SLE RAF/RCF services from the DSMS. Pending on pre-agreed upon interface agreement and design, SPS can either incorporate the information from a received SICF file into a Service Directive or distribute a SICF along with the other support data to the proper DSN equipment and/or Operations.

Step/ Activity	Existing Operations	D^3 Operations
	connection between SPS and TTC&DM. Default SICF: Default SICF files are provided by a flight project to a NOPE. A NOPE puts the received default SICF files to the SPS database (for uplink) and transfers them to SLE/TTC&DM (for downlink).	
(3)	(a) SPS generates support data based on user provided inputs and 7-day schedules. (b) SPS generates support data some configurable amount of time before the scheduled BOA for a scheduled tracking pass. (c) SPS constructs a support data package for each of the DSN assets assigned to support a tracking pass. The DSN assets include: • DSN antennas • DSN front-end service producers (d) A support data package can contain (based on the IFA between the SPS and a DSN asset): • Prediction files (antenna pointing, D/L frequency, U/L frequency, delay, telemetry, and DDOR predictions) • Pass SOE • Mission specific configuration table • Antenna specific configuration table • Default or override SICF (SICF is included in a support data package for the uplink controller. The information from a default SICF is incorporated into a spacecraft command service table for 34m/70m uplink controller. DTT does not need any SICF file.).	(a) Same (b) Same (c) SPS generates a support data package for each of the DSN assets assigned to support a tracking pass. The DSN assets include: Same as the existing operations plus • *DCD* (d) A support data package can contain (based on the IFA between the SPS and a DSN asset): *Same as the existing operations plus* • *The information of an override (or a default) SICF file will be embedded in a pass-specific (or default) Service Directive (pending on the Service Management design). The information from an override/default SICF file is to be provided to DCD and uplink controller.* • *Service Directives*
(4)	The generated support data packages are transmitted from JPL/SPS to the DSCCs.	Same
(5)	The support data package is distributed to each of the DSN assets assigned for tracking support. A MON-2 asset receives a support data package a few minutes before it is assigned to a connection link. A legacy asset receives a support data package right after it is assigned to a connection link.	Same.

3.9.2.2 Production Process Instantiation

(This is included only for showing complete picture.)

Service Directives are used by the subsystems at a DSCC to configure themselves more or less automatically upon assigned to support a link connection. For all MON-2 subsystems (e.g., DTT, UPL, DCD, etc.), the proper subsystem Service Directives and predicts have to be available before reception of a Change Configuration Notice (CCN) to properly succeed in configuring the DSN equipment automatically. A CCN is a protocol used to assign DSN equipment to support a tracking pass (connection link).

A Change Configuration Notice (CCN) provides, among other things, so-called “standard connection monitor data” from the NMC to the subsystems identifying all the other subsystems in the connection, the spacecraft(s) in the connection, and various protocol information such as functional addresses. It is also a signal for the subsystems to begin configuring for the connection based on the standard connection monitor data information and the received subsystem Service Directive. A CCN is delivered from the NMC to the various DSN subsystems as the NMC puts a connection together.

3.9.2.2.1 Comparison of Production Process Instantiation

Table 3-7 Comparison of Production Process

Step/ Activity	Existing Operations	D^3 Operations
(1)	A support data package is distributed to a MON-2 subsystem a few minutes before it is assigned to a connection A support data package is distributed to a legacy subsystem right after it is assigned to a connection.	Same

3.9.2.3 DCD Stream Capture

Operations personnel need not be concerned with constant and continuous monitoring of the DCD. The DCD’s monitoring will be automated and an alert process will be provided to alert the DSCC Operations when its involvement is required to correct a problem. The monitoring function will determine if data flows that need to be captured are being captured as required. This monitoring will provide high level indicators that can be viewed by the DSCC Operations. The indicators will optionally show that a capture service has started and is operating within expected bounds or the data stream has halted or an anomaly has been detected.

3.9.2.3.1 Comparison of Stream Capture

Table 3-8 Comparison of Stream Capture

Step/ Activity	Existing Operations	D^3 Operations
(1)	The RNS at the DSCC is used to capture telemetry and radio metric data generated by the DSN equipment (legacy or MON-2). The data is transmitted from RNS/DSCC to the RNS/JPL for FTDD and legacy data (data from DSN legacy subsystems) delivery. The data is transmitted from RNS/DSCC to SFG for LLDD and legacy data delivery	DCD is used to capture telemetry and radio metric data transmitted by the DTT and UPL.
(2)	DSN has a limited capability to generate accounting report for Mars Reconnaissance Orbiter (MRO). The Frame Accountability Report File (FAR) is generated with data input from a TDS query. The FAR documents frame accountability and frame retransmission requests. The resulting report is published to DOM. The FAR is used in support of Advanced Orbiting Systems (AOS) retransmission requests for the MRO mission.	DCD is required to publish domain specific accounting information data to the messaging bus periodically. SQA (or other application software) can generate accounting reports periodically. Thus, both flight project users and Operations can track/monitor and be informed the status of data flow.
(3)	RNS and SFG are monitored and controlled by the Pasadena Operations Team. RNS/DSCC is also monitored by the DSCC Operations.	DSCC Operations is responsible of monitoring and controlling of the DCD just like all the other DSN assets.

3.9.2.4 DCD Stream Delivery

A Service Directive is used to define and configure the SLE delivery processes. The SLE delivery processes can be automatically invoked by a timing process since all the information required for the service is included in a configuration file (e.g., a Service Directive or a SICF). The stream delivery of the data using the SLE services requires that an association (binding) be established between a service provider and a service user. This association information is specified in a Service Directive (or a SICF, etc) and normally a service user performs the association.

Once the execution of a tracking pass starts, the DSCC Operations can issue Operator Directives (ODs) to affect configuration changes and/or enable/disable various functions of the DSN subsystems during the connection execution. DSCC Operations needs not be concerned with constant and continuous monitoring of the DCD delivery services. The DCD subsystem's monitoring will be automated and an alert process will be provided to alert DSCC Operations when its involvement is required to correct a problem. The monitoring function will determine if data flows that need to be delivered are being delivered as required. This monitoring will provide high level indicators that can be viewed by operations personnel. The indicators will optionally show that a delivery service has started and is operating within expected bounds or the data stream has halted or an anomaly has been detected. The monitoring service should be capable of providing sufficient information to the DSCC Operations to enable a rapid response.

3.9.2.4.1 Comparison of Stream Data Delivery

Table 3-9 Comparison of Stream Data Delivery

Step/ Activity	Existing Operations	D^3 Operations
(1)	For LLDD and legacy data delivery (low latency), data flows from RNS/DSCC to SFG, to external MOCs and/or to GIF (GIF→TDS→SLE for SLE RxF service). For FTDD and legacy data delivery (Complete), data flows from RNS/DSCC to RNS/JPL, to GIF (GIF→TDS→SLE for SLE RxF service). For FTDD and legacy data delivery (Complete), data flows from RNS/DSCC to RNS/JPL, to CDR, to external MOCs and to GIF.	DCD delivers streams (Complete or Timely; online or offline) to the users based on the configuration information provided in a Service Directive or a query request: • DCD will provide RxF frames to the external/JPL MOCs for projects that subscribe to SLE service. • DCD will provide frame files to the external/JPL MOCs (or any user) for projects that subscribe to file delivery service. • DCD will provide RxF frames to the TTD for projects that subscribe to packet service. • DCD will provide RxF frames to the TFD via TTD for projects that subscribe to telemetry file service. • DCD will deliver SFDU blocks (radiometric data) to the TTD for projects that subscribe to the tracking service. • DCD will delivery SFDU blocks (candidate telemetry frames) to the TTD for projects that subscribe to the telemetry service.
(2)	Pasadena Operations is responsible of monitor and control: • RNS/DSCC • RNS/JPL • SFG • CDR. DSOT is responsible of monitor and control: • GIF The Pasadena Operations Team is responsible of configuring/monitoring RNS, SFG, and CDR. DSOT is responsible of monitoring and controlling GIF, TDS, and SLE so that data can be properly flowed to the users/recipients.	DSCC Operations is responsible of monitor and control: • DCD. The involvement of the DSCC Operations is limited to handle exceptional conditions.

(3)	There is no production assurance.	Pasadena Operations will notify DSMS engineering support staff and customers of discrepancies in service provision or data flow as indicated by the accountability information presented.

3.9.2.5 TTD/TFD Data Access and Delivery

Users can access to the TTD data repository catalog to request for tracking data, telemetry frames and telemetry packet data delivery. Data generated by the TTD and TFD are available to the users via the current mechanism.

TTD is used for processing frames, packets, and tracking data and TFD is used for processing recovered telemetry files.

3.9.2.5.1 Comparison of TTD/TFD Data Access and Delivery

Table 3-10 Comparison of TTD Data Access and Delivery

Activity	Existing Operations	D^3 Operations
(1)	GIF Data arrives to the GIF in the form of telemetry data, tracking data, radio science data, and monitor data. In the current operational configuration, the GIF receives data from the RNS. The GIF, in turn, outputs the GIF-processed data units to the TDS.	Same (pending on actual design)
(2)	TDS The TDS is a stream database. The TDS receives various types of data (e.g., GIF-processed data units, TIS-processed frames, TIS-processed packets, TIS-processed channelized packets), then stores that data into the TDS database. The data units are stored in TDS as records, at which time the TDS catalogs information regarding each data unit/record. Telemetry data (e.g., frames, packets, channelized packets) is queried from the TDS	Same
(3)	TIS The TIS performs the major processing of telemetry data. It reads the telemetry stream, correcting obvious errors and creating most of the real-time data records used throughout the data ground system. The TIS can: (a) Perform frame synchronization in the received stream. (b) Decommutate and channelize the minor frames or packets of engineering data by	Same

	separating them into individual channel values according to the specifications of a decommutation map, assigning channel identifiers and lengths to these values. (c) Add Quality, Quantity, and Continuity (QQC) information records to the data stream. (d) Output the data, in SFDU format, making it available to the TDS, as well as to real-time data broadcast channels.	
(4)	SLE Telemetry data received from the spacecraft is stored in the TDS, as described above. The SLE interfaces with the TDS for applicable telemetry data (in the form of "all frames" or "channel frames"), thus making the data available to the applicable MOC.	None. (Note: The SLE RAF/RCF delivery is performed by the DCD.)
(5)	TDDS TDDS provides real-time capabilities for receiving, validating, and correcting radio metric data, and generating observables from the received tracking data. In addition, it provides near-real-time capabilities for generating tracking data products, as well as non-real-time capabilities to process tracking data. Radio metric data is received by the TDDS from the GCFs via the TDS by way of the RNS/SFG and GIF. The TDDS processes radio metric data, and performs automated validations and corrections to the data. The data is further processed by a tracking TIS, then stored in a tracking TDS. Additional processing is performed on the data via TDDS processes, which ultimately results in the creation of tracking data files (per 820-013, TRK-2-34 and TRK-2-18) which are stored in Distributed Object Manager (DOM) and OSCARX.	Radio metric data is received by the TTD from the DCD.

Table 3-11 Comparison of TFD Data Access and Delivery

Step/ Activity	Existing Operations	D^3 Operations
(1)	TFD is used for recovered telemetry files. The telemetry processing performed by TIS results in the TDS storage of CFDP PDUs. As PDUs are stored in the TDS, the PDUs are passed to the FDM, then on to the CFDP. Upon receipt of all necessary PDUs, the CFDP protocol results in the production of the	Same

	downlinked that was downlinked from the spacecraft. The file is then transferred to Distributed Object Manager (DOM) for storage purposes.	
(2)	The FDM is responsible for interfacing with the CFDP to acquire the latest file downlink transaction status. Along the downlink dataflow path, the FDM receives CFDP protocol data units from the TDS, and forwards the CFDP data units to the CFDP.	Same

SECTION 4

Operational Scenarios for D^3 Phase I Implementation

4.1 Use Cases

4.1.1 Use Case: Nominal Operation for Telemetry Frames or Tracking Data

The operation of the proposed DSN Data Delivery Upgrade can be “story-boarded” as follows:

(1) Based on the negotiated DSMS schedule and user-provided service request inputs, SPS generates Service Directives for the Front-End Service Providers, DCD, TTD, and TFD subsystems. These Service Directives contain sufficient information to enable the DSN subsystems to configure themselves without project-specific adaptation or operator intervention. The DSN Data Delivery Upgrade task does not address configuration of the Front-End Providers.

(2) When a pass begins, the Front-End Service Producers will create the requisite data capture units (e.g. telemetry frames, ranging data units, etc), stream instance metadata, and data unit metadata. These are then streamed to the DCD. Upon receipt of acknowledgement (indicating successful capture), custody for the data unit will have been transferred to the DCD. The DCD acquires the received data units, creates a dataset from them, and stores the resulting dataset in the capture repository. The DCD will also create a metadata log product that contains the production mission specific attributes and the frame accounting reports for the stream. A stream dataset consists of an ordered set of data units, frames or packets which is selected according to source, virtual channel(s), time extent, and size in accord with the rules contained in the Service Directive.

(3) If Timely stream delivery service has been requested, a Timely stream provider is instantiated within the DCD. This acquires the incoming stream of data capture units directly (or from the captured stream dataset depending on implementation) and delivers a stream of frames or units to the recipient. Note that Timely stream service can operate independently and in parallel with data capture. In the event of outage or excessive lag, some frames or units will be “dropped” from the delivered stream.

(4) If Complete stream delivery service has been requested, an appropriate Complete stream provider is instantiated within the DCD. The dataset is retrieved from the capture repository and the stream of frames or units is delivered to the user. This operation may be initiated during a tracking pass or at any subsequent time while the data is still held in the capture repository. Upon receipt of acknowledgement (indicating successful delivery), custody for the dataset will have been transferred. A Timely service followed by a Complete service can be scheduled post pass for user gap filling for a Timely service performed during the pass.

(5) If file delivery service has been requested, an appropriate file delivery provider is instantiated within the DCD. The dataset along with the metadata log is retrieved from

the capture repository and the dataset and its metadata log are delivered to the recipient. This operation may initiate during the pass, after the dataset is closed and while it is still held in the capture repository. Again, upon receipt of acknowledgement (indicating successful delivery), custody for the dataset is defined as being transferred to the user and the data is deleted from the capture repository.

(6) DCD produces domain-specific accountability data via DSMS messaging bus.

The nominal operation described above is intended to proceed without operator intervention. However, visibility will be provided both via monitor data pertaining to service execution and via accountability information pertaining to the various accountable items (e.g. frame sequences, files, etc.). The operator will be able to intervene in cases of failure or other special circumstances to control service execution directly. The operators may need to issue proper directives to correct anomalous conditions based on performance and configuration information provided by the DSMS subsystems.

The recipient's role varies with the specific form of service being provided. Obviously, the recipient must provide for receiving the data, whether by binding to a stream or exposing a file repository. One-time queries must provide sufficient information to uniquely characterize the requested dataset and identify the destination and delivery characteristics. The one who submits the service request inputs may not be the one who receives the data. Sufficient information must be provided via service request inputs to determine the nature of service and any selection or prioritization rules. The end-user will have access to the accountability information in the metadata files (but typically not to the internal DSMS monitor data).

A custody transfer protocol is desired to provide positive confirmation that the dataset has been transferred successfully to a user and has been captured within the user's reliable capture archive. This protocol is to be defined. The protocol will provide a discrete acknowledgement of custody that can be used to delete the file from the DSN Data Delivery Upgrade's capture repository. Note that the data transfer mechanism from TTD/TFD to users is expected to remain the same.

4.1.2 Use Case for Nominal Operation for CFDP Telemetry Files

(1) The initial steps are the same as they are for nominal operation for telemetry frames as specified in 4.1.1

(2) Appropriate instances of Frame Besting & Merging and Packet Recovery are initiated[6] within the TTD subsystem based on Service Directives.

(3) Appropriate instance of CFDP telemetry recovery service is initiated within the TFD subsystems. The CFDP processing continues running while that particular instance is valid..

(4) TTD receives steams/files/blocks from DCD.

[6] Or activated, if one already exists.

(5) TTD extracts the frame dataset or datasets from the capture repository or repositories, frames from multiple sources are bested and merged[7], packets are extracted from the frames.

(6) TTD transmits the packets to TFD and designated recipients.

(7) TFD subsystem extracts CFDP PDU's from the received packets sent by TTD.

(8) The PDU's are processed by the CFDP transaction processing engine where the telemetry files or messages are reconstructed and a transaction log file and metadata file are generated for each transaction. "Protocol elements" (e.g. NAK's or FINISH messages) generated as part of this process are conveyed either to the user or to whichever CFDP transaction processing engine is handling the forward link (possibly the same one).

(9) The resulting (possibly partial) files are cataloged for delivery. The file delivery service will then deliver the file as required to the designed recipients (as specified in the service request inputs or a query). Note that how new versions of files are to be delivered to update previously delivered versions is yet to be defined.

4.1.3 Use Case for Nominal SLE RAF/RCF On-line Operations

The following paragraphs illustrate a typical operational scenario for a user-initiated, scheduled online-delivery mode RAF/RCF service instance:

(1) The configuration information of the requested RAF/RCF service instance is specified in a SICF. An override or a default SICF file can be submitted by a flight project user to the DSMS (e.g., SPS) some pre-agreed upon time (e.g., 3 days) prior to the scheduled tracking activities.

(2) SPS generates support data based on the user-provided service request inputs. The support data includes a Service Directive for the DCD.

(3) DCD receives a Service Directive right before it is assigned to support a tracking activity. The RAF/RCF service instances are created by the DCD based on the information specified in the Service Directive. In order for a RAF/RCF service user (e.g., flight project users) to interact with the service provider (DCD), an association (binding) between the user and provider needs to be established. Typically the association is invoked by a flight project user before the start of a tracking activity. At the scheduled start time of a tracking activity, the DSN Front-End Service Provider (e.g., DTT) acquires the signal from the spacecraft and the DCD initiates the production of RAF/RCF service.

(4) The SLE service association, data exchange, data transmission is expected to follow the procedures/processes as specified in reference [7].

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[7] Portions of a single CFDP transaction may be handled by different DSCC's, or by subsequent passes at the same DSCC. Examples of this include file transfers that span from the end of one pass to the beginning of another, as well as cases where some of the data must be retransmitted.

4.1.4 Use Case for DCD subsystem failure

The DCD is designed to be very reliable; however, there will be times when the DCD will go down. Each DCD may have an online backup to minimize the downtime and maximize availability. Since the DTT has a limited capability to buffer telemetry frames (about 40,000 Standard Data Blocks); data will be lost until the DCD is brought back to service.

4.1.5 Use case for TTD/TFD Failure

When TTD/TFD failure occurs,

(1) Datasets from upstream sources remain.

(2) No data deletion is performed by the data provider (e.g., DCD) if custody transfer is not confirmed. Thus, data will not be lost due to TTD/TFD failure.

(3) Data Systems Operations Team is responsible of bringing TTD/TFD back to service.

(4) If outage time is short, data automatically resumes because of protocol design for resumption.

(5) If outage is long and the suspended process on upstream source can not resume (or if different instance of TTD/TFD is brought as a replacement), manual query/retrieval by DSOT will be required.

4.1.6 Use Case for WAN Failure During Data Delivery

The DCD will capture all data delivered to it as long as it is functioning; thus, no data will be lost. The DSCC Operations team will have the capability to replace the failed circuit by switching in the spare circuit. The missed data can be requested after the close of production if they have been stored into the repository of a service provider. This may cause losses for the Timely service and will delay the Complete delivery.

When WAN failure occurs,

(1) DCD continues capture incoming data

(2) Temporary loss of all delivery services

(3) DSCC Operations is responsible of switching to backup router and restore service if router failures occur.

(4) A single network connection failure is masked by the other connection automatically. The outage should only last for a few seconds before the other connections take over.

(5) Timely stream flows from DCD to TTD resumes.

(6) If Complete stream delivery has already subscribed, outage segment is automatically redelivered. Complete Stream resumes where it left off.

(7) If Complete stream delivery has not been subscribed to fill out gaps, user need to initiate query.

(8) File delivery resumes where it left off.

4.1.7 Use Case for Support of Critical Mission Events

Same as 4.1.1 except the redundant connection for that backup data stream is configured at service startup.

APPENDIX A

Abbreviations and Acronym

AGNW	AMMOS Ground Network
APID	Application Identifier
AMMOS	Advanced Multi-Mission Operations System
AOS	Advanced Orbiting Systems
CCN	Change Configuration Notice
CCSDS	Consultative Committee on Space Data Systems
CDR	Central Data Recorder
CFDP	CCSDS File Delivery Protocol
CPD	Command Preparation and Delivery Subsystem
CSTS	Cross Support Transfer Service
DAS	Data Accountability Subsystem
DCD	Data Capture & Delivery Subsystem
DCISCS	DSMS Common Information Services Components (DCISC) Subsystem
DDD	DSN Data Delivery
DDOR	Delta Differential One-Way Range
DISA	DSMS Information Services Architecture
DKF	DSN Keyword File
D/L	Downlink
DMR	Detail Mission Requirements
DOM	Distributed Object Manager
DOR	Differential One-Way Range
DSA	DSMS Service Agreement
DSCC	Deep Space Communications Complex
DSMS	Deep Space Mission System
DSN	Deep Space Network
DSOCC	Deep Space Operations Control Center
DSOT	Data System Operations Team
DSS	Deep Space Station
DTT	Downlink Tracking and Telemetry Subsystem
D^3	DSN Data Delivery

FAR	Frame Accountability Report File
FSP	Full Spectrum Processing Subsystem
FTDD	Fault Tolerance Data Delivery
GCF	Ground Communications Facility
GDD	Ground Data Delivery System
GIF	GIF Interface
GMP	GDD Monitor Processor
GNW	Ground Networks Subsystem
GSSR	Goldstone Solar System Radar
GTX	Ground Transmission Subsystem
IDR	Intermediate Data Record
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LLDD	Low Latency Data Delivery
MGDS	Multi-mission Ground Data System
MOC	Mission Operations Center
MRO	Mars Reconnaissance Orbiter
MSPA	Multiple Spacecrafts Per Antenna
NISN	NASA Integrated Services Network
NMC	Network Monitor & Control Subsystem
NOCC	Network Operations Control Center
NOPE	Network Operations Project Engineer
NSOE	Nominal SOE
OD	Operator Directive
OPS DSCC	DSCC Real Time Operations
OPS-PAS	Pasadena Operations
PDU	Protocol Data Unit
QQC	Quality, Quantity, and Continuity
RAF	Return All Frames
RCF	Return Channel Frames
RMOC	Remote Mission Operations Center
RNS	Reliable Network Server
SCAP	Spacecraft Capability table

SCP	Station Communication Processor
SDP	Support Data Package
SFDU	Standard Formatted Data Unit
SFG	Special Function Gateway
SICF	Service Instance ConFiguration
SLE	Space Link Extension
SM	Service Management
SOE	Sequence of Events
SPS	Service Preparation Subsystem
SQA	Service Quality Assessment Subsystem
SR	Service Request
TDDS	Tracking Data Delivery Subsystem
TFD	TTC File Delivery Subsystem
TMI	TTC Multi-Use Infrastructure Subsystem
TT&C	Telemetry, Tracking, and Command
TTD	Telemetry & Tracking Data Subsystem
U/L	Uplink
UPL	Uplink Tracking and Command Subsystem
WAN	Wide Area Network