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SERVICE CATALOG # 1

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1 INTRODUCTION

This document constitutes the IOAG Service Catalog #1 that describes the cross-support services that will be provided by the ground tracking assets¹ operated by the IOAG member agencies.

The IOAG Service Catalog #1 services provide space communication and navigation capabilities for interaction between a spacecraft control center and a spacecraft directly reachable via a ground tracking asset as shown in Figure 2-1. Measurements using the radio signal are provided as Radio Metric Services for the purpose of spacecraft navigation and communication operation in space.

Related to the provision of the above Space Communication and Radio Metric services is their Service Management, which is understood as all the interactions needed to make the service provision happen and to monitor it. For the simple ABA scenario addressed in Catalog #1, Service Management in addition interacts with the service provider as required to establish physical and link layer communications between the spacecraft and the ground tracking asset.

IOAG Service Catalog #1 is structured into “core” and “extended” services with the understanding that “core” services shall be implemented by all IOAG Agencies by 2020, while “extended” services shall be considered for bi-lateral cross supports. The IOAG agencies current capabilities are documented in the IOAG Communications Asset Table [XSCA].

The definition of IOAG Service Catalog #1 is likely to generate associated guidance of CCSDS work for those standards that are either in progress or to be started. These are mentioned as “to be written” in the list of applicable documents and their titles are therefore indicative and to be confirmed by CCSDS.

A future IOAG Service Catalog #2 is planned to define space communication services for in-space relay and network cross support scenarios which would enable future Solar System Internetworking. That catalog will comprise typically DTN and / or IP technologies. Based on bilateral agreements, some agencies are currently pursuing testing campaigns related to the new internetworking technology that will be addressed in IOAG Service Catalog #2.

1.1 Applicable Documents

1.1.1 GROUND LINK STANDARDS

- | | |
|--------|---|
| [CLTU] | CCSDS 912.1-B Space Link Extension – Forward CLTU Service Specification. Blue Book. |
| [CFFS] | CSTS Forward File Service – Blue Book. TBW |

¹ Ground Tracking Assets may be Ground Stations, Ground Data System or a combination of both.

[CFXS]	CSTS Transfer File Service – Blue Book. TBW
[CORS]	CSTS Offline Radio Metric Service - Blue Book. TBW
[CRFS]	CSTS Return File Service – Blue Book. TBW
[CRTRM]	CCSDS 922.2-B Tracking Data Cross support Transfer Service – Blue Book. TBW
[DDORS]	CSTS Delta DOR Service - Blue Book. TBW
[EDM]	CCSDS 922.1-B Monitored Data - Cross Support Transfer Services – Blue Book. TBW
[FSEF]	SLE Forward Synchronous Encoded Frame Service – Blue Book. TBW
[FSP]	CCSDS 912.3-B Space Link Extension – Forward Space Packet Service Specification. Blue Book.
[RAF]	CCSDS 911.1-B Space Link Extension – Return All Frames Service Specification. Blue Book.
[RCF]	CCSDS 911.2-B Space Link Extension – Return Channel Frames Service Specification. Blue Book.
[ROCF]	CCSDS 911.5-B Space Link Extension – Return Operational Control Fields Service Specification. Blue Book.
[RUFT]	SLE Return Unframed Telemetry Service – Blue Book. TBW
[SM]	CCSDS 910.11-B Space Link Extension – Service Management. Blue Book.

1.1.2 SPACE LINK STANDARDS

[AOS]	CCSDS 732.0-B AOS Space Data Link Protocol. Blue Book.
[CFDP]	CCSDS 727.0-B CCSDS File Delivery Protocol (CFDP). Blue Book.
[ENC]	CCSDS 133.1-B Encapsulation Service. Blue Book.
[PNR]	CCSDS 414.1-B Pseudo-Noise (PN) Ranging Systems. Blue Book.

- [RFM] **CCSDS 401.0-B Radio Frequency and Modulation Systems--Part 1: Earth Stations and Spacecraft. Blue Book.**
This standard includes numerous concise recommendations developed for conventional near-Earth and deep-space missions having moderate communications requirements. Section 2 focuses upon the technical characteristics of RF and modulation systems for Earth stations and spacecraft and it has been subdivided into six modules, each containing an individual subject:
1. Earth-to-Space Radio Frequency (Forward Link)
 2. Telecommand (Forward Link)
 3. Space-to-Earth Radio Frequency (Return Link)
 4. Telemetry (Return Link)
 5. Radio Metric
 6. Spacecraft (Transponder)
- It also includes policy constraints, and procedural elements relating to communications services provided by radio frequency and modulation systems.
- [SPP] **CCSDS 133.0-B Space Packet Protocol. Blue Book.**
- [TC-COP] **CCSDS 232.1-B Communications Operation Procedure-1. Blue Book.**
- [TC-DLP] **CCSDS 232.0-B TC Space Data Link Protocol. Blue Book.**
- [TC-S&C] **CCSDS 231.0-B TC Synchronization and Channel Coding. Blue Book.**
- [TM-DLP] **CCSDS 132.0-B TM Space Data Link Protocol. Blue Book.**
- [TM-S&C] The collection of:

CCSDS 131.0-B TM Synchronization and Channel Coding. Blue Book.

CCSDS 131.2-B Flexible Advanced Coding and Modulation Scheme for High Rate Telemetry Applications. Blue Book.

CCSDS 131.3-B CCSDS Space Link Protocols over ETSI DVB-S2 Standard. Blue Book.

1.1.3 DATA STRUCTURES STANDARDS

Some of the standards mentioned here below are widely used by the other applicable documents mentioned in this chapter and are listed here despite they may not be directly referenced in the rest of this document.

- [DDORO] **CCSDS 506.0-M Delta-Differential One Way Ranging (Delta-DOR) Operations. Magenta Book.**
- [DDRXF] **CCSDS 506.1-B Delta-DOR Raw Data Exchange Format – Blue Book.**
- [ODM] **CCSDS 502.0-B Orbit Data Messages. Blue Book.**
- [SLID] “Registries.” Space Assigned Number Authority.
<http://sanaregistry.org/r/>. This replaces CCSDS 135.0-B Space Link Identifiers. Silver Book.
- [TDM] **CCSDS 503.0-B Tracking Data Message. Blue Book.**



1.1.4 IOAG DOCUMENTS

- [INFT] CCSDS Standards Infusion into IOAG Networks (updated 6.10.07).
<https://www.ioag.org/Public%20Documents/Forms/AllItems.aspx>
- [XSCA] IOAG Cross-Support Communications Assets
<https://www.ioag.org/Public%20Documents/Forms/AllItems.aspx>

1.2 *Acronyms*

AOS	Advanced Orbiting Systems
CCSDS	Consultative Committee for Space Data Systems
CFDP	CCSDS File Delivery Protocol
CLTU	Communication Link Transmission Unit
CSTS	Cross Support Transfer Services
DOR	Differential One-Way Ranging
DTN	Delay/Disruption Tolerant Network
IOAG	Interagency Operations Advisory Group
IOP	Inter Operability Plenary
IP	Internet Protocol
PN	Pseudo Noise
RF	Radio Frequency
SLE	Space Link Extension
SP	Space Packet
SSI	Solar System Internetworking
TBW	To Be Written
TC	TeleCommand
TDM	Tracking Data Message
TM	TeleMetry

2 SCOPE OF CATALOG #1

Catalog #1 shall include the ground based cross-support services currently available or envisaged in short time for supporting the scenario described in Figure 2-1. Such a scenario is sometimes referred to as an ABA scenario to show that an Agency B is providing services to Agency A Control Center for accessing an Agency A spacecraft.

The deployment status of Catalog #1 will be documented in [INFT].

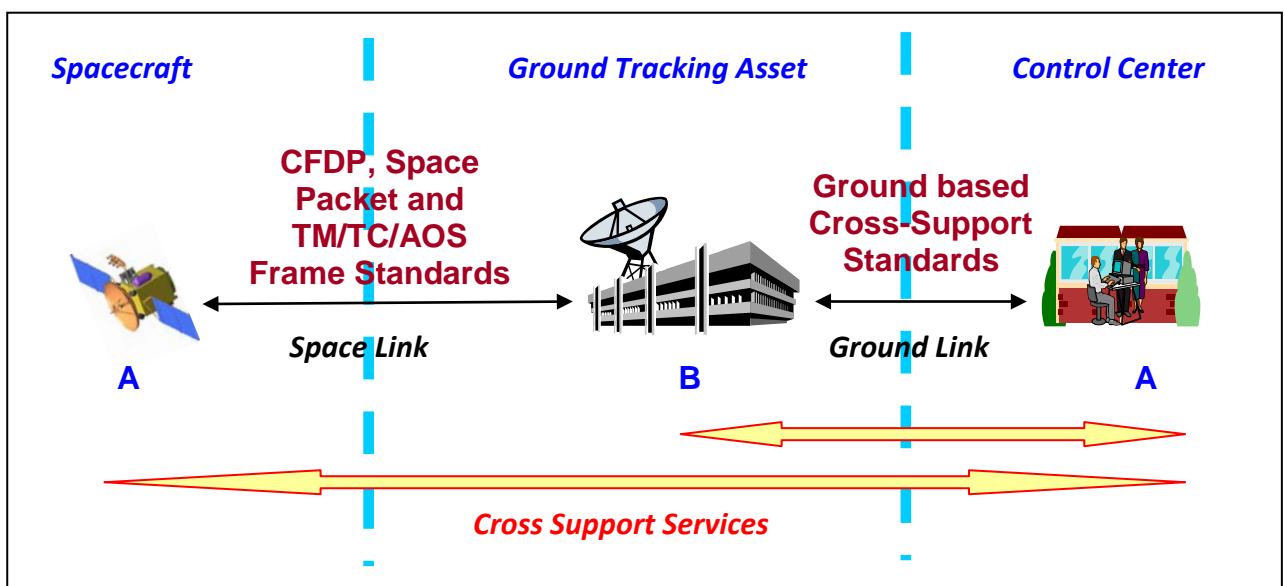


Figure 2-1 ABA Scenario for Catalog #1

As depicted in Figure 2-1, there are two kinds of links (and then two types of interfaces) involved in this scenario: the Space Link (Interface) between the Spacecraft and a Ground Tracking Asset and the Ground Link (Interface) between the Ground Tracking Asset and the Spacecraft Control Center.

On the Space Link, services are based on a set of standards applicable to the transfer of data over this connection, while on the Ground Link the services are defined by a set of standards defining a set of Cross Support Transfer Services (named Space Link Extension services in their simplest form). In addition both kinds of links (and then two types of interfaces) rely on a set of other standards for data structures. The relevant standards are defined by CCSDS.

For the Space Link Interface a very comprehensive list of CCSDS Recommendations is available covering RF and Modulation, Coding and Synchronization and Link Layer Protocols. However those Recommendations are not necessarily fully supported by the plurality of the IOAG agencies (e.g. GMSK modulation, turbo codes, regenerative ranging, forward AOS).

The Cross Support Transfer Services provide the Control Center either with access to information traveling on the Space Link or with access to other information not traveling on the Space Link (but possibly derived from/related to the space link). Therefore the IOAG Service span either between the Control Center and the Spacecraft or between the Control Center and the Ground Tracking Asset as shown by the yellow arrows in the figure.

The Ground Link Interface services fall into the following categories:

1. Cross Support Transfer Services / Space Link Extension Services.
2. "Service Management" Functions.

The Cross Support Transfer Services (CSTS) and the Space Link Extension (SLE) Services define ground link interface between a Control Center and a Ground Tracking Asset.

The "Service Management" functions takes care of

- a. the configuration needed for setting up the exposed service (i.e. service provisioning) , and
- b. the setting of space link parameters not directly exposed by the transfer services such as RF and Modulation, etc. (i.e. service production).

The specification of Service Management is approaching completion, but is not yet deployed and will have to be generalized to accommodate additional services and operational needs.

2.1 Definition of Service

A service is a self-contained function, which accepts one or more requests and returns one or more responses through a well-defined, standard interface. A service does not depend on the context or state of other services or processes (although it may utilize other services via their interfaces). Services are specified from the user's point of view, i.e., in terms of "what it provides" rather than "how it is performed" or "what does the job". Therefore, a service is solely specified in terms of its behavior and performance without reference to a particular implementation.

The services described in this catalog are those services supporting mission operations and relevant to an operational context where a service provider (e.g., a tracking station or a communications network) exists and it provides communications and tracking supports to a service user, i.e., a flight project's mission control center. Figure 2-2 describes the "service provider – service user" relationship in the service paradigm.

The service is the "whole job" in the operations sense. It will thus typically involve a combination of software components, computing and communications hardware, personnel and the procedures they follow, as well as facilities. Further, the service is also the "whole job" in the life-cycle sense. The design, implementation, integration, verification and validation activities needed to supply the service are an inherent part of it.

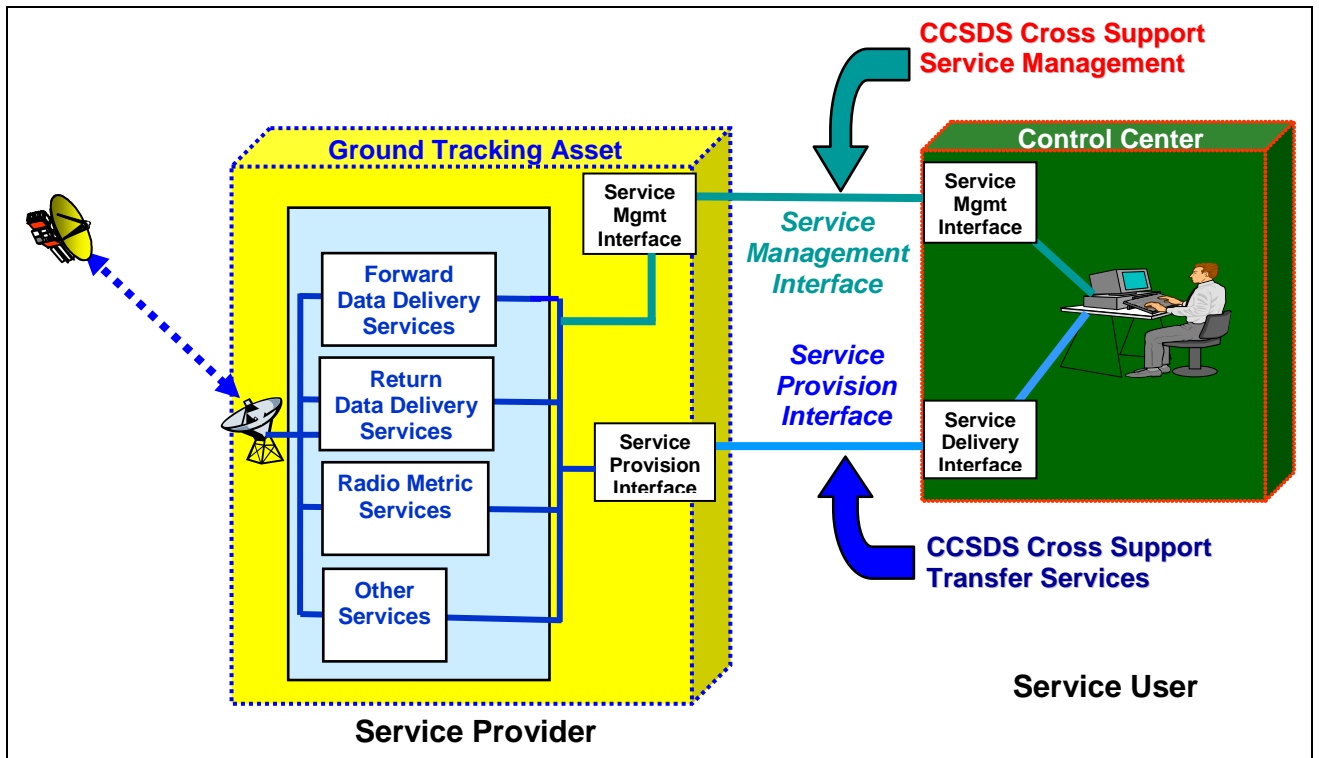


Figure 2-2 Context of the Cross Support Services

This catalog describes a set of standard service types provided by the IOAG member agencies for cross support purposes. The individual service types as defined are distinguished from one another by the functions provided, level of processing involved, and/or the type(s) of source data. Of these service types a few that are minimally required of all member agencies are considered “Core Services”, whereas those to be provided only on a voluntary, bi-lateral agreement basis are “Extended Services”.



3 CATALOG #1 SERVICES

A given IOAG Service can be built on top of a number of combinations of Space Link Interface standards and Ground Link Interface standards as shown in the table below. Both types of standards rely on Data Structure standards that are not shown in the table.

The following groups of IOAG Services have been identified within IOAG Service Catalog #1. Each group includes several service types.

- Forward Data Delivery Services Group. These services allow transfer of data from a control center to a spacecraft.
- Return Data Delivery Services Group. These services allow transfer of data from a spacecraft to a control center.
- Radio Metric Services Group. These services allow the results of radio metric measurements to be provided to a control center.

In addition Service Management functions are defined. They allow for interaction between the space agencies in order to coordinate the provision of the above space communications and radio metric services. Moreover, these functions allow the results of radio link status to be provided to a control center.

The rows marked by light green shadow in Table 3-1 indicate core services for IOAG Service Catalog #1 while the white rows indicate extended services.

IOAG Service Group	IOAG Service Types	Space Link Interface Standards	Ground Link Interface Standards
Forward Data Delivery Services	Forward CLTU Service	<ul style="list-style-type: none"> • Radio Frequency and Modulation [RFM]² • TC Synchronization and Channel Coding [TC-S&C] 	<ul style="list-style-type: none"> • SLE Forward CLTU Service [CLTU]
	Forward Space Packet Service	Those for “Forward CLTU Service” plus: <ul style="list-style-type: none"> • TC Space Data Link Protocol [TC-DLP] • Communications Operation Procedure-1 [TC-COP] 	<ul style="list-style-type: none"> • SLE Forward Space Packet Service [FSP]
	Forward Synchronous Encoded Frame Service	<ul style="list-style-type: none"> • Radio Frequency and Modulation [RFM]³ 	<ul style="list-style-type: none"> • SLE Forward Synchronous Encoded Frame Service [FSEF]
	Forward File Service	Those for “Forward CLTU Service” and/or “Forward Synchronous Encoded Frame Service” plus: <ul style="list-style-type: none"> • Space Packet Protocol [SPP] • Encapsulation Service [ENC] • CCSDS File Delivery Protocol [CFDP] • TM Synchronization and Channel Coding [TM-S&C] • AOS Space Data Link Protocol [AOS] 	<ul style="list-style-type: none"> • CSTS Forward File Service [CFFS], over • CSTS Transfer File Service [CFXS]

² With respect to Forward IOAG Service(s), the applicability of this recommendation is limited to the sections for the recommendations about “Earth to Space RF” and “Telecommand”.

³ With respect to Forward IOAG Service(s), the applicability of this recommendation is limited to the sections for the recommendations about “Earth to Space RF” and “Telecommand”.

IOAG Service Group	IOAG Service Types	Space Link Interface Standards	Ground Link Interface Standards
Return Data Delivery Services	Return All Frames Service	<ul style="list-style-type: none"> • Radio Frequency and Modulation [RFM] ⁴ • TM Synchronization and Channel Coding [TM-S&C] 	<ul style="list-style-type: none"> • SLE Return All Frames [RAF]
	Return Channel Frames Service	Those for “Return All Frames Service” plus: <ul style="list-style-type: none"> • TM Space Data Link Protocol [TM-DLP] • AOS Space Data Link Protocol [AOS] 	<ul style="list-style-type: none"> • SLE Return Channel Frames [RCF]
	Return Operational Control Field Service	<ul style="list-style-type: none"> • Those for “Return Channel Frames Service” 	<ul style="list-style-type: none"> • SLE Return Operational Control Field [ROCF]
	Return Unframed Telemetry Service	<ul style="list-style-type: none"> • Those for “Return All Frames Service” 	<ul style="list-style-type: none"> • CSTS Return Unframed Telemetry [RUFT]
	Return File Service	Those for “Return Channel Frames Service” plus: <ul style="list-style-type: none"> • Space Packet Protocol [SPP] • Encapsulation Service [ENC] • CCSDS File Delivery Protocol [CFDP] 	<ul style="list-style-type: none"> • CSTS Return File Service [CRFS] over • CSTS Transfer File Service [CFXS]

⁴ With respect to Return IOAG Service(s), the applicability of this recommendation is limited to the sections for the recommendations about “Space to Earth RF” and “Telemetry”.

IOAG Service Group	IOAG Service Types	Space Link Interface Standards	Ground Link Interface Standards
Radio Metric Services	Validated Data Radio Metric Service	<ul style="list-style-type: none"> • Radio Frequency and Modulation [RFM] ⁵ • Pseudo-Noise (PN) Ranging Systems [PNR] 	<ul style="list-style-type: none"> • CSTS Offline Radio Metric Service [CORS] over • CSTS Transfer File Service [CFXS]
	Raw Data Radio Metric Service	<ul style="list-style-type: none"> • Those for “Validated Data Radio Metric Service” 	<ul style="list-style-type: none"> • CSTS Real Time Radio Metric Service [CRTRM]
	Delta DOR Service	<ul style="list-style-type: none"> • Radio Frequency and Modulation [RFM] ⁶ 	<ul style="list-style-type: none"> • CSTS D-DOR Data Service [DDORS] over • CSTS Transfer File Service [CFXS]

Table 3-1 Catalog #1 Services

⁵ With respect to Radio Metric IOAG Service(s), the applicability of this recommendation is limited to the sections for the recommendations about “Radio Metric”.

⁶ With respect to Radio Metric IOAG Service(s), the applicability of this recommendation is limited to the sections for the recommendations about “Radio Metric”.

4 DESCRIPTION OF CATALOG #1 SERVICE GROUPS AND TYPES

Catalog #1 includes three groups of Services:

- Forward Data Delivery Services Group
- Return Data Delivery Services Group
- Radio Metric Services Group

4.1 Forward Data Delivery Services Group

The Forward Data Delivery services allow a Control Center to forward messages to a remote spacecraft as shown in Figure 2-1.

4.1.1 FORWARD CLTU SERVICE TYPE

This Service enables a mission to send Communications Link Transmission Units (CLTUs) to a spacecraft. It relies on the following Space Link Interface Standards and Ground Link Interface Standards.

- Radio Frequency and Modulation [RFM] limited to modules for “Earth-to-Space Radio Frequency (Forward Link)” and “Telecommand (Forward Link)”
- TC Synchronization and Channel Coding [TC-S&C]
- SLE Forward CLTU Service [CLTU]

4.1.2 FORWARD SPACE PACKET SERVICE TYPE

This Service enables a mission to send Space Packets to a spacecraft, possibly with the benefits given by the Communications Operation Procedure-1. It relies on the same Space Link Interface Standards applicable to “Forward CLTU Service” (see 4.1.1) plus the following Space Link Interface Standards and Ground Link Interface Standards.

- TC Space Data Link Protocol [TC-DLP]
- Communications Operation Procedure-1 [TC-COP]
- SLE Forward Space Packet Service [FSP]

4.1.3 FORWARD SYNCHRONOUS ENCODED FRAME SERVICE TYPE

This Service enables a mission to send Frames to a spacecraft by allowing a Control Center to provide - in an asynchronous manner - a Ground Tracking Asset with encoded frames for uplink to a spacecraft in a synchronous manner. The Ground Tracking Asset will undertake to insert predefined idle frames in the absence of user supplied data. It relies on the following Space Link Interface Standards and Ground Link Interface Standards.

- Radio Frequency and Modulation [RFM] limited to modules for “Earth-to-Space Radio Frequency (Forward Link)” and “Telecommand (Forward Link)”
- SLE Forward Synchronous Encoded Frame Service [FSEF]

No encoding capabilities are required to the Ground Tracking Asset. This service may be used for - but not limited to - uplinking CCSDS Version-2 Transfer Frames (i.e. AOS Frames).

4.1.4 FORWARD FILE SERVICE TYPE

This Service enables a mission to send the contents of a file to a spacecraft by allowing a Control Center to provide a Ground Tracking Asset with files for uplink. Within Catalog #1, usage of this service is limited to a spacecraft directly reachable from a Ground Tracking Asset (i.e. single hop space link) as per Figure 2-1. It relies on the same Space Link Interface Standards applicable to “Forward CLTU Service” (see 4.1.1) and/or “Forward Synchronous Encoded Frame Service” (see 4.1.3) plus the following Space Link Interface Standards and Ground Link Interface Standards.

- Space Packet Protocol [SPP]
- Encapsulation Service [ENC]
- CCSDS File Delivery Protocol [CFDP]
- CSTS Forward File Service [CFFS] over
- CSTS Transfer File Service [CFXS]
- TM Synchronization and Channel Coding [TM-S&C]
- AOS Space Data Link Protocol [AOS]

Remark - The two CSTS File Services listed above are “to be written”. It is assumed that a generic transfer file service allowing to transfer files between two units, i.e. [CFXS], will be available and - on top of this generic service - more “specialized” file services will allow requesting the dedicated processing for the file being transferred. Therefore, it is expected that the CSTS Forward File Service will allow the Control Center to inform whether the file contains

- a collection of Space Packets, or
- a collection of Encapsulation Packets, or
- a file to be processed into CFDP PDUS to be embedded either in Space Packets or Encapsulation Packets.⁷

Additionally the CSTS Forward File Service will allow the Control Center to state how the Space/Encapsulation Packets shall be forwarded to the spacecraft either within TC Frames or AOS Frames.

4.2 *Return Data Delivery Services Group*

The Return Data Delivery services allow a Control Center to receive messages that a remote spacecraft sent to a supporting Ground Tracking Asset as shown in Figure 2-1.

⁷ For Catalog #1, CFDP runs single hop in ABA scenario, therefore the ground tracking asset shall support the packet service used in the spacecraft and this can be either [SPP] or [ENC].

4.2.1 RETURN ALL FRAMES SERVICE TYPE

This Service enables a mission to send Telemetry Frames (formatted according to Packet Telemetry or AOS standards or privately formatted) to a Control Center. It relies on the following Space Link Interface Standards and Ground Link Interface Standards.

- Radio Frequency and Modulation [RFM] limited to modules for “Space-to-Earth Radio Frequency (Return Link)” and “Telemetry (Return Link)”
- TM Synchronization and Channel Coding [TM-S&C]
- SLE Return All Frames [RAF]

4.2.2 RETURN CHANNEL FRAMES SERVICE TYPE

This Service enables a mission to send Telemetry Frames (formatted either according to Packet Telemetry or AOS standards) to a Control Center. It relies on the same Space Link Interface Standards applicable to “Return All Frames Service” (see 4.2.1) plus the following Space Link Interface Standards and Ground Link Interface Standards.

- TM Space Data Link Protocol [TM-DLP]
- AOS Space Data Link protocol [AOS]
- SLE Return Channel Frames [RCF]

4.2.3 RETURN OPERATIONAL CONTROL FIELD SERVICE TYPE

This Service enables a mission to send Operational Control Fields (extracted from frames formatted either according to Packet Telemetry or AOS standards) to a Control Center. It relies on the same Space Link Interface Standards applicable to “Return Channel Frames Service” (see 4.2.2) plus the following Space Link Interface Standards and Ground Link Interface Standards.

- SLE Return Operational Control Field [ROCF]

4.2.4 RETURN UNFRAMED TELEMETRY SERVICE TYPE

This Service This Service enables a mission to send Telemetry (not presenting any standardized/known formatting to the service provider) to a Control Center. It relies on the same Space Link Interface Standards applicable to “Return All Frames Service” (see 4.2.1) plus the following Space Link Interface Standards and Ground Link Interface Standards.

- SLE Return Unframed Telemetry [RUFT]

This service will accommodate legacy missions not compliant with most recent CCSDS space link standards and it shall not be offered to future missions.

4.2.5 RETURN FILE SERVICE TYPE

This Service enables a mission to send the contents of a file to a Control Center by allowing a Ground Tracking Asset to provide a Control Center with files received from a spacecraft. Within Catalog #1, usage of this service is limited to a spacecraft directly reachable from a Ground Tracking Asset (i.e. single hop space link) as per Figure 2-1. It relies on the same Space Link

Interface Standards applicable to “Return Channel Frames Service” (See 4.2.2) plus the following Space Link Interface Standards and Ground Link Interface Standards.

- Space Packet Protocol [SPP]
- Encapsulation Service [ENC]
- CCSDS File Delivery Protocol [CFDP]
- CSTS Return File Service [CRFS] over
- CSTS Transfer File Service [CFXS]

Remark - The two CSTS File Services listed above are “to be written”. It is assumed that a generic transfer file service allowing to transfer files between two units, i.e. [CFXS], will be available and - on top of this generic service – more “specialized” file services will allow requesting the dedicated processing for the file being transferred. Therefore, it is expected that the CSTS Return File Service will allow the Ground Tracking Asset to inform the Control Center whether the file contains

- a collection of Space Packets, or
- a collection of Encapsulation Packets, or
- a file reconstructed from CFDP PDUS that were embedded either in Space Packets or Encapsulation Packets.⁸

Additionally the CSTS Return File Service will allow the Ground Tracking Asset to report whether the Space/Encapsulation Packets were transmitted from the spacecraft either within TM Frames or AOS Frames.⁹

4.3 Radio Metric Services Group

The Radio Metric services allow a Control Center to receive data involved in orbit computation for a remote spacecraft.

4.3.1 VALIDATED DATA RADIO METRIC SERVICE TYPE

This Service enables a Control Center to receive the data involved in orbit computation as received and validated by a Ground Tracking Asset. Validated data include traditional and Pseudo-Noise ranging results as well as correlated Delta-DOR data. Such data are provided to a Control Center within files assembled by the Ground Tracking Asset. This Service relies on the following Space Link Interface Standards and Ground Link Interface Standards.

- Radio Frequency and Modulation [RFM] limited to module for “Radio Metric”
- Pseudo-Noise (PN) Ranging Systems [PNR]
- CSTS Offline Radio Metric Service [CORS] over
- CSTS Transfer File Service [CFXS]

⁸ For Catalog #1, CFDP runs single hop in ABA scenario, therefore the ground tracking asset shall support the packet service used in the spacecraft and this can be either [SPP] or [ENC].

⁹ It is assumed that the Ground Tracking Asset is configured for receiving the file from the spacecraft before running the CSTS Return File Service. This would also allow retrieving a file already received and reconstructed by the Ground Tracking Asset.

Remark - The [DDORO] Recommended Practice addresses Delta-DOR aspects as e.g., configuration requirements for interagency Delta-DOR measurement; interagency exchange of measurement data; parameters that are necessary in order to correlate and process the data at one of the agencies; interagency transfer of the generated observables; and the end-to-end flow of control.

Remark - The two CSTS File Services listed above are “to be written”. It is assumed that a generic transfer file service allowing to transfer files between two units, i.e. [CFXS], will be available and - on top of this generic service – more “specialized” file services will allow requesting the dedicated processing for the file being transferred. In this case, it is expected that the CSTS Offline Radio Metric Service will allow the Ground Tracking Asset to inform the Control Center about applied processing and file contents (i.e. Tracking Data Messages (TDM) according to the [TDM] standard specifying a format for use in exchanging spacecraft tracking data).

4.3.2 RAW DATA RADIO METRIC SERVICE TYPE

This Service enables a Control Center to receive the data involved in orbit computation as soon as they are received/built by a Ground Tracking Asset. Such data are provided to a Control Center within files assembled by the Ground Tracking Asset. It relies on the same Space Link Interface Standards applicable to “Validated Data Radio Metric Service” (See 4.3.1) plus the following Space Link Interface Standards and Ground Link Interface Standards.

- CSTS Real Time Radio Metric Service [CRTRM]

Remark - The CSTS Real Time Radio Metric Service is “to be written”. It is assumed that it will implement delivery of TDM formatted data via streaming interface.

4.3.3 DELTA DOR SERVICE TYPE

This Service enables a Control Center to receive Delta-DOR raw data¹⁰ or Open Loop Recording data¹¹ acquired by a Ground Tracking Asset. Such data are provided to a Control Center within files assembled by the Ground Tracking Asset. It relies on the following Space Link Interface Standards and Ground Link Interface Standards.

- Radio Frequency and Modulation [RFM]
- CSTS D-DOR Data Service [DDORS] over
- CSTS Transfer File Service [CFXS]

Remark - The [DDORO] Recommended Practice addresses Delta-DOR aspects as e.g., configuration requirements for interagency Delta-DOR measurement; interagency exchange of measurement data; parameters that are necessary in order to correlate and process the data at one of the agencies; interagency transfer of the generated observables; and the end-to-end flow of control.

Remark - . The CSTS D-DOR Data Service [DDORS] is “to be written”. It is assumed that a generic transfer file service allowing to transfer files between two units, i.e. [CFXS], will be

¹⁰ Note that this service only provides Delta-DOR raw data while Delta-DOR correlated data are provided via the “Validated Data Radio Metric Service”.

¹¹ In fact, the data format defined in [DDRXF] can also be used to store Open Loop Recording data.



available and - on top of this generic service – more “specialized” file services will allow requesting the dedicated processing for the file being transferred. In this case, it is assumed that the CSTS D-DOR Data Service [DDORS] will implement delivery of D-DOR “raw data” or Open Loop Recording data stored according to [DDRXF].

5 SERVICE MANAGEMENT FUNCTIONS

Services provided by an IOAG member agency are requested and controlled via a standard service management function. Service management by itself is not a service. It is a function performed cooperatively by both the tracking network (on the service provider's side) and the mission operations center (on the service user's side). It includes:

- Allocation and scheduling of space communication resources and assets during the service commitment and planning phases.
- Configuring, monitoring, and controlling the communication assets during the service provision phase (i.e., before, during, and after a communication contact).
- Reporting of service execution results.

The service management interfaces employed for some of the above will be in compliance with the CCSDS Cross Support Service Management Specification [SM].

For configuring of the tracking asset in terms of antenna pointing the [ODM] standard shall be applied.

5.1.1 ENGINEERING MONITORING DATA DELIVERY

IOAG Service Catalog #1 foresees one Link Monitoring function (see Table 5-1) to allow a Control Center to receive data monitoring the status of the space link between a Ground Tracking Asset and a remote spacecraft. Such monitoring data are not limited to the status of the space link and they may also include information about space link related status and/or processing of the equipment at the Ground Tracking Asset.

The Engineering Monitoring Data Delivery relies on the following Ground Link Interface Standards.

- CSTS Engineering Data Monitoring [EDM]

	IOAG Service Function	Space Link Interface Standards	Ground Link Interface Standards
Service Management Functions	Engineering Monitoring Data Delivery	<ul style="list-style-type: none"> • N/A 	<ul style="list-style-type: none"> • CSTS Engineering Data Monitoring [EDM]

Table 5-1 Catalog #1 Service Management Functions