

Technical Note Concerning Space Data System Standards

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| Requirements for SimplE Configuration Profiles AND Service Agreements  |

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# Introduction

The Cross Support Services Area (CSSA) is developing a Recommended Standard for Service Management Utilization Request Formats (SMURF, reference [1]). One of those formats – the Service Package Request – is used to request the provision of space link and terrestrial data transfer services from a Provider Cross Support Service System (CSSS) (see reference [2] for definition). An important characteristic of the Service Package Request is the citation of one or more pre-defined *configuration profiles* that identify the space communication resources being requested and the detailed configuration parameters of those resources. In its simplest form, a Service Package Request asks that configuration profile *x* be provided from time *y* to time *z*.

Configuration profiles are, in turn, constrained by *service agreements*. With respect to configuration profiles, service agreements set the boundaries within which the configuration profiles are created. For example, a service agreement between Provider CSSS A and Mission B may specify that up to three Return All Frames (RAF) service instances may be provided concurrently during the same space link session (SLS), and then various configuration profiles for Mission B may contain one, two, or three RAF instances.

CSSA is planning to develop a Recommended Standard for Service Agreements and Configuration Profiles, but resource and timing constraints will likely defer availability of the full Recommended Standard until sometime after the SMURF book is published. Fortunately, the SMURF book does not require a fully-articulated, standardized Configuration Profile/Service Agreement specification in order for Service Package Requests to exist and be exchanged between Missions and Provider CSSSes; early adopters of the SMURF will be able to use “semi-private”, Provider CSSS-defined configuration profile formats in conjunction with the SMURF. However, there is a minimal set of requirements to which all such configuration profiles must adhere in order to work with SMURF.

## Purpose OF THIS TecH Note

The purpose of this Tech Note is to define the minimal set of requirements to which Provider CSSS-defined configuration profile contents and service agreement contents must conform in order to work with the SMURF.

While SMURF conformance is the primary driver for these requirements, configuration profiles contain information that will be used (referenced) by the planned Service Package Result and Space Link Event Sequence Recommended Standards. This Tech Note also addresses the requirements on configuration profiles in order for those Recommended Standard to be used in those contexts.

Finally, configuration profiles play a critical role in identifying the Functional Resource mappings to the physical resources that provide the services. This Functional Resource mapping is crucial to the use of the soon-to-be-published Monitored Data Cross Support Transfer Service (MD-CSTS) (reference [4]) and the planned Service Control CSTS (SC-CSTS).

## Background

Use of the configuration profile approach is the de facto method that TT&C networks employ for configuring space link sessions (a.k.a. contacts, passes, tracks, Events). However, the term “configuration profile” is itself the CCSDS name for this entity – actual Provider CSSSes (a.k.a TT&C networks) currently have their own network-dependent names (e.g., SN service specification codes (SSCs), NEN Support Activity Codes).

When requesting that a space link session be scheduled, instead of asking for an explicitly-detailed set of resources and associated configuration parameter values, the Mission simply references one or more configuration profiles that has been previously negotiated between the Mission and the Provider CSSS.

The common characteristics of configuration profiles are:

1. They represent a collection of space link data processing resources
2. They represent the values of the configuration parameters of all of the resources in the collection
3. They represent the interconnection of the resources
4. Data flow between space link and interface to user ground element(s)
5. “Lateral” data flows between forward and return links (e.g., CLCW throttling of forward link)
6. They have identifiers that are used in service package requests as short-hand indicators for what is being requested
7. Service package requests and resulting schedules associate start/stop times with configuration profiles
8. For some Provider CSSSes, *respecification* (in the service request) and/or *reconfiguration* (real-time control, event sequences) of individual configuration parameter values must relate to configuration profiles

Today, each Provider CSSS has its own syntax and semantic rules for its configuration profiles.

### SCCS-SM Blue-1 (2009)

The Space Communication Cross Support Service Management (SCCS-SM) Service Specification (reference [5]), published in 2009, included standard XML-formatted Configuration Profile and Service Agreement specifications.

The principle component of the Blue-1 Configuration Profile is the *Space Communication Service Profile*, which contains one or more *Space Link Carrier Profiles*. Each Space Link Carrier Profile includes components related to RF modulation, synchronization and channel coding, space link protocols and terrestrial transfer services. Support was defined for the CCSDS 401 RF modulation, TM, TC, and AOS Sync and Coding and Space Data Link Protocols, and RAF, RCF, and FCLTU SLE transfer services as specified at that time. The Space Communication Service Profiles also provided a simple method for offsetting the start/stop times of the space link carriers within them.

The Blue-1 Configuration Profile was designed as part of a Configuration Profile Service, in which new configuration profiles could be generated dynamically by a Mission and submitted to the Provider CSSS shortly (minutes to hours) before the submission of a Service Package Request that referenced that Configuration Profile. The need for a Provider CSSS to be able to quickly validate a Configuration Profile led to a highly-formalized Service Agreement standard against which the individual parameter values in the dynamically-generated Configuration Profiles could be automatically and quickly validated.

The Blue-1 Configuration Profile has several shortcomings that have subsequently inhibited its implementation:

* The structure of the Space Communication Service Profile is quite monolithic – there is no easy way to incrementally insert new RF modulation schemes, sync and channel coding, space data link protocols, or remaining SLE/new CSTS transfer services
* The rudimentary timing offset relationships among “carrier” subsets made available within the Space Communication Service Profile was not comprehensive enough to accommodate the needs of more-sophisticated scheduling algorithms
* The “all CCSDS or none” nature of the configuration profile cannot accommodate Provider CSSSes that offered a mixture of CCSDS and legacy services – any support for legacy services requires a full-up “bilateral” configuration profile.
* There is little or no semantic linkage between the detailed bits and pieces of the Blue-1 Configuration Profile and the aggregate service categories (command, telemetry, tracking, etc.) in common usage today (and still in usage in the forthcoming Simple Schedule Formats standard (reference [6]).

### “Extensible” Configuration Profiles (2010 – April 2016)

Following completion of SCCS-SM Blue-1, the CSSA Cross Support Service Management Working Group began an “Extensible” Service Management effort to develop a set of standards that would overcome the shortcomings that were already evident in the SCCS-SM B-1 book by the time that it was published.

With respect to Configuration Profiles, the extensible version was to be based on a modular, plug-and-play approach that would allow new technologies to be introduced at differing rates and in different combinations. A key component of this approach was the adoption of Functional Resources as the representation of the “chunks” of resource functionality. Functional Resources had originally been developed for purposes of unambiguously identify the source of monitored data parameter values in the MD-CSTS (reference [4]).

In order to create the desired plug-and-play architecture, it was necessary to identify the rules by which one “block” could be plugged in as a replacement for another “block”. This led to the creation of the Functional Resource Strata model (which is partially defined in the latest draft Functional Resources Tech Note (reference [7]), which defines the various abstract Functional Resource Strata and groups the currently-defined Functional Resource types into Functional Resource Sets that reside within those strata. The Functional Resource Sets effectively comprise the plug-and-play blocks. Service Access Points (SAPS), Service Accessors, and required/provided ancillary interfaces are additional facets of this plug-and-play architecture.

The extensible configuration profile approach was to have also replaced the rudimentary SCCS-SM B-1 relative offset mechanism for controlling the start/stop time of space link carriers with an extensible approach that would allow not only a greater initial set of timing relationships to be defined, but also allow new timing relationships to be defined and use in the future. The parameters of these timing relationships were to have been definable within the configuration profiles themselves, so that routinely-used timing relationships could be invoked without having to re-specify them as part of each Service Package Request.

As with the SCCS-SM B-1, extensible configuration profiles would continue to be validated against the service agreements. But whereas the structure of the B-1 configurations profile and service agreement XML schemas differed, the structures of their extensible counterparts were to have been more closely aligned. This closer alignment is a logical consequence of the extensible approach – for every new Functional Resource type that is defined, there is to be a service agreement schema that can be plugged into a Mission’s service agreement(s) with the Provider CSSS, and a corresponding configuration profile schema that can be plugged into that Mission’s configuration profiles.

The existence of the extensible configuration profile architecture implies a living, evolving lifecycle for configuration profile and service agreement components. The CSSMWG originally aimed to create a set of guidelines that would allow the specification of the configuration profile and service agreement models/schemas of new Functional Resource types could be delegated to the technical bodies (e.g., CCSDS working groups) that create the new technologies (e.g., modulation and coding schemes, space data link protocols) represented by those Functional Resource types. While that “delegation through guidelines” approach remains possible as a future goal, for the near term the CSSMWG settled on an approach in which the development of new configuration profile and service agreement models and schemas would be developed within the CSSMWG itself. This more-pragmatic approach eliminates the need to first “build the system [guidelines] to build the system [the actual set of configuration profile and service agreement schemas]”. Furthermore, if and when the CSSMWG decides to attempt to develop the aforementioned guidelines, the practical experience of having defined some of the evolving set of configuration profile and service agreement components will greatly inform the task of writing those guidelines.

Up until April 2016, several iterations of configuration profile models and example schemas had been attempted and subsequently refined. These models/schemas were quite complex, owing primarily to the need to express the wide array of theoretically-possible relationships among the various Functional Resource types. It is *necessary* for a configuration profile to define the configuration parameters values of each Functional Resource instance in the configuration, *but it is not sufficient* – the configuration profile must also define the “wiring” among those Functional Resource instances. It is the specification of this wiring that complicates the configuration profile model and schemas that were developed prior to April 2016.

One drawback of the SCCS-SM B-1 configuration profiles remained with the extensible configuration profiles – they still provided no semantic linkage between commonly-used aggregate service categories (command, telemetry, tracking, etc.) and the Functional Resources and Functional Resource Sets that comprise the configuration profiles.

### CCSDS Spring 2016 Workshop – Cleveland (April 2016)

At the spring 2016 CCSDS Workshop in Cleveland, Ohio, the most-recent concepts, model, schemas, and examples for standard Configuration Profiles were presented and discussed, and improvements and simplifications were identified. The major agreements were:

1. The concept of Service Components was softened. Going into Cleveland they had represented service management entities that contained Functional Resources but that had their own unique operational identifiers and interfaces. Henceforth they would just represent sets of Functional Resources that would be plugged in as a set: all operational identification and interfaces would now belong solely to the Functional Resources themselves. The name “Service Component” itself was changed to “Functional Resource Set”.
2. Concurrent with the demotion of Service Components, the composition of Configuration Profiles themselves was simplified. Whereas going into Cleveland a Configuration Profile was defined as a specific wiring configuration among pre-defined Service Component Profiles (which necessitated the separate establishment of the Service Component Profiles and the Configuration Profile), the simplified Configuration Profile would be an entity that directly contained all of the Functional Resource instances that it uses.
3. The specification of all timing relationships among entities within a configuration profile, as well as timing relationships among the entities of multiple configuration profiles executing in the same service package, would be supplied by the Service Package Request – no timing relationship information would be contained within the configuration profiles themselves.
4. Configuration profiles would contain a mapping between the Functional Resources within those profiles and the “top level” service designations (e.g., command, telemetry, tracking) traditionally used by TT&C networks, and still used in the Simple Schedule Formats.

NOTE - For clarity, in this Tech Note these top-level traditional service designations are referred to as *space link services* to differentiate them from the other kinds of services (e.g., SLE transfer services and CSTSes) available.

The mapping between configuration profiles and space link services raises the question of hierarchical relationship – does each space link service have its own configuration profile, or can a configuration profile cover multiple space link services. Both approaches were discussed, and the consensus was that a configuration profile *could* cover multiple space link services (to support, for example routine configuration that have concurrent command and telemetry services), but that service packages with multiple, single-service configuration profiles also need to be supported. (This consensus has been re-affirmed in subsequent meetings and telecons).

Even with these simplifications, it was realized at the April 2016 meeting that the resources needed for completion of the Configuration Profile/Service Agreement format standard were probably not sufficient to complete the Recommended Standard for a fully interoperable set of formats by the time that the SMURF would be published[[1]](#footnote-1). However, as noted above in this Tech Note, the SMURF does not require the existence of a fully-interoperable, standard Configuration Profile: the SMURF can be made to work with any number of configuration profile formats, as long as those formats contain the minimal set of configuration profile *information* that the SMURF needs to reference and possibly manipulate.

In light of this realization, a two-phased approach was developed. The first phase would consist of identifying and documenting the minimal set of configuration profile information requirements that configuration profiles would need to meet in order for them to be used in conjunction with the SMURF Service Package Request. These requirements may also support only the most common set of configurations that are in use today, rather than the full theoretical set of possibilities that are supported by the SCCS-SM B-1 configuration profiles and envisioned for the Extensible Configuration Profiles.

The second phase would consist of developing fully-interoperable configuration profile and service agreement formats. This set of configuration profiles and service agreements would likely also support services and configurations that are not supported today but envisioned for the future (e.g., services from IOAG Service Catalog #2).

The expectation is that the information requirements can be ready by the time the SMURF is published, and any agency that wishes to implement the Service Package Request component of SMURF and use all of its features will be able to do so as long as its proprietary configuration profiles and service agreements contain the minimally-required information. Of course, an Agency may decide to wait until the CCSDS-standard Configuration Profile and Service Agreement formats are defined and published.

## Scope

This Tech Note identifies and documents the minimal setoff information requirements needed to allow configuration profiles and service agreement to be used in conjunctions with the Service Package Request of the SMURF.

These information requirements do not specify the formats or additional information necessary to convey all of the configuration profile information necessary for a Provider CSSS and a Mission to have an unambiguous mutual understanding of the configuration being requested and subsequently provided. A Provider CSSS that implements these minimal information requirements must therefore also define the formats of their configuration profiles and provide in those configuration profiles the means to express the relationships among the different functional entities represented therein.

## Document Organization

Section 2 describes the general concepts for configuration profiles and service agreements.

Section 3 lays out the minimum requirements for simplified configuration profiles.

Section 4 provides an example use of simplified configuration profiles in a SMURF Service Package Request, and how the use of those profiles would subsequently appear in the Simple Schedule and the Service Package Request.

Section 5 identifies an initial set of space link service profiles, identifies the IOAG Service Catalog services that they support, and identifies the Simple Schedule Service Types that that each of the space link service profiles maps into.

Section 6 addresses issues related to the need to link interacting space link service profiles. In this draft version of the Tech Note, this section is a placeholder. It will be developed in futures drafts of the Tech Note.

## References

The following documents are referenced in this Technical Note. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this Technical Note are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS documents.

[1] *Service Management Utilization Request Formats* Recommendation for Space Data System Standards, CCSDS 902.1-W-0.4. White Book. Issue 0.4. Washington, D.C.: CCSDS, April 2017.

[2] *Space Communication Cross Support – Architecture Description Document*. Report Concerning Space Data System Standards, CCSDS 901.0-G-1. Green Book. Issue 1. Washington, D.C.: CCSDS, November 2013.

[3] *Extensible Space Communication Cross Support – Service Management - Concept*. Report Concerning Space Data System Standards, CCSDS 902.0-G-1. Green Book. Issue 1. Washington, D.C.: CCSDS, September 2014.

[4] *Cross Support Transfer Services – Monitored Data Service*. Recommendation for Space Data System Standards, CCSDS 922.1-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, (forthcoming).

[5] *Space Communication Cross Support - Service Management – Service Specification*. Recommendation for Space Data System Standards, CCSDS 910.11-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, August 2009.

[6] *Simple Schedule Formats*. Recommendation for Space Data System Standards, CCSDS 902.1-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, [forthcoming].

[7] Functional Resource Tech Note.

[8] IOAG Service Catalog #1.

# General Concepts for Configuration Profiles and Service Agreements

## General Configuration Profile Concepts

What CCSDS calls “configuration profile” is even today the generally accepted method for configuring space link sessions (also known as passes, contacts, tracks, and Events) from Provider CSSSes (TT&C networks). “Configuration Profile” is the CCSDS name for these entities - each Provider CSSS has its own name for the same concept (e.g., the NASA Space Network’s service specification code (SSC) and the NASA Near Earth Network’s Support Activity Code). Each Provider CSSS in operation today has its own syntax and semantic rules for its configurations profiles.

All of these “configuration profiles” (including the CCSDS SCCS-SM B-1 Configuration Profile) have a common set of characteristics, which are required in order for the Provider CSSS and the Mission to unambiguously mutually understand what is being requested and what is being provided:

1. They represent a collection of space communication and radiometric data processing resources.
2. They contain the initial values of the configuration parameters of all of the data processing resources in the collection.
3. They represent the relationships among the resources. These relationships may be for the primary flow of data to and from the space link, and also for “lateral” data flows (e.g., the connection between the return link resource chain for the purpose of supplying CLCWs to the forward link resource chain in order to “gate” the traffic on the forward link).
4. They have identifiers that are used in service requests to point to their contents (as opposed to having the full content of the configuration profiles embedded in the service requests).

In addition to the above characteristics that are shared by all users of configuration profiles, some Provider CSSSes support what the NASA SN calls *respecification*: a configuration profile is referenced by the service request, but the service request has the capability to alter the initial values of one or more configuration parameters. The SMURF Service Package Request also supports respecification. The Simple Schedule does not identify information down to the individual configuration parameters, so it is unaffected by respecification. The verbose mode of the Service Package Result is currently planned to report the values altered by respecification, and possibly even in terse mode will report the respecified values.

Some Provider CSSSes support (near) real-time *reconfiguration*, in which the Mission is able to change the values of certain configuration parameters during the course of the space link session (the specific set of reconfigurable parameters – if any - is defined by each Provider CSSS). Since the SMURF Service Request Package, Simple Schedule, and Service Package Result all report on the services as they are configured at the beginning of the Service Package, reconfiguration does not have any impact on those information entities. However, reconfiguration is essentially the function to be performed by the forthcoming Service Control CSTS (SC-CSTS). The configuration profile must identify the controllable parameters in a way that is usable by SC-CSTS; i.e., in terms of Functional Resource instances and parameterIds of the controllable parameters of those FR

Some Provider CSSSes support *space link event sequences*, pre-planned sequences of configuration parameter value changes that are triggered by time and/or other events (e.g., upon acquisition of a carrier signal). Support for space link event sequences will be supported by the Extensible SCCS-SM Event Sequence information entity. As of this writing, it is not clear whether the Event Sequence will associate the configuration parameters with space link carriers only (the method currently used in the DSN) or be generalized to work with functional resources at various levels within the space communication “stack”.

A configuration profiles just specifies what is to be scheduled and configured – the service request that references the configuration profile adds the timing information to the request. The timing information may be expressed in simple absolute times (start at time *x* and end at time *y*) or in algorithmic terms (e.g., between 3 and 5 times a week, no more than 3 days apart and no closer than 1 day).

## General Service Agreement Concepts

The main conception of a service agreement is as the specification of the boundary or envelope of resources and services that a Provider CSSS agrees to provide to a Mission during a defined time period and under and agreed set of conditions.

Historically, service agreements have been documents that are negotiated and manually composed by Mission planning teams and their counterparts in Provider CSSS planning organizations.

The B-1 SCC Service Management included the notion that multiple Service Agreements between a Provider CSSS and a Mission could be valid at the same time. Formally, each “mission phase” may have its own Service Agreement, but “mission phase” was never tightly defined, and so the possibility of a Mission being in different phases day to day (or even contact to contact) resulted in each Configuration Profile having to be defined in the context of a specific Service Agreement, and likewise each Service Package being provided in the context of a specific Service Agreement. The identification of the controlling Service Agreement was therefore part of the various information entities in B-1 SCCS-SM.

The notion that multiple Service Agreements can exist simultaneously for a given Provide CSSS/Mission pair continues to be supported by the SMURF Service Package Request, the Simple Schedule, and the Service Package Result. Therefore, at a minimum, Service Agreements need identification by which they can be referenced by Service Package Requests, Simple Schedules, and Service Package Results.

The SCCS-SM B-1 version of the Service Agreement was an attempt at a standard, machine-readable (XML-formatted) file. The main driver for making the Service Agreement standard and machine readable was to support the automation of the validation process that would be necessitated by dynamic creation and execution of Configuration Profiles. Traditionally, Configuration Profiles have been constructed and tested in more of a software development environment in which they are manually validated against the controlling service agreements. The SCCS Service Management concept introduced the ability for Missions to create Configuration Profiles, submit them to a Provider CSSS, and then be able to reference/use them in as little as a few minutes.

The SMURF Service Package Request, the Simple Schedule, and the Service Package Result do not require the existence of *standard-formatted* Service Agreements. The only aspect of the Service Agreement to which these information entities are exposed is the *reference* to the Service Agreement. The syntax, semantics, and the media (e.g., electronic file vs. paper document) of the Service Agreement have no effect on the Service Package Request, the Simple Schedule, and the Service Package Result, as long as the referenced Service Agreements are mutually understandable by the agreeing parties.

The B-1 SCCS-SM Service Agreement also grew to contain information not just about the space communications services to be provided, but also about the Service Management Services themselves. For example, the B-1 Service Agreement contains parameters regarding messaging timeouts, maximum number of outstanding Service Package Requests, etc. This category of information is relevant to what CSSMWG is now calling Service Management Automation: it has no effect on the Service Package Request, the Simple Schedule, or the Service Package Result.

In summary, the SMURF Service Package Request, the Simple Schedule, and the Service Package Result only require that Service Agreements exist and can be uniquely identified by string identifiers. If we defer any requirements for dynamic creation of configuration profiles and make no assumptions about how configuration profiles are validated, there are no requirements for CCSDS-standard, parameter-by-parameter Service Agreements. This conditions should be easily satisfied in the early, “simple” deployments of SMURF, Simple Schedule, and Service Package Result.

# Minimum Requirements for Simplified Configuration Profiles

## Common Charactheristcs of Configuration Profiles

Section 2.1 contains a list of the common characteristics that all configuration profiles must have in order for a Provider CSSS and Mission to unambiguously mutually understand what is being requested and what is being provided, and two additional capabilities (respecification and reconfiguration) that will be supported by the SMURF Service Request Package, Simple Schedule, and/or Service Package Result. This section examines each of those characteristics/capabilities and their effect on the SMURF Service Request Package, Simple Schedule, Service Package Result, Event Sequence, and/or SC-CSTS.

### a collection of space communication and radiometric data processing resources that together provide service(s)

The common representation for space communication and radiometric data processing resources is as Functional Resources. Each Functional Resource instance is identified in terms of its CCSDS-standard (and SANA-registered) Functional Resource Type (an OID) and FR Instance Number. Identification of the resources down to the individual FR instance is required by:

* respecification in the SMURF Service Package Request,
* the verbose mode of the Service Package Result
* the terse mode of the Service Package Result for those FR instances that have respecified configuration parameters (proposed)
* Event Sequences (TBD)
* MD-CSTS
* SC-CSTS

### The specification of the values of the configuration Parameters of the resources of the collection

The common representation for the configuration parameters of space communication and radiometric data processing resources is as Functional Resource parameters, of which is identified in terms of its CCSDS-standard (and SANA-registered) parameter ID (an OID). Identification of the resources down to the individual FR configuration parameter is required by:

* respecification in the SMURF Service Package Request,
* the verbose mode of the Service Package Result
* the terse mode of the Service Package Result for those FR instances that have respecified configuration parameters (proposed)

### Representation of interconnection of the resources

A configuration profile specifies not only the Functional Resource instances and associated configuration parameter values, it also specifies the relationships among those FR instances. For example, it is not sufficient to establish that a configuration profile contains one (multi-band) Antenna FR instance , two Return 401 Space Link Carrier Reception FR instances (one S-band, one X-band), and two Return TM Sync and Channel Decoding FR instances (and more); the configuration profile must specify which Return TM Sync and Channel Decoding FR instance is connected to which Return 401 Space Link Carrier Reception FR instance, and so forth.

For a standard, fully-interoperable Configuration Profile, the expression of these interrelationships must itself be standardized. For example, in the B-1 SCCS-SM Configuration Profile, the relationships were (primarily) represented as XML containment relationships. More recently, for ESCCS-SM Configuration Profiles, we explored expressing the relationships strictly in terms of port pairing before returning (at least for now) to a combination of XML containment for the primary data flow relationships and ancillary interfaces for secondary relationships (e.g,. access by a forward link FR instance to CLCW data received on the return link).

However, even though configuration profiles must contain this inter-FR relationship information in order for the Provider CSSS unambiguously understand how the Mission wants the system to be configured (and subsequently to allow the Mission to understand the significance of the monitored data being acquired via MD-CSTS), the SMURF Service Package Request, Simple Schedule, Service Package Result, MD-CSTS, SC-CSTS, and Event Sequence do not need nor make any use of information regarding the interconnection of the Functional Resource instances that comprise a configuration profile.

Therefore, it is possible for a Provider CSSS to develop a proprietary configuration profile specification in terms of the CCSDS-standard Functional Resource instances (including their parameters and OIDs) but using a locally-defined expression of the inter-relationships among those FR instances, and still have those configuration profiles usable in conjunction with the SMURF Service Package Request, Simple Schedule, Service Package Result, MD-CSTS, SC-CSTS, and Event Sequence.

In the longer term, of course, we will need to specify a standard way of expressing these interrelationships, so that the resulting Configuration Profiles will be fully interoperable and not reliant on any Provider CSSS-unique material.

One approach that will be explored in the coming months will be the extent to which such relationships can be expressed in terms of the *data channels* that the FR instance operate on. The space link data channel is a concept that was developed as part of the original Cross Support Reference Model but it was subsequently unused beyond that. In an nutshell, the idea is that every space link data channel is identified (e.g., a virtual channel is globally uniquely identified by its global VCID (GVCID). A rough idea of how space link data channels might be applied in a configuration profile would be to specify that Packet Extraction & De-encapsulation FR instance #5 processes GVCID [1:15:3]. In the forward link portion of the configuration profile, TC Sync and Channel Encoding FR instance #18 gets its CLCWs from GVCID [1:15:3]. Thus the relationship between Packet Extraction & De-encapsulation FR instance #5 and TC Sync and Channel Encoding FR instance #18 is established without nay explicit “ports” or “interfaces” being established between the two FR instances.

### Configuration Profile identification

The SMURF Service Package Request, Simple Schedule, and Service Package Result expect the configuration profile to be identified by a string identifier.

MD-CSTS and SC-CSTS do not know or care about configuration profile identification.

The degree to which Event Sequences will need to know or care about configuration profile identification is TBD.

## Mapping Functional Resource Instances to Space Link Services

One of the discontinuities between SCCS-SM configuration profile concepts and traditional TT&C network schedules is that SCCS-SM configuration profiles have (until now) been constructed in terms of the individual functions performed by the configuration profile, whereas traditional schedules refer to aggregate “services” such as command, telemetry, tracking, etc.

From now on, both perspectives will be included in the configuration profiles, such that (for example) a Service Package that is scheduled using the SMURF Service Package Request (which can re-specify individual configuration parameters of the configuration profiles) can be included in a Simple Schedule that does not even reference configuration profiles but instead speaks simply in terms of command, telemetry, etc., services.

For clarity, in this Tech Note these top-level traditional services are referred to as *space link services* to distinguish them from other kinds of service (e.g., Cross Support Transfer Service (CSTS), Space Link Extension Transfer Service (SLE TS))

The basic approach is to insert an intermediate level of organization – associated with the space link services – within the configuration profile. I.e., the configuration profile is made up of one or more space link services, each of which comprises the collection of FR instances that realize that space link service.

Figure 3‑1 illustrates the concept. The configuration profile has a configuration Profile ID that applies to the whole profile. Within the configuration profile are (in this case) three (abstractly-named) space link service profiles. Each of these space link service profiles is in turn composed of unique instances of the particular Functional Resource types for that space link service. For this diagram, the Functional Resource types are categorized by their Functional Resource strata (i.e., the layers of the Functional Resource Reference Model).

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**Figure 3‑1: Notional Simplified Configuration Profile**

Each space link service profile has a Frequency Band attribute. The existence of this attribute allows multiple space link service instances of the same service type to exist in the same Service Package, as long as their corresponding space link service profiles have different Frequency Band attribute values.

NOTE 1 - Using frequency band to distinguish between different instances of the same space link service type is the method employed by the Simple Schedule. Employing that method in the configuration profiles aids the correspondence between services scheduled using configuration profiles and space link service identification in the Simple Schedule.

NOTE 2 - The validation process for the configuration profile (whether manual or automated) will need to ensure that the frequency band designated for the space link service profile is consistent with frequency-related information contained in the FR instances that comprise that space link service profile.

As shown in the figure, the same FR instance can show up in multiple space link service profiles within the same configuration profile. In this case, the same aperture (e.g., Antenna) FR instance is shared by the forward (command), return (telemetry), and tracking space link services, and the same Physical Channel (e.g., Return 401 Space Link Carrier Reception) FR instance is shared by the return (telemetry) and tracking space link services.

Although it is not shown in the figure, the same FR instance may also be used in different configuration profiles. An example is the case of two configuration profiles, one of which configures both a Command service at S-band and a Telemetry service at S-band, and the other profile configuring a Telemetry service at X-band. Use of the same Antenna FR instance in both profiles indicates that when both profiles are used in the same Service Package, a single (multi-band) Antenna is to be used.

The space link service profiles must also describe the relationships among the FR instances within the same space link service profile, and in some cases relationships between FR instances in different space link service profiles within the same service package. Relationships among FRs within the same space link service profile deal primarily (exclusively?) with data processing flow – e.g., modulated waveform “flowing” between Aperture and Physical Channel, physical channel symbols between Physical Channel and Synch & Channel En/Decoding, etc. The relationships among FRs in different space link service profiles represent information exchanges – e.g., linkage that identifies which space link service instance a return space link service instance is coherently related to.

As noted earlier in this Tech Note, these relationships among FR instances within the same space link service profiles and across different space link service profiles **do not need to be standardized** in order for configuration profiles to be used by the SMURF Service Package Request, the Simple Schedule, the terse mode of the Service Package Result, Event Sequences, MD-CSTS, and SC-CSTS. In the figure, the orange dashed lines represent these relationships.

As shown in the figure, each Functional Resource instance within a space link service profile has a Functional Resource Type (an OID), a Functional Resource Instance Number (FRIN, and integer value), a set of configuration parameterIDs (OIDs) and their corresponding values, and the boolean isConfigured parameter which is common to all FR instances. The isConfigured parameter supports respecification of a space link service profile by “turning off” optional FR instances of that profile.

As illustrated in the figure, each space link service profile is terminated by FR instances in the Data Transfer Service FR stratum. In this approach, the timing of the *service instance provision period* for each transfer service instance is specified by time-window parameters that specify when the Data Transfer service is to start with respect to the start time of the space link service itself, and likewise when the Data Transfer service is to stop with respect to the stop time of the space link service. In this approach, the start/stop time of the space link service is determined by the scheduling process, based on timing constraints specified in the Service Package Request, and the start/stop times of the transfer service instances are automatically set according to the offsets in the profile. Parametrically linking the start/stop times of the service instance provision period to that of the space link service is essentially the approach taken in B-1 SCCS-SM. The advantage to this approach was seen to be that it is one less type of start/stop time that has to be defined by the Service Package Request.

However, we might consider the pros and cons of eliminating this parametric linking and instead defer setting the start and stop times for the Data Transfer service instances to the Service Package Request, just as the start/stop times of the space link services will be deferred to the Service Package Request. In order to do so, the Service Package Request would have to be able to “address” the individual Data Transfer service instances.

Finally, the figure shows the Data Transfer service instances as being part of the space link services. This raises the issue of how switch-overs from one space link service to another can be accomplished while using the same Data Transfer service instance and not requiring those service instances to unbind and re-bind. We faced the same problem in B-1 SCCS-SM, and our solution was to keep the Data Transfer service instances separate from the space communication service instances, and to establish transfer service maps to define the relationships between them. This approach worked, but at the expense of rather extensive and contortion-filled composition rules. It may be possible to establish such relationships more simply and directly, using the concept of space link data channels. This approach will be explored more in the coming months.

# Appearance of Simplified Configuration Profiles with SMURF Service Package Request, Simple Schedule, and Service Package Result – An Example

This section presents an example of how simplified configuration profiles are used in a SMURF Service Package Request, and how the results appear in the resulting Simple Schedule and Service Package Result.

## SMURF Service Package Request

Figure 4‑1 is the SMURF formats class diagram from the current draft SMURF white book (reference [1]). Of particular interest is the OnlineSrvPgkReqDetails class and the classes contained by it. Specifically, the composition of the configProfileOffsets class (a specialization of TimingInfo) puts the timing at the complete configuration profile level.

Under this formulation, multiple space link service profiles can be contained in a single configuration profile only if the scheduled space link service instances all have the same start and stop times. If different space link service instances need to have different start and stop times, they must be specified as different configuration profiles.

Consider the example of a Service Package for a Mission for which three (among others) configuration profiles exist:

* one named “standardTelecommandConfiguration”, which contains a Telecommand space link service profile with the Frequency Band attribute set to “S-Band”;
* one named “standardDopplerConfiguration”, which contains a Doppler space link service profile with the Frequency Band attribute set to “S-Band”: and
* one named “standardTelemetryConfiguration”, which contains a Telemetry space link service profile with the Frequency Band attribute set to “S-Band”. The standardTelemetryConfiguration contains (among other FR instances) three RAF TS Provider FR instances, with FRINs 1, 2, and 3. In this example, it is assumed that the start and stop times for transfer service instances are set parametrically based on the offset configuration parameters of the corresponding transfer service FR instances, and so the Service Package Request does not explicitly set the start and stop offsets for them.

A Service Package Request is constructed. For the purposes of this example, it is sufficient to state that concrete instances of the *Constraints* class are set to request that the Service Package has a duration of 15 minutes.



**Figure 4‑1: Service Management Utilization Request Formats Class Diagram**

These three configuration profiles are used in the example Service Package Request for:

1. A Command service instance that implements standardTelecommandConfiguration that starts 2 minutes after the start time of the Service Package and ends 10 minutes before the end of the Service Package;
2. A Doppler service instance that implements standardDopplerConfiguration that starts 6 minutes after the start time of the Service Package and ends at the end of the Service Package; and
3. A Telemetry service instance that implements standardTelemetryConfiguration that operates for the full duration of the Service Package, **except** that the RAF TS service instance represented by the RAF TS Provider FR with FRIN = 3 is not used.

Figure 4‑2 illustrates the objects (class instances) of the SMURF OnlineSrvPkgReqDetails and contained classes that capture the request information.



**Figure 4‑2: Service Package Request Using Three Configuration Profiles**

As shown in the figure, the OnlineServiceDetails object that references the standardTelecommandConfiguration configuration profile contains a configProfileOffsets object with both configProfileStartOffset (120 seconds) and configProfileEndOffset (600 seconds) parameters.

The OnlineServiceDetails object that references the standardDopplerConfiguration configuration profile contains a configProfileOffsets object with only a configProfileStartOffset (360 seconds), since there is no end-time offset.

The OnlineServiceDetails object that references the standardTelemetryConfiguration configuration profile contains a configProfileOffsets object with no parameters, since neither the start nor the end times are offset. This empty object is required by the current construction of the schema – if containment of the TimingInfo-derived classes were optional, then this instance of configProfileOffsets could simply be omitted.

The OnlineServiceDetails object that references the standardTelemetryConfiguration configuration profile also contains an OIDParameter object. When contained directly by an OnlineServiceDetails object, the OIDParameter object is used to respecify a parameter of the configuration profile. In this case, the isConfigured parameter of third instance of the RAF TS service is set to FALSE, which excludes it from the requested Service Package.

## Simple Schedule

Figure 4‑1 is the Simple Schedule class diagram from the current draft Red Book (reference [6]). Of interest here is the ScheduledPackage class and the classes contained by it.



**Figure 4‑3: Simple Schedule Class Diagram**

Figure 4‑4 shows the ScheduledPackage, the contained objects, and the parameters of interest for the example Service Package. Because the Service Package contains space link services of three different start/end combinations, the corresponding Simple Schedule contains three ScheduledActivity objects, each of which contains one ServiceInfo object. There is no identification of the configuration profiles that were used to schedule the services – the only linkage is through the serviceType and frequencyBand parameters of the respective ServiceInfo objects.



**Figure 4‑4: Simple Schedule Objects for 3-Service Service Package**

## Service Package Result

The Service Package Result provides information regarding the configuration profiles. Two modes of the Service Package Result are currently envisioned: the Terse Mode and the Verbose Mode.

### Service Package Result Terse Mode

The Terse Mode is intended to reference the configuration profiles that are the basis of the scheduled Service Package, but not the individual FR instances nor their configuration parameter values. The concept behind the Terse Mode is that where no respecification of configuration profile parameter values occurs, merely referencing the mutually-agreed and –known configuration profiles is sufficient to identify all of the configuration parameter values. However, when respecification *does* occur, defining the Terse Mode in this wayleaves undocumented (i.e., unacknowledged) the as-scheduled values or any of those repecified parameters. The B-1 Service Package Result (see [5]) covered this case by including the SpaceCommunicationServiceProfileRespecResult objects, which contained a set of RespecifiedParameter objects – one for each respecified parameter. The new Service Package Result Terse Mode should also support reporting the respecified values of configuration profile parameters.

The Terse Mode can be used with simplified configuration profiles, because all of the required information is available in those profiles – i.e., the identification of the configuration profiles and any FR instances that are reconfigured in the Service Package Request.

### Service Package Result Verbose Mode

The Verbose Mode is intended to be a complete read-back of the configurations of all services scheduled in the Service Package. At least one existing TT&C network – the NASA Space Network – currently reports back all configuration profile parameters for the SN’s equivalent of the Service Package, and the Verbose Mode is intended to replicate that level of detail.

When fully-standardized configuration profiles become available (i.e., configuration profiles that contain not only all of the FR instances and parameters but also the relationships among those FR instances), the Verbose Mode can be accomplished by simply including a copy of the configuration profile(s) within the Service Package Result, wherein any respecified configuration parameter values are substituted for the original values from those configuration parameters.

Until such fully-standardized configuration become available, Service Package Results could support a version of Verbose Mode in one of two ways.

In the first approach, the Service Package Result could contain the configuration profiles in whatever format is used by that Provider CSSS, again with any respecified parameter values being substituted for the original values.

In the second approach, the Service Package Result could contain a collection of objects that represent the FR instances and their contained configuration parameters, without indication of the relationships among them. In this approach, the representation of the FR Instances would be part of the Service Package Result standard, but the Provider CSSS and Mission would still need to have mutual understanding of the original (proprietary-formatted) configuration profile for the inter-FR instance relationship information.

# Space Link Service Profiles

The Simple Schedule draft Red Book specifies eleven “service types”[[2]](#footnote-2):

* APA-AZ/EL
* APA-X/Y
* DELTADOR
* DOPPLER
* OFFLINE-TM-RECORDING[4])
* OFFLINE-TM-PROVISION
* RF-ONLY
* RANGING
* TELECOMMAND
* TELEMETRY
* VLBI

Extensible Space Communication Cross Support Service Management (ESCCS-SM) was originally formulated in terms of support for IOAG services (see [4]). The initial scope of ESCCS-SM was to support the services defined in IOAG Service Catalog #1 (reference [8]). In contrast to the Simple Schedule space link services’ point of reference being the RF (or optical, in the future) interface between the Provider CSSS and the Mission spacecraft, the point of reference for the IOAG services is the *data delivery* interface between the Provider CSSS and Mission ground nodes:

* Forward Data Delivery Services Group
	+ Forward CLTU
	+ Forward Space Packet
	+ Forward Synchronous Encoded Frame (Forward Frames[[3]](#footnote-3))
	+ Forward File
* Return Data Delivery Service Group
	+ Return All Frames
	+ Return Channel Frames
	+ Return Operational Control Field
	+ Return File
* Radiometric Services Group
	+ Validated Data Radiometric
	+ Raw Data Radiometric
	+ Delta-DOR

As a result of this difference in point of reference for identifying service type, the mapping of Simple Schedule space link service types to IOAG Catalog #1 service types tends to be one-to-many. E.g., the four IOAG services in the Forward Data Delivery Group all map into the TELECOMMAND space link service type.

Previous work on configuration profiles in the Functional Resource Reference Model followed the IOAG orientation by defining the service profiles in terms of the data delivery services (F-CLTU, RAF, etc.). However, the IOAG service categorizations do not distinguish between online service instances (that is, service instance that connect all the way through the RF/optical space links to the Mission spacecraft) and offline service instances (ones that terminate in a storage component in a Provider CSSS ground node). The online/offline distinction is *very* important for scheduling considerations – in almost all cases, it is the resources needed for online services (apertures, transmitters. receivers, etc.) that are the scarce resources that need to scheduled, but for many (most?) Provider CSSSes the provision of offline service instances does not require scheduling[[4]](#footnote-4). So the CCSDS configuration profiles have further separated the IOAG service services into online and offline service profiles.

For the simplified configuration profiles, the service profiles are defined in terms of the space link service categories – hence the term space link service profiles. Some of the space link service profiles are for online services, while others are for offline services.

The following subsections identify the Functional Resource types that comprise the space link service profiles for the Service Types called out in the Simple Schedule, and the relationships among those FR types within each of the profiles. The mapping of each space link service profile to its respective IOAG service type(s) is also identified.

IOAG Service Catalog #1 also calls out a category of Service Management Functions, and identifies the Engineering Monitoring Data Delivery function. The final subsection below addresses the space link service profiles associated with the Service Management Functions.

## Forward Communication space link service profileS

There are currently four forward communication space link service profiles, all of which map into the TELECOMMAND[[5]](#footnote-5) Simple Schedule Service Type:

* Forward CLTU
* Telecommand multiplexed
* AOS CADU
* AOS multiplexed

Note that these four profiles capture a unique combination of functional resource types in the four strata (Aperture, Physical Channel, Sync and Channel Coding, and Data Transfer Service). As different functional resource types become available in the underlying strata (e.g., the introduction of a Forward 415 Space Link Carrier Transmission), new space link service profiles will have to be created. When that happens, the naming of the service profiles will also have to become more detailed in order to distinguish the different “flavors” of service, e.g., “Forward CLTU/415.” This will be true in general for all space link service profiles. This is of course the combinatorial explosion that will be faced by the creation and maintenance of service and configuration profiles in the longer term. But for the near(er) term, simplified configuration profile approach, in which we are only trying to satisfy those configurations that lie at the intersection of the Simple Schedule service types and the IOAG service catalog #1 service types, it will be sufficient to explicitly create these simpler “cookie cutter” space link profiles.

### Forward CLTU space link service profile

Figure 5‑1 shows the functional resource types that comprise the Forward CLTU Space Link Service Profile. The Forward CLTU Space Link Service Profile is used to schedule the IOAG Forward CLTU service.



**Figure 5‑1: Forward CLTU Space Link Service Profile**

The grey arrows in the diagram indicate information exchanged with functional resources in other space link services: the physical resource represented by the Forward 401 Space Link Carrier Transmission FR supplies the carrier frequency to the return space link carrier reception resource of a return link service when that service is coherently modulated with respect to the forward link, and the Forward TC PLOP, Sync, and Channel Decoding FR receives RF availability and carrier lock information from CLCWs received on the return link in order to gate the transmission of CLTUs[[6]](#footnote-6). As discussed elsewhere in the Tech Note, this inter-relationship information must somehow be expressed in the space link service profiles and/or configuration profiles, but for the purposes of the SMURF Service Package Request, Simple Schedule, Service Package Result (terse mode), and Event Sequences the information is not needed.

### Telecommand Multiplexed space link service profile

Figure 5‑2 shows the functional resource types that comprise the Telecommand Multiplexed Space Link Service Profile. The Telecommand Multiplexed Space Link Service Profile is used to schedule the IOAG Forward Space Packet, Forward Frames (which is not actually required until IOAG Service Catalog #2) and Forward File services over Telecommand links.

Unlike the Forward CLTU service profile (in which a single instance of Forward CLTU transfer service supplies the content of the forward link), by its multiplexing nature the Telecommand Multiplexed profile can be used to schedule multiple transfer services of different types – whole virtual channels via the Forward Frames CSTS, CCSDS packet channels via the Forward Space Packet (SP) TS, and file transfers via the Forward File service (represented in the diagram by the Forward File Data Store, Forward File Service Production, and CFDP Sending Entity). Note that in the case of the forward file service, the Terrestrial File Transfer Provider FR is not included in the service profile because it is assumed to enabled independently of any given scheduled space link session (i.e., it will be either permanently provisioned or made available as part of an offline Service Package).



**Figure 5‑2: Telecommand Multiplexed Space Link Service Profile**

### AOS CADU space link service profile

Figure 5‑3 shows the functional resource types that comprise the AOS CADU Space Link Service Profile. The AOS CADU Space Link Service Profile is used to schedule the IOAG Forward Synchronous Encoded Frame service.

The AOS CADU service is the AOS equivalent of the TC Forward CLTU service: a single user of the Forward Frames CSTS (operating in CADU mode) provides all of the CADUs (encoded, possibly randomized, and sync-markered frames) for the forward physical channel.



**Figure 5‑3: AOS CADU Space Link Service Profile**

### AOS Multiplexed space link service profile

Figure 5‑4 shows the functional resource types that comprise the AOS CADU Space Link Service Profile. The Telecommand Multiplexed Space Link Service Profile is used to schedule the IOAG Forward Frames and Forward File services over AOS links.

As with the Telecommand Multiplexed service profile, the AOS Multiplexed profile can be used to schedule multiple transfer services of different types – whole virtual channels via the Forward Frames CSTS, and file transfers via the Forward File service. Note that there is no CCSDS-standard Forward Space Packet service is currently defined only in terms of packets over Telecommand protocols, and so no CCSDS-standard service currently exists to transmit individual real-time space packets over AOS links.



**Figure 5‑4: AOS Multiplexed Space Link Service Profile**

## Return Communication space link service profileS

There are currently two forward communication space link service profiles:

* Return Online Communication
* Return Offline Communication

### Return Online Communication space link service profile

Figure 5‑5 shows the functional resource types that comprise the Return Online Communication Space Link Service Profile. The Return Online Communication Space Link Service Profile is used to schedule the IOAG Return All Frames (online), Return Channel Frames (online), Return Operational Control Field, and the online production portion of the Return File services.



**Figure 5‑5: Return Online Communication Space Link Service Profile**

Note that the space data link protocol FRs in this profile (MC Demux and Reception, etc.) are defined to support both AOS and Packet Telemetry protocol variations, so there is no need to have separate AOS and Packet Telemetry return online profiles. It is likely that these FR types will be further redefined to encompass the new Unified space datalink protocol (which itself is designed to encompass AOS and Packet Telemetry). However, in the longer term, if and when space data link protocols that are not based on CCSDS framing and packetization are introduced, they will likely require their own set of FR types, which in turn will result in the creation of additional return online communication space link service profiles.

The Return Online Communication space link service profile currently maps into two Simple Schedule service types, TELEMETRY and OFFLINE-TM-RECORDING. Under the current concept, if return communication (e.g., telemetry) data of a designated type (e.g., a given VC) is to be recorded during a given Service Package, all of that data is recorded during the execution of the Service Package. Under this concept, it makes sense to combine the return communication and recording resources into a single space link profile. However, if there is a requirement to be able to record for only a portion of the duration of the Service Package, it may then be necessary to break out the recording functionality into its own space link service profile so that it may be accessible by the Service Package Request for purposes of assigning stop and end times/offsets.

### Return Offline Communication space link service profile

Figure 5‑6 shows the functional resource types that comprise the Return Offline Communication Space Link Service Profile. The Return Offline Communication Space Link Service Profile is used to schedule the IOAG Return All Frames (ofline), Return Channel Frames (ofline), and the delivery of return files via the Terrestrial File Transfer service.



**Figure 5‑6: Return Offline Communication Space Link Service Profile**

The Return Offline Communication space link service profile maps into the OFFLINE-TM-PROVISION Simple Schedule service type.

NOTE- -There is some discussion regarding whether offline services need to be actually scheduled, or can simply assumed to be available at all times due to adequate provisioning of the needed resources (e.g., data storage capacity, terrestrial communications bandwidth). If it is determined that such offline services do not need to be scheduled, then OFFLINE-TM-PROVISION should be removed from the set of Simple Schedule service types.

## Radiometric space link service profileS

There are four radiometric space link service profiles:

* Doppler
* Ranging
* Delta-DOR
* Open Loop

### Doppler space link service profile

Figure 5‑7 shows the functional resource types that comprise the Doppler Space Link Service Profile. The Doppler Space Link Service Profile is used to schedule the IOAG Raw Data Radiometric service (real-time delivery and recording for complete mode delivery) and the production and non-validated data storage functions of Validated Data Radiometric service.



**Figure 5‑7: Doppler Space Link Service Profile**

NOTE 1 - The offline delivery of Raw Radiometric data from the TDM Recording Buffer is performed by a Tracking Data CSTS Provider operating in complete delivery mode. Whether the resources to provide this complete-mode delivery are long-term provisioned or need to be scheduled in some way is TBD. The radiometric data validation process involves a non-standardized processing step that takes the non-validated RM data from the Non-validated RM Data Store and deposits the resulting validated RM data in a validated RM Data Store for subsequent offline delivery via the Terrestrial File Transfer Service. The offline delivery of validated radiometric data is not scheduled.

The Doppler space link service profile maps into the APA-AZ/EL, APA-X/Y, and DOPPLER Simple Schedule service types.

NOTE 2 - The Forward 401 Space Link Carrier Transmission FR instance is present only for 2-way Doppler service.

### Ranging space link service profile

Figure 5‑8 shows the functional resource types that comprise the Ranging Space Link Service Profile. The Ranging Space Link Service Profile is used to schedule the IOAG Raw Data Radiometric service (real-time delivery and recording for complete mode delivery) and the production and non-validated data storage functions of Validated Data Radiometric service.



**Figure 5‑8: Ranging Space Link Service Profile**

NOTE 1 - The offline delivery of Raw Radiometric data from the TDM Recording Buffer is performed by a Tracking Data CSTS Provider operating in complete delivery mode. Whether the resources to provide this complete-mode delivery are long-term provisioned or need to be scheduled in some way is TBD. The radiometric data validation process involves a non-standardized processing step that takes the non-validated RM data from the Non-validated RM Data Store and deposits the resulting validated RM data in a validated RM Data Store for subsequent offline delivery via the Terrestrial File Transfer Service. The offline delivery of validated radiometric data is not scheduled.

The Ranging space link service profile maps into the APA-AZ/EL, APA-X/Y, and RANGING Simple Schedule service types. It may also map into the DOPPLER Simple Schedule service type when Doppler and ranging service are operated concurrently.

NOTE 2 - The Forward 401 Space Link Carrier Transmission FR instance is present only for 2-way Doppler service.

### Delta-DOR space link service profile

Figure 5‑9 shows the functional resource types that comprise the Delta-DOR Space Link Service Profile. The Delta-DOR Space Link Service Profile is used to schedule the collection and production and data storage functions of IOAG Validated Data Radiometric service.



**Figure 5‑9: Delta-DOR Space Link Service Profile**

NOTE - The ultimate delivery of Delta-DOR data to the Mission involves subsequent offline delivery via the Terrestrial File Transfer Service. The offline delivery of Delta-DOR data is not scheduled.

The Delta-DOR space link service profile maps into the APA-AZ/EL, APA-X/Y, and DELTADOR Simple Schedule service types.

### Open Loop space link service profile

Figure 5‑10 shows the functional resource types that comprise the Open Loop Space Link Service Profile. The IOAG does not explicitly include an Open Loop service.



**Figure 5‑10: Open Loop Space Link Service Profile**

NOTE - The ultimate delivery of Open Loop data to the Mission involves subsequent offline delivery via the Terrestrial File Transfer Service. The offline delivery of Open Loop data is not scheduled.

The Open Loop space link service profile maps into the APA-AZ/EL, APA-X/Y, and RF-ONLY Simple Schedule service types.

## Service Managemetn Function Space Link Service Profiles

There are currently two Service Management Function space link service profiles:

* Monitored Data
* Service Control

### Monitored Data Space Link Service Profile

Figure 5‑11 shows the functional resource types that comprise the Monitored Data Space Link Service Profile. The Monitored Data Space Link Service Profile is used to schedule the IOAG Engineering Monitoring Data Delivery function.



**Figure 5‑11: Monitored Data Space Link Service Profile**

Because it is a Service Management function, the Monitored Data function is not part of any space link configuration as such. Rather, it provides reports on the execution of all aspects of the execution of the Service Package, and it is available for the duration of the Service Package. The Monitored Data function is not reported in the Simple Schedule.

### Service Control Space Link Service Profile

Figure 5‑11 shows the functional resource types that comprise the Service Control Space Link Service Profile. The Service Control Space Link Service Profile is not called for in the IOAG Service Catalogs..



**Figure 5‑12: Service Control Space Link Service Profile**

Because it is a Service Management function, the Service Control function is not part of any space link configuration as such. Rather, it provides reports on the execution of all aspects of the execution of the Service Package, and it is available for the duration of the Service Package. The Service Control function is not reported in the Simple Schedule.

# Interconnections Among Space Link Service Profiles

This section is To Be Supplied. It will be fleshed out in future drafts of this Tech Note.

1. Reference Bookmarks (to be deleted)

[1] nRef\_902x1\_SMURF

[2] nRef\_901x0\_SCCS\_ADD

[4] nRef\_902x0\_ESCCS\_SM\_Concept

[4] nRef\_922x1\_MD\_CSTS

[5] nRef\_910x11\_SCCS\_SM

[6] nRef\_902x1\_Simple\_Schedule

[7] nRef\_Functinal\_Resources\_Tech\_Note

[8] nRef\_IOAG\_Cat1

1. Subsequent to the Cleveland meeting, the resources that were anticipated for application to configuration profile/service agreement development were actually further reduced. [↑](#footnote-ref-1)
2. The Simple Schedule book actually names four additional enumerated values: ‘Reserved’, ‘TBD’, ‘Test’, and ‘Unused’. [↑](#footnote-ref-2)
3. CCSDS is not developing a separate Forward Synchronous Encoded Frame (FSEF) service but is proceeding directly to the Forward Frames service (an IOAG Catalog #2 service), which encompasses the capabilities of the FSEF service. [↑](#footnote-ref-3)
4. In the larger communications community, the term *provisioning* is used for the acquisition and installation of sufficient bandwidth, sufficiently-fast modems, etc., to support the expected demand for service. Thus as long as the transfer service components and terrestrial communication links between Provider CSSS ground nodes and Mission ground nodes are adequately provisioned, scheduling of offline transfer services should not be necessary. Unfortunately, the multiple uses of “provision” can be problematic in CCSDS terminology, where we refer to the scheduling of SLE and Cross Support Transfer Service “provision”. SLE and Cross Support TS instances are *provided*, whereas long-term communication capacity is *provisioned*. [↑](#footnote-ref-4)
5. Using the name “TELECOMMAND” for all forward space link services is misleading, because “Telecommand” is the name of one specific forward space data link protocol. It is equivalent to Advances Orbiting System (AOS) and the forthcoming Unified Space Link protocol. The Simple Schedule space data link service name should be changed to something more generic. For example, “COMMAND”. [↑](#footnote-ref-5)
6. The current version of the FR Reference Model Tech Note shows this information being provided to the Forward TC PLOP, Sync and Channel Encoding FR, but it may be more appropriate to show it being provided to the F-CLTU Provider FR instead. [↑](#footnote-ref-6)