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# DOCUMENT

## Solar Orbiter Instrument Operation Request Interface Control Document (IOR ICD)

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**Reference** SOL-SGS-ICD-0003  
**Issue** 1  
**Revision** 0  
**Date of Issue** [13/03/2017](#)  
**Status** Draft  
**Document Type** ICD  
**Distribution**



# APPROVAL

<b>Title</b>	
<b>Issue</b> <a href="#">1</a>	<b>Revision</b> <a href="#">0</a>
<b>Author</b> Chris Watson	<b>Date</b> <a href="#">13/03/2017</a>
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## CHANGE LOG

Reason for change	Issue	Revision	Date
<a href="#">First issue for signature</a> <a href="#">Changes detailed in change log</a>	<a href="#">1</a>	<a href="#">0</a>	<a href="#">March 2017</a>
Changes detailed in change record	0	7	Jan 2017
Refined VSTP IORs Added VSTP_max TCs attribute +1 command count for each VSTP window Updated schema for VSTP_max_TC Updated timing on VSTP IOR delivery Do not represent a re-entry point Added SOC slot usage to section 7 Removed references to STP periods spanning an RSW - Baseline is now that STP periods are always a week, even within RSWs Updated Schema for ICD version Added Open issues section and “backup” LTP plans	0	6	Jan 2016
AdG comments	0	5	July 2015
Added Acronyms list AdG comments AW comments Updates to schema	0	4	July 2015
Added VSTP IORs elements and descriptions Added filenaming Inserted ICDVersion attribute (JM comment) CV (EUI) comments Observation ID replaces unique ID Typos, XML profile example clean up Added first draft of schema	0	3	July 2015
Comments from JL, IT, BS Comments from AdG	0	2	Aug 2014
First draft	0	1	July 2014



# CHANGE RECORD

Issue <u>1</u>	Revision <u>0</u>		
Reason for change	Date	Pages	Paragraph(s)
<a href="#">Major revision to the reservation of VSTP windows</a>  <a href="#">Minor revision of filenaming</a>  <a href="#">Creation of header2 to duplicate “filename metadata” within the content, and to isolate non-legacy header information in a single place.</a>  <a href="#">Clarify usage of formal parameter &lt;position&gt; field</a>  <a href="#">Add IERS to acronyms</a>  <a href="#">Complete removal of passID</a>  <a href="#">Remove InsertOrDeleteFlag</a>  <a href="#">Remove subscheduleID</a>  <a href="#">Typo corrections</a>			

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# 1 INTRODUCTION

This document defines the mission planning interface between Instrument Teams and the Solar Orbiter SOC, by which the planned operations for each instrument are submitted for routine operations. The files passing across this interface are called “**Instrument Operational Requests**” or **IORs**. This commanding interface is active in Cruise Phase, NMP and EMP (i.e. after NECP).

The format of the ICD is derived from the Solar Orbiter PLID [RD-1], which is in turn a tailoring of the generic ESOC infrastructure mission planning document “Planning Files Interface Control Document” [RD-2].

This ICD is not strictly a “tailoring” of [RD-1] because formally the PI-SOC interface lies outside the scope of the PLID. However it is sensible to maintain these interface formats as common as possible. It is acknowledged that there are fields within this ICD that are redundant when viewed solely within the scope/context of the IOR. This is a consequence of maintaining consistency with the generic ICDs.

## 1.1 IOR context

Outside of NECP and dedicated special operations and/or contingency recoveries, the instrument operations for Solar Orbiter are integrated into a single consistent plan at SOC and then forwarded to the OGS. This occurs in Medium-Term Planning (MTP) and Short-Term Planning (STP) cycles<sup>1</sup>.

In these phases instrument teams plan their operations

- According to the scientific goals of the specific period, types of pointing target (for RSWs) and data quotas as decided by the SWT and as elaborated in i) the Science Activity Plan, and then ii) the SOOPs at a greater level of detail.
- According to the windows and constraints communicated in the planning skeleton file (i.e. the E-FECS), and resource allocations communicated by corresponding files.

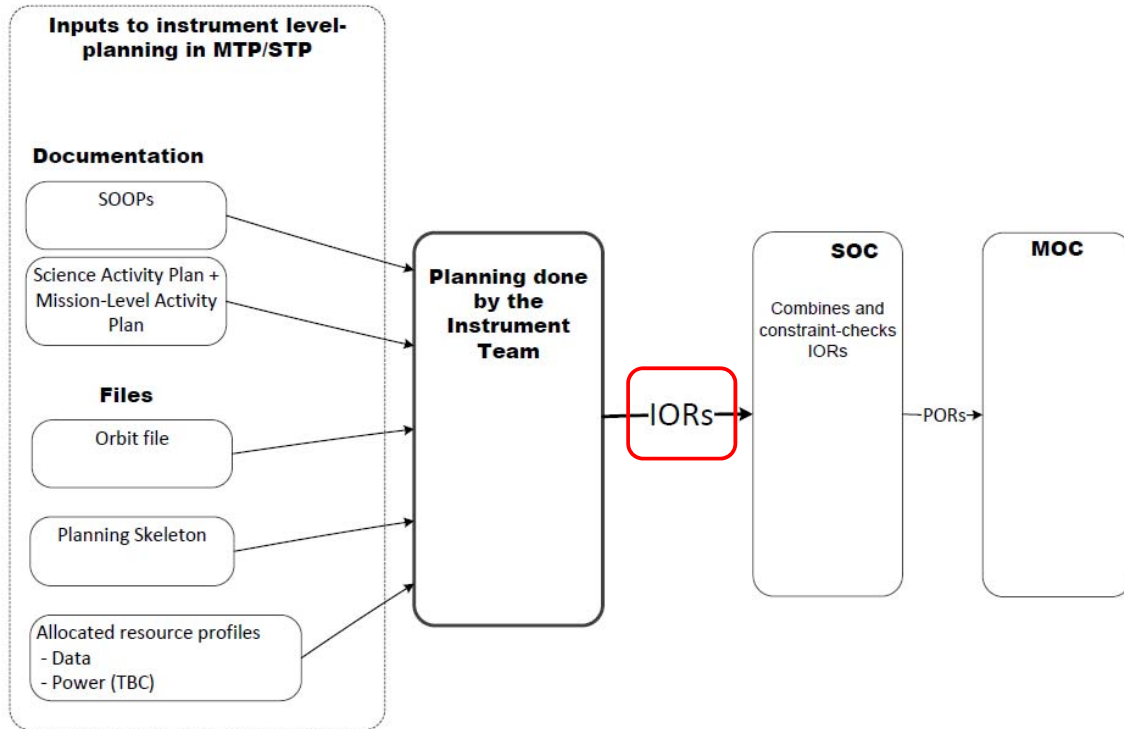
The instrument teams submit their planned instrument commanding to the SOC in an **IOR**. For commonality reasons this interface retains the same general format as the PDOR interface with OGS, but implements a restricted subset of functionality<sup>2</sup>.

At the SOC the plans are integrated together and checked for consistency and resource constraints (example: power consumption, predicted SSMM usage). Problems at this stage are resolved, normally by discussion with the Instrument Team and submission of a revised IOR.

---

<sup>1</sup> The LTP process is different, being driven more by coordination than by detailed commanding products.

<sup>2</sup> Some elements of the PDOR interface are necessarily excluded. For example all IOR commanding is directed to the MTL.



**Figure 1, IOR interface in context**

Within NMP and EMP phases the scope of the planning cycles the IOR is used as follows:

Planning cycle	Use of IOR
LTP	No IOR. LTP is performed without this level of detail of specific instrument commanding inputs.
MTP	Preliminary MTP IORs are created as preparation for the SOWG MTP meeting. Main MTP IORs are refined as necessary following the SOWG MTP meeting.  Only the main IORs are fed downstream from SOC to the MOC. The MTP IORs are used to come to an integrated and robust set of operations. Once this is done the instrument resource envelopes are considered frozen <sup>3</sup> .

<sup>3</sup> Part of the rationale here being to prevent that tuning of one instrument’s planned ops between MTP and STP causes another instrument’s un-tuned MTP plan to become invalid at STP.



STP	The STP IORs are processed into telecommands that are uploaded to the spacecraft. These IORs are required to fit the resource profile of the final MTP IORs.
VSTP	VSTP IORs are used to add commands within specific windows identified in the STP IOR. This is foreseen only for commanding where there is a tight space->ground->space loop needed.

## 1.2 Reference Documents

[RD-1] “Solar Orbiter Planning Interface Control Document (PLID)”, Luca Michienzi (ESOC), SOL-ESC-IF-05010, v1\_2, July 2015

[RD-2] “Planning Files Interface Control Document”, Arek Kowalczyk (ESOC), MDS-MCS-SW-ICD-1001-OPS-GD, v4\_4, Nov 2016

[RD-3] “Solar Orbiter SOC<->Instrument Teams File transfer ICD”, Emilio Salazar, SOL-SGS-ICD-0009, v0\_3, Jan 2017

## 1.3 Acronyms

CP	Cruise Phase
E-FECS	Enhanced Flight Events and Communication Skeleton <i>Also called planning skeleton. This is a SOC-extended version of the FECS that comes from MOC which details the spacecraft events</i>
EMP	Extended Mission Phase
HK	Housekeeping telemetry
<a href="#">IERS</a>	<a href="#">International Earth Rotation and reference system Service</a>
IOR	Instrument Operational Request
IS	In-Situ
LLD	Low-Latency Data <i>That “thin-slice” of science data that can always be downlinked promptly to ground</i>
LTP	Long-Term Planning
MiB	“MibiBytes” <i>Non-SI unit of storage. 1 MiB = 2<sup>20</sup> = 1048576 Bytes For info: single sector of SSMM is 1 MiB, and total available SSMM volume (2 modules) is 62 GiB</i>
MIB	Mission Information Database <i>The database defining the TM TC structures, used for example by SCOS-2000 at MOC.</i>
MOC	Mission Operations Centre. <i>For Solar Orbiter this is ESOC in Darmstadt.</i>
MTL	Mission TimeLine <i>The onboard time-tagged queue from which nominal operations execute</i>
MTP	Medium-Term Planning
NMP	Nominal Mission Phase
RS	Remote Sensing
RSCW	Remote-Sensing Checkout Window <i>The checkout windows for RS-instruments in cruise phase</i>
SAP	Science Activity Plan <i>The top-level science plan of how solar orbiter will utilise the time within CP, NMP, EMP to fulfil its science goals</i>
SOC	Science Operations Centre <i>For Solar Orbiter this is ESAC near Madrid</i>
SpW	SpaceWire
SSMM	Solid State Mass Memory
STP	Short-Term Planning
TAC	Turn-Around Calibration <i>Complements LLD as prompt science link to ground. Because a “fatter slice” of science can come through this (compared to LLD) it is normally OFF, and only enabled for specific activities that need</i>





	<i>it (those where there is a mandatory tight space-&gt;ground-&gt;space loop needed), and then only when the downlink can support it.</i>
TMC	TeleMetry Corridor
TMC-M	TMC-Measured <i>TMC plus Measured data of actual write rates seen at the SSMM</i>
VSTP	Very Short Term Planning



## 2 DELIVERY ASPECTS

### 2.1 Delivery mechanism

The IORs shall be delivered to SOC via the file-transfer mechanism detailed in [RD-03]. Deliveries of sets of IORs (as occurs at MTP, STP) shall be zipped together according to the instructions of [RD-03]. Delivery of VSTP IORs is single IOR at a time.

### 2.2 Delivery timing and time-span

#### 2.2.1 NMP and EMP

MTP IORs are delivered to cover a time-range of a ~six month planning period corresponding to the station scheduling exercise. Approximately this corresponds to one period covering [Jan, June] and one period covering [July, Dec] each year<sup>4</sup>. Working backwards from the start of execution of this period, T:

- Final MTP IORs are delivered to SOC at T-6 weeks.
- Where needed, the SOWG meeting where the initial MTP IORs are iterated is scheduled sometime within a 4 week window between T-7 weeks and T-9 weeks.
- Preliminary MTP IORs are delivered to SOC at T-12 weeks

STP IORs are delivered in a batch to cover a time-range of 1 week.

This time-range of execution begins on a Saturday, at the **end of the pass** (as recorded by the Planning Skeleton aka E-FECS), and extends to the equivalent start point of the next time-range. Instrument-teams shall ensure that all commanding delivered for a given planning cycle shall lie exclusively inside the relevant time-range. This constraint applies both at the level of:

- The sequence call times contained in the IOR
- The individual command times that result once the sequences are expanded to commands

Additionally instrument-teams shall ensure

- The time-range constraints shall be met also once the sub-second time-shifting of section 7 is taken into account. Practically-speaking this can be easily achieved by ensuring that the final 1 second of the time-range is clear of all commanding.

The STP IOR files shall be delivered to SOC on the Tuesday 10 days prior to this Saturday. This gives time to process the IORs and iterate if necessary with Instrument Teams prior to delivery to MOC at 4 days prior.

---

<sup>4</sup> Clearly this period is **not** the same as an orbit. The above planning period has been chosen to ensure that MTP is always done with a firm station baseline already in place.



Within the identified VSTP-IOR supported periods, VSTP files shall be delivered to SOC at least TBC<sup>5</sup> hours **prior to the start of the pass which completes prior to start of the reserved slot at STP**<sup>6</sup>. Pass times are visible in the E-FECS “planning skeleton” file.

### 2.2.2 Cruise Phase

In principle the Cruise Phase mission planning works in a similar way as NMP/EMP. The duration of each STP will be extended such that the number of STPs within each MTP are reduced, consistent with reducing the operational overhead in Cruise. It would be expected that consecutive RSCWs fall into separate STPs.

## 2.3 Filename

Previous issues of this icd attempted to maintain commonality with the Solar Orbiter Metadata standard. However the meta data standard has not been designed with planning products in mind. Further there are legacy filenaming approaches at MOC which are different.

Therefore in this issue the filenaming approach is revised.

```
IOR_[delivery_cycle]_S[mission-STP-number]F[IOR-number]_[instrument]_[version].SOL
```

Where [delivery\_cycle] is

M	MTP delivery
S	STP delivery

It could appear that there is redundancy between the delivery cycle and the Sxxx fields that follow, but this is not the case because MTP and STP boundaries are known already at MTP. As such an e.g. ...SQ02... reference occurs both within an MTP delivery and within subsequent STP delivery.

There is an additional [delivery\_cycle] enumeration

V	i-VSTP delivery
---	-----------------

but this has a slightly modified filename format as detailed below.

**For the MTP IORs the file-name becomes:**

```
IOR_M_S[mission-STP-number]F[IOR-number]_[instrument]_V[version].SOL
```

Where

[mission-STP-number] is the **three** digit number of the STP cycle **within** the **mission**, starting from 1

[IOR-number] is the two digit number of the IOR file **within** the STP, starting from 1

<sup>5</sup> 36 hours TBC.

<sup>6</sup> Within VSTP, the timing is tight enough that the position of the individual passes becomes important. Furthermore uplink of operations within the same pass that they are executed is excluded. Thus instrument teams are encouraged to place VSTP slots immediately following a pass, where turn-around time is critical.



[instrument] is the source, being a mnemonic for one of the instrument teams. Baseline mnemonics are the [four](#) character IDs ([used also deeper in the XML](#)).

[SEPD EPD](#)  
[SEUI EUI](#)  
[SMAG MAG](#)  
[SMET METIS](#)  
[SPHI PHI](#)  
[SRPW RPW](#)  
[SSPI SPICE](#)  
[SSHI SOLO-HI](#)  
[SSTX STIX](#)  
[SSWA SWA](#)

[version] is a one character the version of the file, starting from 1. It start from 1 again for each new instance of an IOR having [different](#) preceding fields.

Alphabetical characters may be used within the version-field to identify IORs created as part of a ground test activity.

**And for the STP IORs the filename is:**

IOR\_S\_S[[mission](#)-STP-number]F[[IOR-number](#)][\_[instrument](#)][\_V[version](#)].SOL

As such it is the same as the MTP filenaming, except for the early “S” identifier of an STP delivery.

**For the VSTP IORs the filename is:**

IOR\_V\_S[[mission](#)-STP-number]X[[vstp-slot-number](#)][\_[instrument](#)][\_V[version](#)].SOL

The [[vstp-slot-number](#)] which is two digit decimal number, nn, starting from 01 **at each new STP-cycle**, and incrementing by one with each reserved VSTP slot. The VSTP slot number is therefore a reference within each STP.

VSTP slots have to be declared or “reserved” in the content of the STP. As well as reserving a time-span free of STP commanding, this STP IOR slot declaration is also identifying the slot-number – this is required to match the slot-number in the subsequent VSTP filename that provides commands for the reserved time-range. This means that if a reserved slot is not ultimately used, then the slot numbers within the submitted VSTP IORs will not be contiguous (there will be a gap).

[version] is a fixed prefix “V” followed by a single digit decimal number, starting from 1, which increments each time a new IOR for the VSTP slot in question has to be issued. There is no link at filename-level between this and either the STP IOR version or the MTP IOR version. Alphabetical characters may be used within the version-field to identify IORs created as part of a ground test activity.

**N.B. this field is maintained for consistency with other IOR filenames. However given that the VSTP cycle occurs very late, and is not guaranteed to reach the spacecraft (e.g. non-critical commanding only) then any iteration on delivered**



**VSTP IORs is very likely to mean that the commanding is not ready in time.  
Reaching a 9<sup>th</sup> version of a VSTP IOR is in practise impossible.**



### 3 SPECIAL FEATURES OF VSTP IORS

#### 3.1 Time-span and relationship to STP

In certain respects VSTP IORs are treated very differently to other IORs, as described here.

The MTP delivery of IORs fully covers a ~six month planning period.

The STP delivery of IORs fully covers a shorter period (typically 1 week, identified by STP\_BOUND events in the EFECS). The commanding that arrives in the STP IOR **entirely replaces** the previous MTP content across this period.

Both MTP and STP deliveries have IOR file granularity that respects section 6, such that

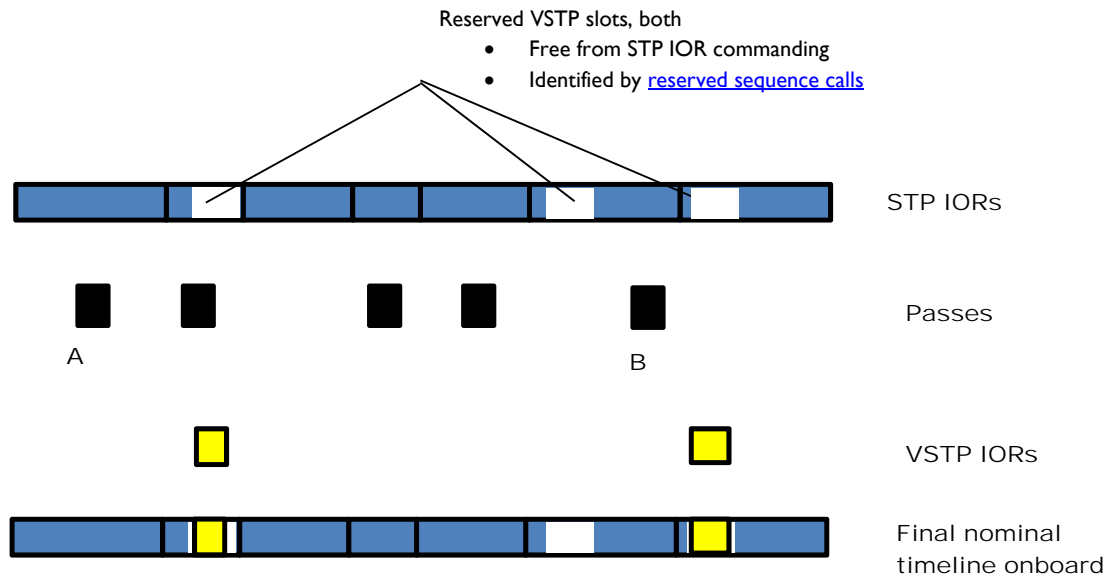
- There is an IOR boundary at the MTP planning period boundary
- There is an IOR boundary at each STP planning period boundary
- IOR boundaries reflect “safe restart points” in terms of planning

The VSTP IORs don't replace STP commanding, but insert additional commanding. There is no modification nor deletion of the existing STP commanding. The addition/insertion is only allowed within empty slots already identified/reserved at STP<sup>7</sup>. Each VSTP IOR corresponds to a specific reserved slot. The reserved slots must be free from STP commanding (a small margin either side of the reserved slot must also be free to cover the timing issues of section 7.1.1, value TBC but probably 1 second). Only (maximum) two VSTP slot reservations are allowed within any single **MTP/STP IOR file**.

VSTP usage is only supported for RSWs (and agreed precursors/RSW\_EXT periods) in NMP/EMP.

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<sup>7</sup> In other words, besides the sequence calls of the MTP/STP IOR, these IORs also have to identify where (in time) subsequent VSTP commanding will/may be inserted. These identified periods are the “empty slots”.



**Figure 2, VSTP IOR relationship to STP IOR**

It is not mandatory that a reserved slot is actually used. Also the VSTP commanding does not need to **fill** the reserved time, as long as all its commanding lies inside the range.

In section 2 the timing of VSTP deliveries was discussed. Because of the tight timing of the VSTP cycle, the timing of passes has to be taken account when determining delivery deadlines. Furthermore it is not allowed to assume that a VSTP IOR can be uploaded inside the same pass within which it also executes (if indeed it executes during a pass). Thus in the diagram above the first and third VSTP IORs shown, would nominally be uploaded in the passes A and B respectively. Instruments wanting to minimise the turn-around time of VSTP IORs are therefore recommended to schedule their VSTP slots shortly after a pass.

### 3.2 VSTP IORs are resource neutral

The VSTP cycle is too short to allow resource checking on the incoming VSTP IORs. Therefore the VSTP IORs are required to be resource-neutral commanding only. Resource neutral includes:

- No changes to power consumption profiles wrt previous planning cycles
- No changes to EMC-noisy activities wrt previous planning cycles
- No changes to data production wrt to the prediction derived from the previous cycles

In order to ensure that VSTP is only used for resource neutral activities, the SOC will (in discussion with the instrument teams) write and maintain a document detailing the identified and agreed sequences that are allowed be called within VSTP. This list is expected to be restricted to those sequences bound to tight-loop calibration updates (i.e. small subset of



overall instrument sequences). The planning software will only forward to MOC VSTP IORs consistent with this list.

### **3.3 VSTP IORs are non-critical**

There must be no criticality if the commanding is not sent. Because of the tight-loop of VSTP commanding the forwarding schedule and uplink to the spacecraft is success-orientated, and could easily fail in the event of e.g. station failure. VSTP commanding is therefore best-effort, and not guaranteed. It is unsuitable for e.g. safety related activities.

### **3.4 VSTP allowed sequence calls will be whitelisted**

In order to allow to enforce the previous points, each instrument will establish in discussion with SOC and MOC a whitelist of instrument sequences that meet the resource-neutral and non-critical criteria and that **are** foreseen to be used for i-VSTP.

### **3.5 VSTP commanding is only allowed within RSWs**

Both remote sensing and in-situ instruments may make use of the VSTP capability, but only within RSWs.

### **3.6 Reserving the VSTP slot at STP (and MTP)**

Each slot is reserved by inserting two special sequence calls in the STP IOR<sup>8</sup>. One sequence call identifies the start of a reservation and the second identifies the end of a reservation. Each instrument will be assigned its own two sequences to use. These sequence names will be listed in this ICD once known.

These sequences are defined by MOC but are configured such that the relevant instrument team is allowed to call them. They will contain no formal parameters. All normal rules concerning sequence calls apply to these calls as well.  
Each of these calls contributes one TC to the allowed 150 per day.

The one special feature is that the first sequence carries additional meta data (as XML attributes) describing the reservation.

### **3.7 Declared number of commands per slot**

Instruments have an EID-A requirement to respect 150 TCs/ day.

When a VSTP slot is declared in the IOR at MTP or STP, the syntax includes a maximum number of TCs that will/can be inserted later.

---

<sup>8</sup> It is good practise to include foreseen slot reservations in the MTP IORs, when known, to maximise the representativity of the MTP planning. However since MTP IORs are not loaded to the spacecraft, the actual reservation stems from whatever arrives in the STP IORs. Thus slot-reservation is the same as commanding wrt MTP versus STP.



- This allows SOC to check that the sum of normal and VSTP commanding still meets this constraint.

Additionally each VSTP slot [reservation](#) adds [two](#) implicit commands [as described above](#).

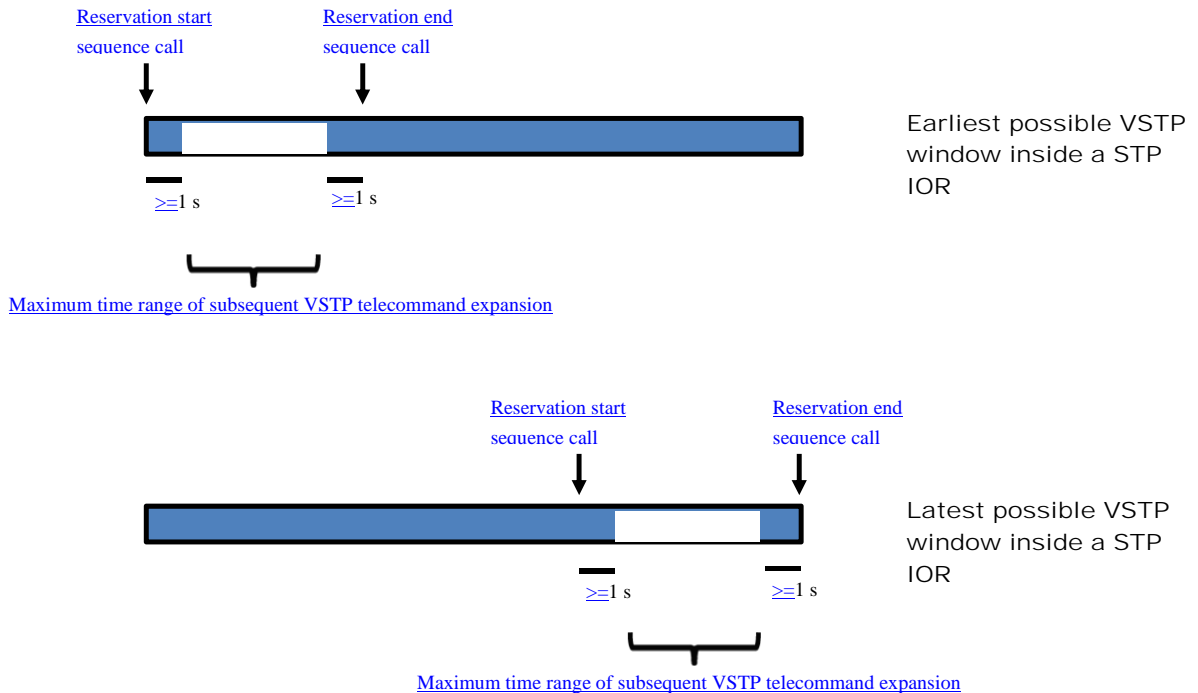
Later any VSTP IORs delivered will be checked that they do not exceed the VSTP\_max\_TCs parameter declared at STP.

### 3.8 Earliest and latest VSTP positions inside a POR

VSTP windows must be fully contained inside the MTP/STP IOR in which they occur. I.e. they cannot span a normal IOR boundary.

The reservation calls occupy a second each, so the window really available for VSTP execution times starts one second later and ends one second earlier than the corresponding reservation calls. This window defines both the limit of execution times that can come in the subsequent VSTP IOR and the metadata values that shall be attached to the first call.

This limit of execution times applies to the child **telecommands** that will be expanded from the VSTP sequences, not simply the parent sequence execution times.



**Figure 3. Positioning of VSTP window inside an MTP/STP IOR**



Only one VSTP reservation is allowed within a given observationID.

## 4 DETAILED FORMAT

Each IOR file is an XML file with structure as defined in the following subsections.

Within the tables the following abbreviations are used:

E/A Element/Attribute

### Need

M Mandatory

O Optional

Q Qualified, the need for the field depends on other elements, as described

### 4.1 Command Request File Format

Top level elements are <planningData>, which contains child <commandRequests>, which in turn contains children <header> and <occurrenceList> as described below.

#### 4.1.1 header

The <header> element contains

Field	E/A	Type	Description	Need
type	A	string	Enumerates the filetype. For IORs this shall be set to “ <b>IOR</b> ” <sup>9</sup>	M
formatVersion	A	integer	“1”	M
genTime	E	string	File generation time in format YYYY-DDDThh:mm:ssZ <i>Subseconds are not supported in the IOR</i>	M
validityRange	E	complex	See below	M

The validity range complex element contains the following:

Field	E/A	Type	Description	Need
startTime	E	string	YYYY-DDDThh:mm:ssZ <i>Subseconds are not supported in the IOR</i>	M
stopTime	E	string	YYYY-DDDThh:mm:ssZ <i>Subseconds are not supported in the IOR</i>	M

The validity range identifies the period of time that the IOR file covers. In other words it defines the IOR file boundaries. This is not the same thing as execution times of the individual sequence calls within. See ASCII diagram below.

<sup>9</sup> N.b. this is not an allowed enumeration within the [PLID]. As mentioned before the IOR ICD is not strictly a tailoring of the PLID.



```

|---x---xxx-----x-----x---|x-----x---x-xxxx--x---|--x--x---x-----x---x-|
|
|      IOR boundaries (reflected in validity range)
x      actual sequence call execution times inside the IOR

```

The end of one validity period to be contiguous with the start of the next (except for periods e.g. outside of RSWs where RS-instruments are not actively operating). There shall be IOR boundaries that align with the once-weekly STP\_BOUND event, and with the start/end of each ~six month MTP planning period. Other IOR boundaries are up to the instrument teams to set. All IOR boundaries identify “safe restart points”, see section 6.

Sequence call timing shall be such that the subsequent expansion to child telecommands remains inside the validity range. In other words one cannot call a sequence that lasts one minute, less than sixty seconds from an IOR boundary.

#### **4.1.2 Header2**

The <header2> element does not exist in the legacy CRF format. Its purpose is to group all non-standard/non-legacy header data in a single place. This includes items from the filename, which are duplicated explicitly as metadata in this header, and have the same meaning as detailed in section 2.3.

The <header2> element contains:

<b><u>Field</u></b>	<b><u>E</u></b> <b><u>/</u></b> <b><u>A</u></b>	<b><u>Type</u></b>	<b><u>Description</u></b>	<b><u>Need</u></b>
<u>ICDVersion</u>	<u>A</u>	<u>string</u>	<u>This field allows direct comparison of the version of this ICD that the XML (or indeed the schema) is created against “v0 8”<sup>11</sup></u>	<u>M</u>
<u>VSTP_slot_count</u>	<u>A</u>	<u>integer</u>	<u>A count of the number of VSTP slot windows embedded in the IOR file</u>	<u>M</u>
<u>planningCycle</u>	<u>A</u>	<u>string</u>	<u>“M”, “S” or “V” as from IOR filename</u>	<u>M</u>
<u>missionSTP</u>	<u>A</u>	<u>integer</u>	<u>of form _____xxx As from IOR filename</u>	<u>M</u>
<u>IORorSlotNumberInSTP</u>	<u>A</u>	<u>integer</u>	<u>If planningCycle is “M” or “S” then this field is the number of the M or S IOR inside of the STP. Otherwise (VSTP) it is the</u>	<u>M</u>

<sup>11</sup> This is an added attribute for the IOR, not present in the generic CRF definition. At the current time the schema enforces this value by making the attribute both “required” and “fixed”

			<u>number of the reserved VSTP slot inside the STP. of form <math>\_\_\_\_\_\_xx</math> as from IOR filename.</u>	
<u>instrument</u>	<u>A</u>	<u>string</u>	<u>SEPD EPD SEUI EUI SMAG MAG SMET METIS SPHI PHI SRPW RPW SSPI SPICE SSHI SOLO-HI SSTX STIX SSWA SWA as from IOR filename.</u>	<u>M</u>
<u>IORVersion</u>	<u>A</u>	<u>Integer (character may be allowed for test files)</u>	<u>of form <math>\_\_\_\_\_\_x</math> as from IOR filename.</u>	<u>M</u>

Note that currently the “instrument” metadata from the filename is included here, even though it can be redundant with the “source” of later sequence calls. This is to cover a possible use of IORs where in-situ instruments with very low commanding rates might submit IOR files without a single sequence call.

### **4.1.3 Occurrence List**

Within the IOR the standard occurrence is a sequence call. The sequences called are defined in the instrument MIB.

Also within the occurrence list it is possible to include VSTP slot windows.

First an <occurrenceList> is defined.

Content of <occurrenceList>:

<b>Field</b>	<b>E / A</b>	<b>Type</b>	<b>Description</b>	<b>Need</b>
count	A	integer	A count of the number of sequence calls contained in the occurrence list	M
creationTime	A	string	The creation time of the occurrence list in absolute time format YYYY-DDDThh:mm:ssZ	M
author	A	string	Used to identify the user that created the IOR. For the internal use of the instrument-team.	M
sequence	E	<u>complex</u>	Sequence calls	O

And each sequence-call <sequence> occurrence contains the following:

<b>Field</b>	<b>E / A</b>	<b>Type</b>	<b>Description</b>	<b>Need</b>
name	A	string	The name of the sequence. This must match exactly the 8 character CSF_NAME of the sequence in the MIB	M
observationID	E	string	See section <a href="#">4.1.4</a> <sup>13</sup>	M
source	E	string	Indicates the Instrument Team “SEPD” EPD “SEUI” EUI “SMAG” MAG “SMET” METIS “SPHI” PHI “SRPW” RPW “SSPI” SPICE “SSHI” SOLO-HI “SSTX” STIX “SSWA” SWA	M
destination	E	string	“R” meaning routine	M
executionTime	E	complex	See below	M
parameterList	E	complex	See below. Mandatory if the sequence call requires parameters.	Q

[For the case in MTP/STP where the sequence <name> is the special sequence for the start of a VSTP reservation the following child element must be added to the <sequence>.](#)

<b>Field</b>	<b>E / A</b>	<b>Type</b>	<b>Description</b>	<b>Need</b>
<a href="#">iVSTP</a>	E	simple	<a href="#">A container for metadata associated to a VSTP reservation</a>	<a href="#">Q</a> <a href="#">Use only if the parent &lt;name&gt; is the special sequence for start of a VSTP reservation</a>

[Where <iVSTP> is present, it contains the following attributes:](#)

<b>Field</b>	<b>E / A</b>	<b>Type</b>	<b>Description</b>	<b>Need</b>

<sup>13</sup> To be noted that this ID reference is not available onboard (it is not part of the CCSDS TC structure that is uplinked).



<a href="#">starttime</a>	<a href="#">A</a>	<a href="#">string</a>	<a href="#">in absolute time format YYYY-DDDThh:mm:ssZ</a> <a href="#">This is the earliest execution time that the subsequent VSTP IOR will be allowed to use. There must be at least one second margin between this time and the execution time of the reservation start call</a>	<a href="#">M</a>
<a href="#">endtime</a>	<a href="#">A</a>	<a href="#">string</a>	<a href="#">in absolute time format YYYY-DDDThh:mm:ssZ</a> <a href="#">This is the latest execution time that the telecommand expansion of the subsequent VSTP IOR will be allowed to use. There must be at least one second margin between this time and the execution time of the reservation end call.</a>	<a href="#">M</a>
<a href="#">VSTP_max_TCs</a>	<a href="#">A</a>	<a href="#">Integer</a>	<a href="#">Defines the maximum number of telecommands that will be inserted within the slot, via VSTP commanding. This allows to check the 150 TCs/day constraint prior to the delivery of VSTP IORs<sup>14</sup>.</a>	<a href="#">M</a>
<a href="#">slotInSTP</a>	<a href="#">A</a>	<a href="#">Integer</a>	<a href="#">Is the positional count of the VSTP slot in the STP. This is used to link to the latter VSTP IOR that will (may) arrive to fill this slot. The value here has to correspond to the [vstp-slot-number] component of the later VSTP IOR filename</a>	

[VSTP slot windows can only be present in MTP or STP IORs. They reserve a slot for later use in VSTP. Only STP IORs are actually used to reserve the slot, however inclusion also in earlier MTP IORs is recommended to validate the locations. The time range indicated by the slot must be free of other IOR called commanding.](#)

The <executionTime> complex element is composed of the following:

<b>Field</b>	<b>E</b>	<b>Type</b>	<b>Description</b>	<b>Need</b>
	/			

<sup>14</sup> [I.e. the allowed number of normal \(non VSTP\) commands per day allowed will be reduced from 150, by the sum of all <VSTP\\_max\\_TCs> parameters within that day. The number of normal commands implied by the IOR will be determined by using MIB information for the number of TCs present within each sequence call.](#)



	<b>A</b>			
actionTime	E	string	Absolute time at which the sequence is requested to be begun onboard. YYYY-DDDThh:mm:ssZ <i>Subseconds are not supported in the IOR</i>  <i>See also section 7</i>	M

The <parameterList> complex element is composed of the following:

Field	E / A	Type	Description	Need
count	A	integer	A count of the number of parameters to be specified for the sequence call.	M
parameter	E	Complex	One element for each formal parameter of the sequence in question. These shall be ordered in the same order as the formal parameters of this sequence in the MIB (i.e. according to the CSP_FPNUM <sup>1516</sup> )	M

The <parameter> complex element is composed of the following:

Field	E / A	Type	Description	Need
name	A	string	This field must exactly match the MIB CSP_FPNAME	M
position	A	integer	Defines the position of the <a href="#">formal parameter within the called sequence</a> .  <a href="#">Since formal parameters are already required to be ordered (above) the position values of (formal) parameters inside a given sequence call always follow the natural number sequence 1, 2, 3, ....</a>  <a href="#">The position removes any ambiguity in</a>	M

<sup>15</sup> [The official definition of the formal parameter ordering inside sequences comes from the instrument procedures embedded in the MOC Flight Operations Plan \(FOP\), and equivalently in the corresponding system MIB created at MOC \(if distributed\). In terms of the system MIB, the position reflects the CSP\\_FPNUM. Typically this ordering simply reflects the order in which the formal parameters appear in the procedure/sequence.](#)

<sup>16</sup> [Other CRF-based interfaces that are not IORs \(e.g. PDORs\) may allow access to both sequences and telecommands as occurrences. Here, in the case of direct telecommand parameter access \(rather than via sequence formal parameter access as in the IOR\) the position instead reflects the order of the parameters inside the TC structure \(i.e. ordered according to MIB CDF\\_BIT value\).](#)



			case a given sequence has multiple instances of a given parameter. The first parameter shall have position 1.	
unit	A	string	For engineering parameters: if the unit is given in the MIB database then the same unit must be specified here, and if the unit is not present in the database then it must also be absent from the <a href="#">IOR</a> file. n.b. MIB restrictions limit the unit to no more than 4 characters	Q
value	E	<a href="#">complex</a>	If this field is omitted then the default value (specified in the MIB) will be used, unless no default is defined in which case the IOR is invalid. The format to be used to specify the parameter value shall comply with the parameter type for raw values, and with the calibration type for engineering values. This field is <b>mandatory</b> if the representation is specified.  See below for associated attributes	Q
<a href="#">description</a>	E	string	Comment field	O

Attributes of the <value> complex element are:

representation	A	string	This field specifies whether the value is supplied in the native format of the parameter, or in a calibrated form. <ul style="list-style-type: none"> <li>“Raw”: The value is supplied in uncalibrated form, i.e. no decalibration is needed to encode the parameter into the uplink. N.b. Raw parameters are not necessarily unsigned int. It depends on native format of the parameter defined via the MIB CPC_PTC and CPC_PFC.</li> <li>“Engineering”. The value is supplied in a calibrated form, which assumes decalibration prior to encoding on the uplink. Depending on the type of parameter calibration (e.g. textual or numeric) the engineering value can be different formats.</li> </ul>	Q
----------------	---	--------	--	---



radix	A	string	<p>The radix must be specified for all Raw parameters. It must be omitted for all engineering parameters.</p> <p>For <b>unsigned integer</b> raw parameters it can take one of the following</p> <ul style="list-style-type: none"> <li>• “Decimal”</li> <li>• “Hexadecimal”</li> <li>• “Octal”</li> </ul> <p>For <b>all other</b> raw parameter types it must be “Decimal”</p>	Q
-------	---	--------	---	---

#### 4.1.4 Observation ID

The following rules shall be followed for the definition of the Observation ID.

- It shall be limited to 20 characters
- The first 4 characters shall identify the source (same as for the subsequent field<sup>17</sup>)
- The last (up to) 16 characters shall contain a hexadecimal value, unique for this source

The SOC proposal for this field is that the ID reflects the “Observation ID” assigned at LTP. I.e. The SOOP planning performed at LTP will identify periods of operation linked to science goals. These periods will be assigned IDs. The instrument teams would ensure that their IOR sequence calls relating to each SOOP would contain the appropriate ID<sup>18</sup>.

Current proposed scheme for LTP ObservationIDs is as follows:

AAAA000112233444

AAAA: 4 Character instrument ID (as before)

000: 3 Digit decimal MTP ID

11: 2 Digit hexadecimal SOOP ID, this represents the SOOP archetype, e.g. 1C might be Coronal Dynamics

22: 2 Digit hexadecimal SOOP instance, with the scope per MTP so the nth instance of SOOP X in MTP Y

33: 2 Digit hexadecimal observation ID, with scope per instrument so nth observation defined for MAG

444: 3 digit hexadecimal observation instance, with scope per MTP, so the nth instance of that observation ID in the MTP, regardless of SOOP.

This uses 16 of the 20 available characters.

Possibly instrument teams will want to assign observation IDs of their own for specific operations. This could happen if, for example, there are operations (i.e. sequence calls) that are needed but

<sup>17</sup> This redundancy of source information is necessary to allow the planning system to search on a single field.

<sup>18</sup> Exact form of the SOOP ID is TBC. Potentially some parts of the field may remain free for instrument-team usage.



- These are too fine grained / instrument internal to have been planned explicitly at LTP, and
  - It does not make sense to give them the nearest SOOP based observation ID.
- The final 4 characters (unused in the above definition) allow for this possibility.

An electronic interface would need to be defined to make the LTP planning IDs available to the instrument teams to incorporate into IORs.

The ID is a facility of the IOR with two general goals:

- To help SOC and MOC to track the evolution between MTP and STP in terms of “what has moved?” and “what is new?”
- To help instrument teams track “observations” between planning products and TC History.

The concept for this ID is that it identifies a self-contained scientific “observation” or meaningful macro-level unit of science acquisition<sup>19</sup>. It is accepted that this definition is vague and the details how an ID spans operations will vary instrument to instrument. Often it will be that a group of consecutive sequences share the same ID because they work together to achieve a particular operation. Depending on how the instrument’s operations are organised it may or may not be the case that the ID is redundant with the IOR granularity concept of Section 6.

Conceptually the idea is that the same Observation ID should be maintained between MTP and STP planning cycles when the “operation” that the ID belongs to is still present, even if parameter details or execution time have changed. Newly inserted operations at STP, of course require new IDs.

*N.b. The observationID has to be renamed to the (confusingly named) “Unique ID” by the SOC when converting IORs to PORs for the MOC in order to maintain XML compatibility with the generic planning file ICD (see section 1). This is transparent to the Instrument Teams.*

The Unique ID appears in the XML-format of the Telecommand History data provided by MOC. This provides one means for instrument teams to find the commanding status (once the commands have been dispatched to the Spacecraft)<sup>20</sup>. Note that the unique IDs are not uplinked and are therefore not available onboard<sup>21</sup>.

<sup>19</sup> I.e. not necessarily, or not usually, unique per sequence.

<sup>20</sup> Of course for the Solar Orbiter mission only very minor time-shifting of IOR timings occur within the planning stream so equally the executionTime provides a key to search for specific operations

<sup>21</sup> Although nothing stops command parameters communicating an “observation ID” to the instrument to use onboard. Instruments that have foreseen functionality like this may find it useful to match the IOR unique ID to their onboard ID.



## **4.2 Constraints on the IOR content not explicit from the structure**

Sequence calls are required to be ordered in time-order within the IOR.

No new sequence call can be made before all child commands of the previous call have completed. This is checked within SOC mission-planning based on known duration of sequences.



## 5 USE OF IOR RESOURCE PROFILES

In common with ESA planetary mission planning approach, spacecraft resource usage will be checked at MOC/SOC. These resources include

- Data production onto Spacewire
- Power
- EMC quietness

For Solar Orbiter, the baseline approach is to perform these checks by processing the IORs submitted by the instrument teams, using a SOC model of the instrument behaviour derived from IUMs and discussion.

For certain instruments this parsing of the IOR to deduce approximate resources may be impossible. Therefore, on a **case-by-case basis**, and in agreement with MOC and SOC, instruments may be permitted to submit their own resource estimate(s), as a substitute for the independently computed resource estimate, as a component of the IOR. Where such is agreed it is recorded below.

### 5.1 SOLO-HI use of IOR resources

SOLO-HI operations run from a schedule within the instrument, elements of the schedule being loaded as an instrument-level file transfer. This creates two problems

- resource usage implicit in the IOR is completely opaque
- the MTL execution times are not directly connected to the resource usage times, being the time the schedule file is transferred to the instrument across Spacewire, not the time that the schedule will execute.

Therefore it is agreed to support SOLO-HI resource definitions as follows:

#### 5.1.1 SOLO-HI modelling sequences

SOLO-HI will insert calls to a “fake” (or “modelling”) sequence, invented to carry resource information as parameters. The sequence shall be called at the start of each IOR, and at each point in time when **any** of the resources change. Resources are

- Worst-case 5-min-average power
- HK rate
- Low-latency rate
- Bulk science rate
- EMC status

These “modelling sequences” are interleaved amongst the genuine sequences achieving the file load to SOLO-HI. However the timing of the modelling sequences reflects the actual timing of the resource changes and is therefore not directly linked to the adjacent file load content. It is SOLO-HI responsibility to ensure that IORs are delivered with correct modelling sequences, even when e.g. resource changes arise from content-changes within different IOR files.



These modelling sequences will be interpreted by SOC and

- Used internally for SOC modelling
- Converted to ESOC “resource profiles” for subsequently inclusion in the PORs transferred from SOC->MOC. (The modelling sequences themselves are removed from the PORs).

Note that exceptionally modelling sequences **are** allowed overlap with, and occupy identical UTC second slots with MIB sequences. Also modelling sequences do not count towards the 150 commands per day (not contributing commands).



### Example:

```
<occurrenceList count="9" creationTime="2016-280T12:00:00Z" author="Anik De Groof" vstp_slot_count="0">
  <sequence name="HI_RESRC"> <!--Fake sequence 'SoloHI resources with parameters'-->
    <observationID>SSHI0000000001</observationID>
    <insertOrDeleteFlag>Insert</insertOrDeleteFlag>
    <source>SSHI</source>
    <destination>R</destination>
    <executionTime>
      <actionTime>2022-001T00:00:00Z</actionTime>
    </executionTime>
    <parameterList count="5">
      <parameter name="SHI_PWR" position="1" unit="W">
        <value representation="Engineering">9</value>
        <description>SoloHI worst-case 5-min-avg power</description>
      </parameter>
      <parameter name="SHI_HK" position="2" unit="b/s">
        <value representation="Engineering">0</value>
        <description>SoloHI HK datarate</description>
      </parameter>
      <parameter name="SHI_LL" position="3" unit="b/s">
        <value representation="Engineering">0</value>
        <description>SoloHI LL datarate</description>
      </parameter>
      <parameter name="SHI_SCI" position="4" unit="b/s">
        <value representation="Engineering">0</value>
        <description>SoloHI Science datarate</description>
      </parameter>
      <parameter name="SHI EMC" position="5" >
        <value representation="Engineering">1</value>
        <description>SoloHI EMC Noise Level</description>
      </parameter>
    </parameterList>
  </sequence>
</occurrenceList>
```



## 6 IOR GRANULARITY AND TIMELINE-REENTRY

### 6.1 150 TCs/day constraint in practise

The EID-A establishes a limit of 150 TCs/day from ground/MTL<sup>22</sup>. A part of this constraint arises from how full the MTL can be at any time. The MTL will be “topped up” in units of entire IORs. Thus, the 150 TCs/day constraint has to be interpreted as the maximum number of commands per IOR.

Then because the constraint isn’t solely MTL-fill-driven, and to avoid encouraging unhelpful workarounds<sup>23</sup>, we have to retain the constraint in its original form as well.

Therefore we have two parallel constraints that apply to IOR command numbers:

- **No more than 150 TCs per IOR**
- **No more than 150 TCs per day per instrument**

E.g. **if** one chooses the maximum allowed granule-size of an IOR, spanning from one STP boundary to the next (7 days) then the restriction is **150 TCs per seven days**. Or in other words, only the simple form in the EID-A (second bullet) applies **providing** the IOR granularity is daily.

In both cases the 150 includes TCs arising from reserved i-VSTP slots (section 3.6).

SOC will determine no. of TCs arising from each sequence call in the IOR by consulting the applicable MIB sequence tables.

### 6.2 Timeline Reentry

During a contingency condition on an instrument, commands to the instrument may be lost. Some instruments will have complex commanding in the MTL, where current commands assume the successful execution of preceding commands. In these cases the point of re-entry into the running MTL for an instrument that was in contingency cannot be performed arbitrarily, and has to be done at a suitable point.

- i. For instruments requiring control of the re-entry into MTL, the granularity of the IOR shall be used to convey this information. I.e. the start of a new individual IOR file is used to indicate a usable re-entry point. It is recommended that **at least** one such point occurs each day of nominal operations to reduce delays in restarting an instrument’s science operations. Where this approach is used, the first IOR file of a planning period must also be a legitimate re-entry point. This is the one-point in each STP planning period where the positioning of a re-entry point is time-constrained. The link between IOR granularity and timeline re-entry applies only to MTP and STP IORs. In other words the positioning of the VSTP IOR windows have no meaning wrt to timeline re-entry.

<sup>22</sup> I.e. does not include service-20 TCs for inter-instrument communication, nor TCs operating in an automatic way (e.g. event-action) that bypass the MTL.

<sup>23</sup> Like creating multiple fine-granularity IORs solely for the purpose of exceeding 150 TCs/day





- ii. For instruments that don't require any control of the re-entry into the MTL, a granularity of one individual IOR file every 24 hours is proposed.

It is assumed that instruments will make clear in their User Manuals (and specifically their contingency recovery procedures) whether their re-entry into the MTL needs to be controlled in this way or not.

## 7 TIME-TAGGING AND MTL LOADING

### 7.1 MTL-load levelling

The spacecraft MTL has a limit on the number of TCs that can exist within a single execution slot in the MTL<sup>24</sup>. In order to avoid that any MTL overload situation can occur in-flight, the following approach is adopted.

- The sequences calls shall be time-tagged only in whole seconds
- The sequences called in the IORs contain command delta-times in the database only in whole number of seconds<sup>25</sup>
- The SOC shall apply a specific time-offset (<1 second) to each instrument's timestamps to spread the commands of the various instruments. See Table 1.

Time offset applied at SOC	Instrument
0 (no offset)	EPD, MAG
+0.125 sec	EUI
+0.250 sec	METIS, SOC-1
+0.375 sec	PHI
+0.500 sec	RPW, SWA
+0.625 sec	SOLO-HI
+0.750 sec	SPICE, SOC-2
+0.875 sec	STIX

**Table 1, Provisional allocation of time-offsets applied at SOC**

Consequences of this approach:

- The actual execution time of an operation will not exactly match the UTC given in the IOR (but with offset less than 1 second)
- In general instruments cannot arrange to execute a particular MTL-commanded operation at exactly the same instant<sup>26</sup>.

SOC-1 and SOC-2 slots are for SOC commanding. One known set of SOC-inserted commanding is for SSMM and Downlink control. Other sets are possible – e.g. commands to “glue” i-VSTP commanding into the existing MTL, heatshield door operations.

#### 7.1.1 *Aside on clock drift*

A fine detail also worthy of note in this context:-

<sup>24</sup> Max 5 TCs within a given execution slot. Slots occur every 0.125 seconds.

<sup>25</sup> This means that the optional millisecond sub-field within CSS\_EXETIME of the MIB shall be set to “000” or not used.

<sup>26</sup> The mechanism used by certain IS instruments to synchronise acquisitions according to a modulo operation applied on the raw OBTT (as seen at the instrument) is not MTL-commanded, and is not affected by this constraint.



The execution slots in the IOR exist in “UTC ticks”. The onboard execution slots exist in “OBT ticks”. The mapping between these time systems is performed transparently within the MOC. Inevitably this means that besides the deterministic time offset described above, there can be up to a +/-0.0625 sec offset in the actual execution time of a command introduced in the mapping from UTC ticks to OBT ticks. Normally speaking this UTC->OBT offset is consistent and 1:1, but occasionally the onboard clock will have drifted such that it is approximately half-way between UTC ticks. As the clock drifts across this midpoint there can be a point in time where the mapping “flicks” from e.g round-up to round-down, and in this instant the mapping is not 1:1.

This is not foreseen to be a problem.

- This was the reason in Table 1 to separate the execution slots which contain two instruments such that they are not adjacent. This minimises the max. TC load that can occur (arising from IOR commanding) instantaneously in this special case to 3 TCs in a single slot.
- The ordering of TCs per instrument is still preserved, even in this special case, thanks to the restrictions on 1 second commanding. The actual delta time between two TCs nominally separated by 1 sec could (rarely) drop to 0.875 sec (or equivalently increase to 1.125 sec) due to this effect.

### 7.1.2 Leap-seconds

Occasionally leap-seconds will be announced by the IERS.

Because

- Legacy systems at SOC/MOC are unaware of leap-seconds in planning
- Leap-second decisions will not be known at the time of LTP, MTP planning (and we want to avoid creating avoidable deltas between e.g. MTP and STP)
- There is no geometrical need for 1 sec absolute time accuracy in commanding<sup>27</sup>
- Safety constraints on commanding intervals are almost always of the form “not less than”

the handling of leap-seconds within mission-planning is excluded.

For commanding/ IORs:

- No IOR shall ever contain a time of the form YYYY-DDDT23:59:**60**, even in the case that a leap second exists at this time <sup>28</sup>
- The conversion of UTC to OBT is performed at the time of uplink (and some days of commanding are held onboard at any time as protection against missed-pass) thus:
  - The insertion of leap-second for TC relates to **time-of-uplink**, rather than **time-of-execution**<sup>29</sup>

<sup>27</sup> Example: 1 second offset at perihelion is equivalent to a third of an arcsecond error on pointing.

<sup>28</sup> The “60” possibility for the seconds field has been removed from the schema

<sup>29</sup> Note that nominally time correlation on **telemetry** behaves differently, inserting the leap-second at the correct time. Thus for instrument teams precisely tracking TC execution in terms of TM events/acknowledgements there can be a 1 sec offset



- For any instrument planning that **ignores** leap-seconds this manifests as an additional one second worth of command interval delay that will appear between subsequent sequence calls. This additional second will occur ~a day to some days after the IERS leap-second, typically at the boundary between individual IOR files.
- For any instrument team planning that internally **includes** leap-seconds, there is **additionally** the disappearance of 1 sec worth of expected commanding interval at the IERS leap-second (i.e. in terms of the **time-separation** between two sequence calls). Instruments planning in this way shall protect themselves against impact of this possibility<sup>30</sup>.

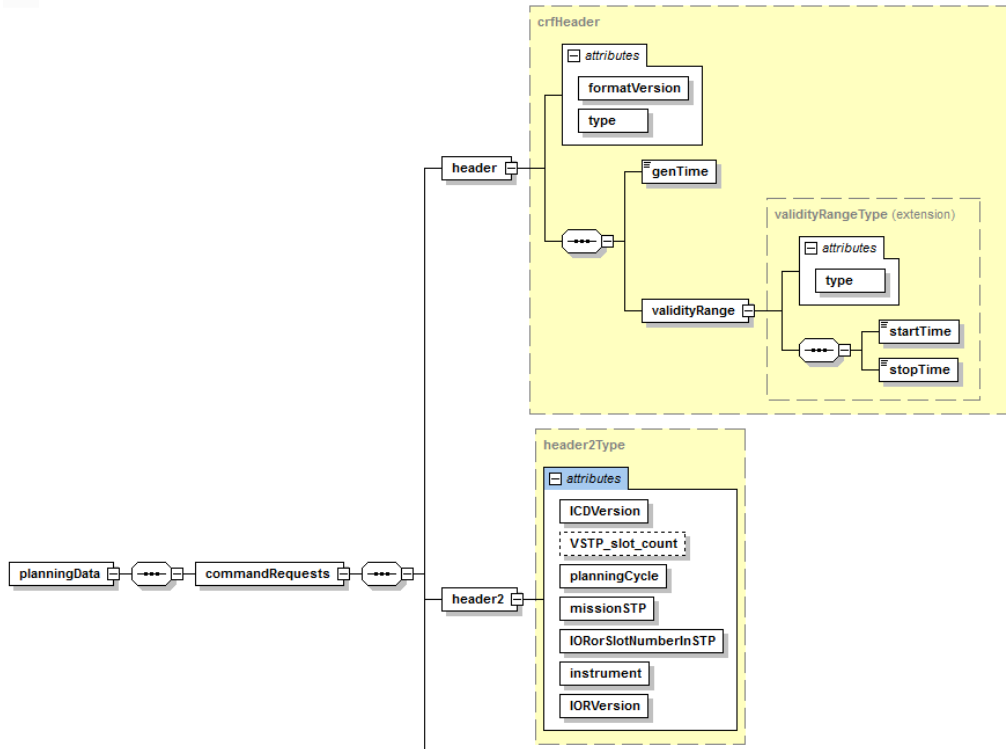
---

apparent between the formal leap-second occurrence and the time that the leap-second becomes reflected in TC. This is on top of the offset/jitter effects mentioned earlier in this section.

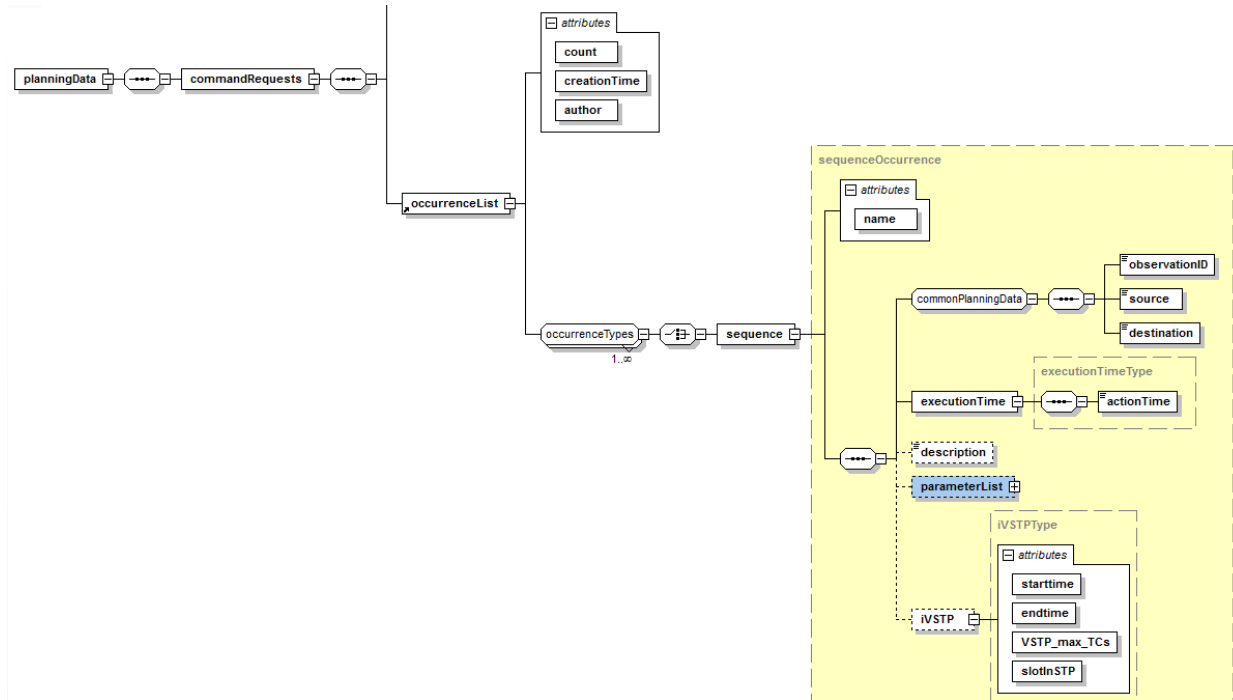
<sup>30</sup> E.g. for commanding intervals that have a minimum separation, applying intervals in the IOR that are at least 1 second larger than the minimum allowable. This could be done either in general or e.g. specifically close to 00:00:00 of every 1 Jan and 1 July.

## 8 SCHEMA

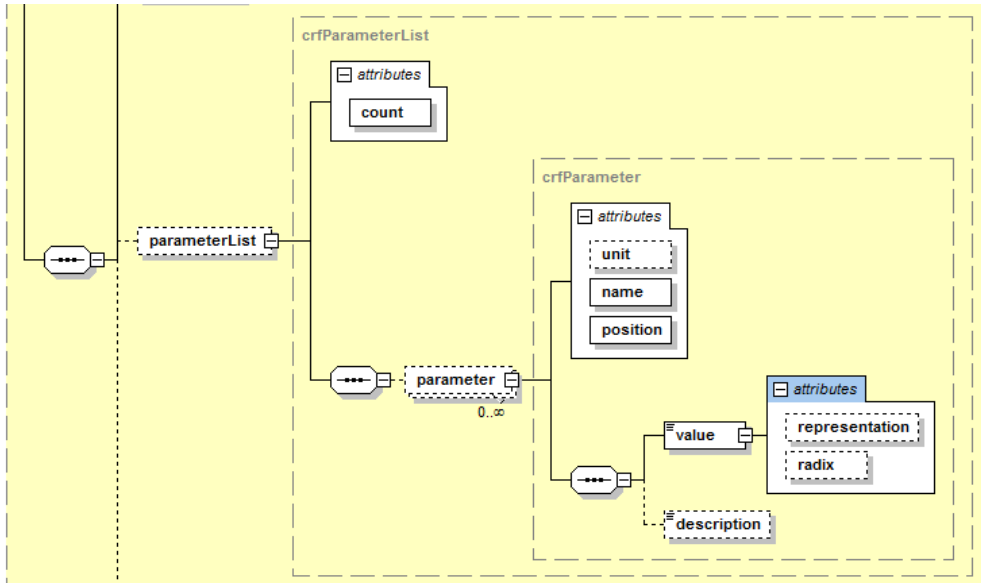
### 8.1 Graphical representation



**Figure 4. Header structures**



**Figure 5. Sequence structures, without parameterList expansion**



**Figure 6. ParameterList expansion**



## 8.2 Textual version

```

<?xml version="1.0" encoding="UTF-8"?>
<!-- edited with XMLSpy v2015 rel. 4 (x64) (http://www.altova.com) by Chris Watson (ESA - ESAC) -->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns="soc.solarorbiter.org"
targetNamespace="soc.solarorbiter.org" elementFormDefault="qualified">
  <!-- ##### -->
  <!-- IOR schema, adapted from generic ESOC Command Requests (CRF) schemas -->
  <!-- ##### -->
  <xs:element name="planningData">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="commandRequests">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="header" type="crfHeader"/>
              <xs:element name="header2" type="header2Type"/>
              <xs:element ref="occurrenceList"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
  <!-- CRF Header -->
  <xs:complexType name="crfHeader">
    <xs:sequence>
      <xs:element name="genTime" type="DOY UTC Time"/>
      <xs:element name="validityRange">
        <xs:complexType>
          <xs:complexContent>
            <xs:extension base="validityRangeType"/>
          </xs:complexContent>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
    <xs:attribute name="formatVersion" type="xs:positiveInteger" use="required" fixed="1"/>
    <xs:attribute name="type" type="xs:string" use="required" fixed="IOR"/>
  </xs:complexType>
  <!-- Solar Orbiter specific header -->
  <xs:complexType name="header2Type">
    <xs:attribute name="ICDVersion" type="xs:string" use="required" fixed="v1_0"/>
    <xs:attribute name="VSTP_slot_count" type="xs:nonNegativeInteger" use="optional"/>
    <xs:attribute name="planningCycle" type="planningCycleType" use="required"/>
    <xs:attribute name="missionSTP" type="xs:positiveInteger" use="required"/>
    <xs:attribute name="IORorSlotNumberInSTP" type="xs:positiveInteger" use="required"/>
    <xs:attribute name="instrument" type="instrumentType" use="required"/>
    <xs:attribute name="IORVersion" type="xs:string" use="required"/>
  </xs:complexType>
  <!-- Type used for validity range inside header -->
  <xs:complexType name="validityRangeType">
    <xs:sequence>
      <xs:element name="startTime" type="DOY UTC Time"/>
      <xs:element name="stopTime" type="DOY UTC Time"/>
    </xs:sequence>
    <xs:attribute name="type" type="xs:string" use="required" fixed="absoluteTime"/>
  </xs:complexType>
  <!-- Occurrences -->
  <xs:element name="occurrenceList">
    <xs:complexType>
      <xs:group ref="occurrenceTypes" maxOccurs="unbounded"/>
    </xs:complexType>
  </xs:element>

```



```

<xs:attribute name="count" type="xs:nonNegativeInteger" use="required"/>
<xs:attribute name="creationTime" type="DOY UTC Time" use="required"/>
<xs:attribute name="author" type="xs:string" use="required"/>
</xs:complexType>
</xs:element>
<xs:group name="occurrenceTypes">
<xs:choice>
<xs:element name="sequence" type="sequenceOccurrence"/>
</xs:choice>
</xs:group>
<xs:group name="commonPlanningData">
<xs:sequence>
<xs:element name="observationID" type="xs:string"/>
<xs:element name="source" type="instrumentType"/>
<xs:element name="destination">
<xs:simpleType>
<xs:restriction base="xs:string">
<xs:enumeration value="R"/>
</xs:restriction>
</xs:simpleType>
</xs:element>
</xs:sequence>
</xs:group>
<xs:complexType name="sequenceOccurrence">
<xs:sequence>
<xs:group ref="commonPlanningData"/>
<xs:element name="executionTime" type="executionTimeType"/>
<xs:element name="description" type="xs:string" minOccurs="0"/>
<xs:element name="parameterList" type="crfParameterList" minOccurs="0"/>
<xs:element name="iVSTP" type="iVSTPType" minOccurs="0"/>
</xs:sequence>
<xs:attribute name="name" type="xs:string" use="required"/>
</xs:complexType>
<xs:complexType name="iVSTPType">
<xs:attribute name="starttime" type="DOY UTC Time" use="required"/>
<xs:attribute name="endtime" type="DOY UTC Time" use="required"/>
<xs:attribute name="VSTP_max_TCs" use="required"/>
<xs:attribute name="slotInSTP" use="required"/>
</xs:complexType>
<!-- Execution Time -->
<xs:complexType name="executionTimeType">
<xs:sequence>
<xs:element name="actionTime" type="DOY UTC Time"/>
</xs:sequence>
</xs:complexType>
<!-- CRF Parameters -->
<xs:complexType name="crfParameterList">
<xs:sequence>
<xs:element name="parameter" type="crfParameter" minOccurs="0" maxOccurs="unbounded"/>
</xs:sequence>
<xs:attribute name="count" type="xs:nonNegativeInteger" use="required"/>
</xs:complexType>
<xs:complexType name="crfParameter">
<xs:sequence>
<xs:element name="value">
<xs:complexType>
<xs:simpleContent>
<xs:extension base="xs:string">
<xs:attribute name="representation" use="optional">
<xs:simpleType>
<xs:restriction base="xs:string">

```





```

        <xs:enumeration value="Raw"/>
        <xs:enumeration value="Engineering"/>
    </xs:restriction>
</xs:simpleType>
</xs:attribute>
<xs:attribute name="radix" type="valueRadix" use="optional"/>
</xs:extension>
</xs:simpleContent>
</xs:complexType>
</xs:element>
<xs:element name="description" type="xs:string" minOccurs="0"/>
</xs:sequence>
<xs:attribute name="unit" use="optional">
    <xs:simpleType>
        <xs:restriction base="xs:string">
            <xs:pattern value="[0-9a-zA-Z]{0,4}"/>
        </xs:restriction>
    </xs:simpleType>
</xs:attribute>
<xs:attribute name="name" type="xs:string" use="required"/>
<xs:attribute name="position" type="xs:positiveInteger" use="required"/>
</xs:complexType>
<!-- ##### -->
<!-- Common Types -->
<!-- ##### -->
<xs:simpleType name="DOY UTC Time">
    <xs:restriction base="xs:string">
        <xs:pattern value="20[0-9][0-9]-([0-2][0-9][0-9])[3[0-5][0-9][36[0-6])T([0.1][0-9][2[0-3]):[0-5][0-9]:[0-5][0-9]Z"/>
        <!-- the pattern accepts YYYY-DDDThh:mm:ssZ format -->
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="constrainedDeltaTime">
    <xs:restriction base="xs:string">
        <xs:pattern value="(-)?([0.1][0-9])([2[0-3]):([0-5][0-9]){2}"/>
        <!-- the pattern accepts the [-]hh:mm:ss format -->
        <!-- currently restricted to be less than +/- 24 hours delta -->
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="valueTypes">
    <xs:restriction base="xs:string">
        <xs:enumeration value="UInt"/>
        <xs:enumeration value="Int"/>
        <xs:enumeration value="UInt64"/>
        <xs:enumeration value="Int64"/>
        <xs:enumeration value="Float"/>
        <xs:enumeration value="ExtendedReal"/>
        <xs:enumeration value="Double"/>
        <xs:enumeration value="ASCIIString"/>
        <xs:enumeration value="OctetString"/>
        <xs:enumeration value="BitString"/>
        <xs:enumeration value="CDSAbsoluteTime"/>
        <xs:enumeration value="CUCAbsoluteTime"/>
        <xs:enumeration value="CCSDSA"/>
        <xs:enumeration value="CCSDSB"/>
        <xs:enumeration value="DeltaRelativeTime"/>
        <xs:enumeration value="CommandID"/>
        <xs:enumeration value="ParameterID"/>
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="valueTypeSubset">
    <xs:restriction base="valueTypes">

```

```

<xs:enumeration value="UInt"/>
<xs:enumeration value="Int"/>
<xs:enumeration value="Double"/>
<xs:enumeration value="ASCIIString"/>
<xs:enumeration value="OctetString"/>
<xs:enumeration value="CCSDSA"/>
<xs:enumeration value="CCSDSB"/>
<xs:enumeration value="DeltaRelativeTime"/>
</xs:restriction>
</xs:simpleType>
<xs:simpleType name="valueRadix">
<xs:restriction base="xs:string">
<xs:enumeration value="Decimal"/>
<xs:enumeration value="Hexadecimal"/>
<xs:enumeration value="Octal"/>
</xs:restriction>
</xs:simpleType>
<xs:simpleType name="instrumentType">
<xs:restriction base="xs:string">
<xs:enumeration value="SEPD"/>
<xs:enumeration value="SEUI"/>
<xs:enumeration value="SMAG"/>
<xs:enumeration value="SMET"/>
<xs:enumeration value="SPHI"/>
<xs:enumeration value="SRPW"/>
<xs:enumeration value="SSPI"/>
<xs:enumeration value="SSHI"/>
<xs:enumeration value="SSTX"/>
<xs:enumeration value="SSWA"/>
</xs:restriction>
</xs:simpleType>
<xs:simpleType name="planningCycleType">
<xs:restriction base="xs:string">
<xs:enumeration value="M"/>
<xs:enumeration value="S"/>
<xs:enumeration value="V"/>
</xs:restriction>
</xs:simpleType>
<xs:simpleType name="crfSequenceType">
<xs:annotation>
<xs:documentation>Type used by each mission to identify any subtypes</xs:documentation>
</xs:annotation>
<xs:restriction base="xs:string">
<xs:enumeration value="SQ"/>
</xs:restriction>
</xs:simpleType>
</xs:schema>

```

### 8.3 Notes on inconsistencies wrt MOC CRF format

As noted in the introduction, the IOR ICD is largely consistent with the MOC CRF format.

Ignoring

- Transparent removal of unneeded elements
- Restrictions on field values
- Changes of optional->mandatory

this subsection is highlighting the few deliberate differences.

These are:



- The observationID of this document is called “uniqueID” in the CRF
- There is no VSTP metadata associated to the reserved VSTP reservation sequence calls in the CRF.
- There is no <header2> in the CRF



## 9 OPEN ISSUES

### 9.1 Handling “backup” LTP plans

Sometimes the science goals of a particular RSW may depend critically on the availability of a suitable solar feature that cannot be guaranteed in advance.

The proposed approach to handle these cases is to have two plans at LTP. Firstly a prime plan based on the availability of the hoped-for feature, secondly a back-up plan that can run reliably regardless of the actual solar conditions encountered.

N.b. to prevent an explosion of permutations, only **one RSW** of a given six-month planning period would be allowed to have this dependency. The plans would be identical up to the critical RSW (and perhaps precursor), and would then diverge thereafter.

Both plans would be completed in the LTP planning, dual E-FECSs and TMCs would be delivered to the instrument teams, and dual IORs returned for the MTP planning. During the execution of the plan, it is assumed that the availability of the requisite feature can be decided by the SOOP coordinator with ~2 weeks lead time<sup>31</sup>, such that only a single chain of STP plans have to be considered.

It is assumed that planning periods having this dependency are rare, since it implies significant additional planning work by both SOC and Instrument Teams

This approach implies the ability to manage parallel prime and backup TMCs, E-FECSs and MTP IORs. The filenaming convention herein needs to be expanded to support this.

---

<sup>31</sup> This is not implying additional precursor activities. It is assumed that Earth-based assets (and perhaps Solar Orbiter low-latency data from earlier RSWs) is sufficient to decide the availability of a suitable feature.