Addendum to the NIO IRD
VGL-HO-ESA-NIO-0057

Vigil Team

ESA ESTEC

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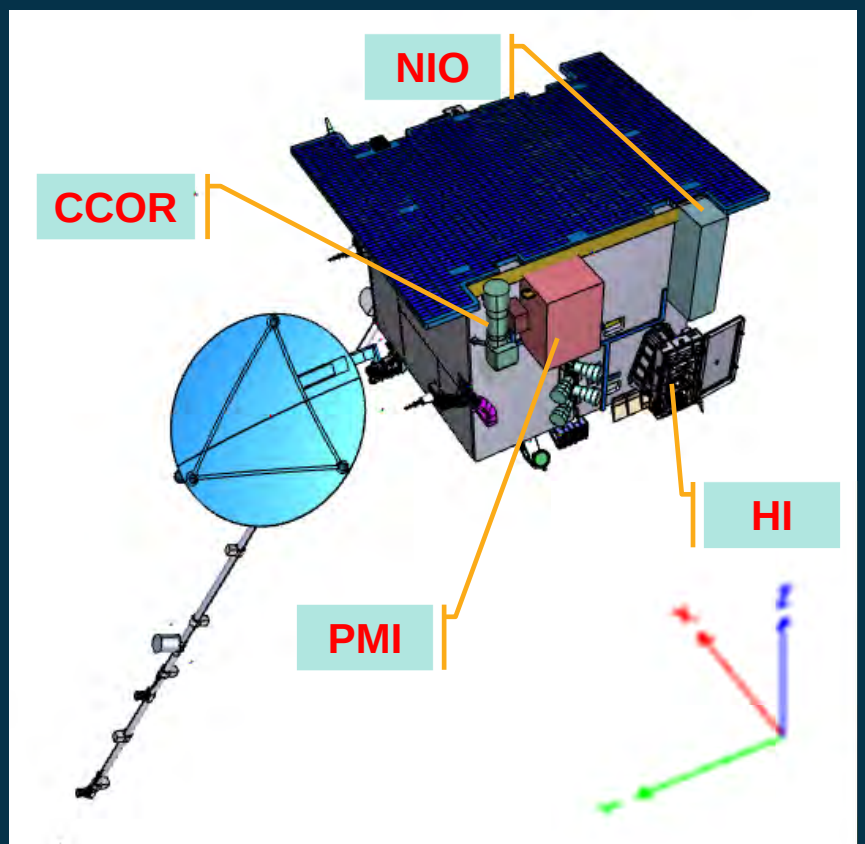
Introduction

- **The objective of this presentation is to complement the NIO Interface Requirement Document (VGL-IRD-ESA-NIO-0037 issue 1.1) with the information obtained at the end of the extension Preliminary Design definition (Phase B1) of the Vigil spacecraft.**
  - The main evolution during the Phase B1 extension has been the reduction of the number of instruments in the payload suite from 9 to 6, with the need to re-analyse the satellite configuration.
  - The reader shall be aware that some of the information reported in this presentation still refer to the old Vigil configuration.
  - A full update of the Vigil documentation will be available after the Kick-Off of the Consolidated Design definition (Phase B2), planned at the end of 2023.
- **The slides of this presentation will cover the following topics:**
  - NIO Accommodation
  - Attitude Domain and Pointing Errors
  - Mechanical Environment
  - Thermal Environment
  - Data Interface (SpaceWire, PUS-C)

NIO Accommodation

- **The NIO instrument will be accommodated on the $-X_{MRF}$ panel (also indicated as MX) of the Vigil platform close to the edge with the $+Z_{MRF}$ (PZ) and $-Y_{MRF}$ (MY) panels.**
- **Following the descoping of the LUCI and XFM instruments, placed between NIO and PMI, it could be possible to consider a different positioning of the instrument on the $-X_{MRF}$ panel.**
  - Any deviation from the baselined accommodation will have to be discussed with Airbus UK.



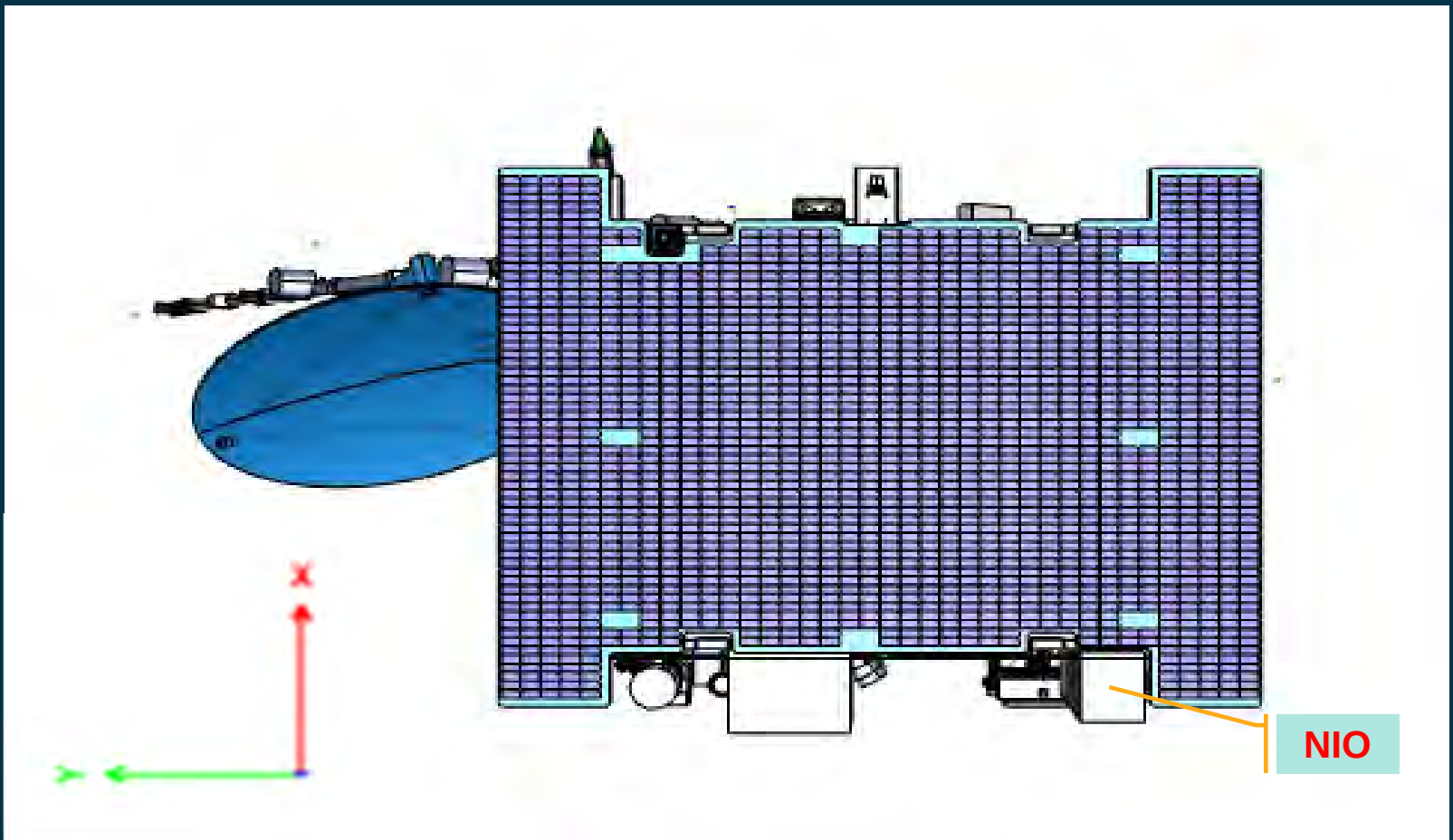
Note: in the figure

X (red) = $+X_{MRF}$

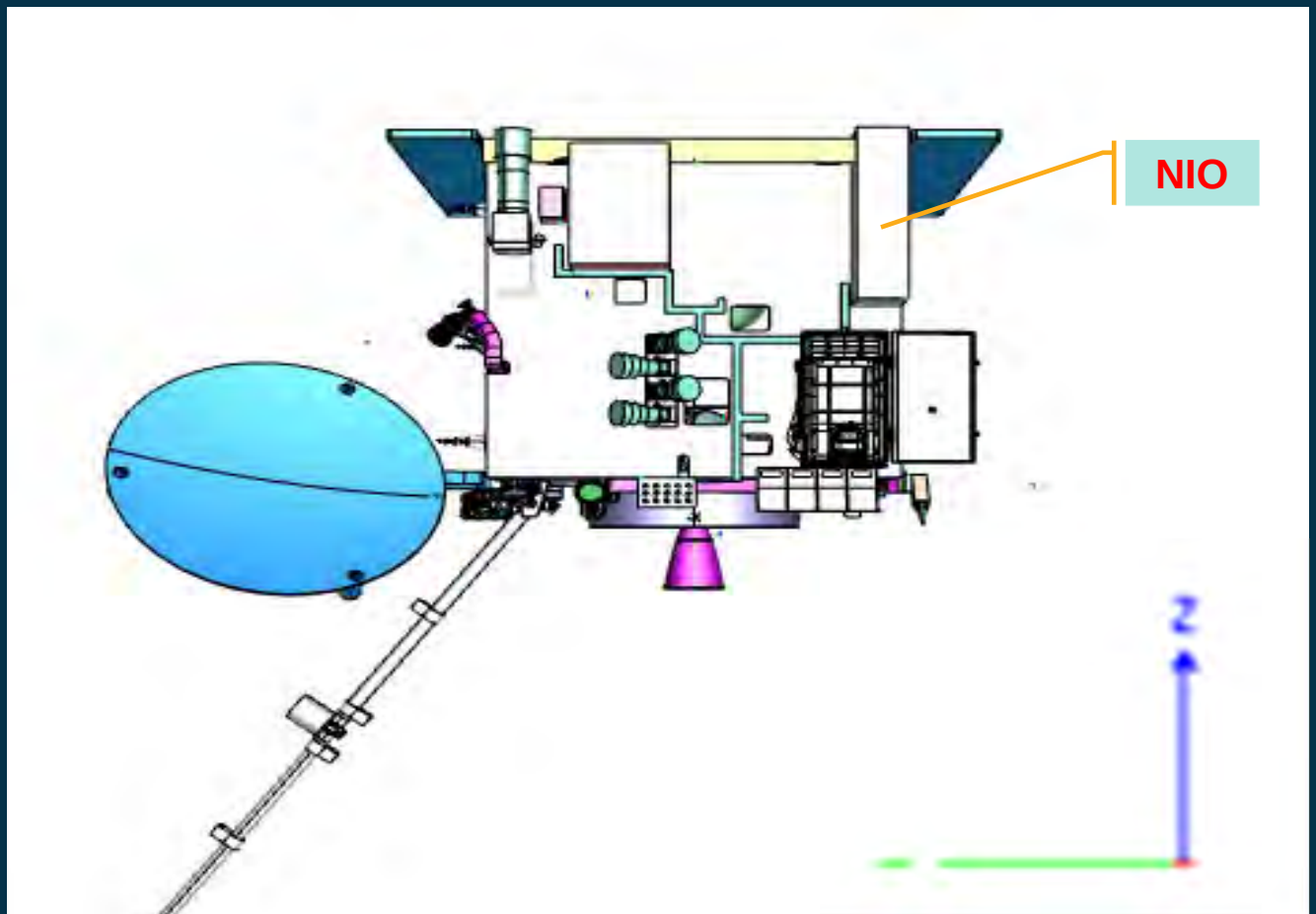
Y (green) = $+Y_{MRF}$

X (red) = $+Z_{MRF}$

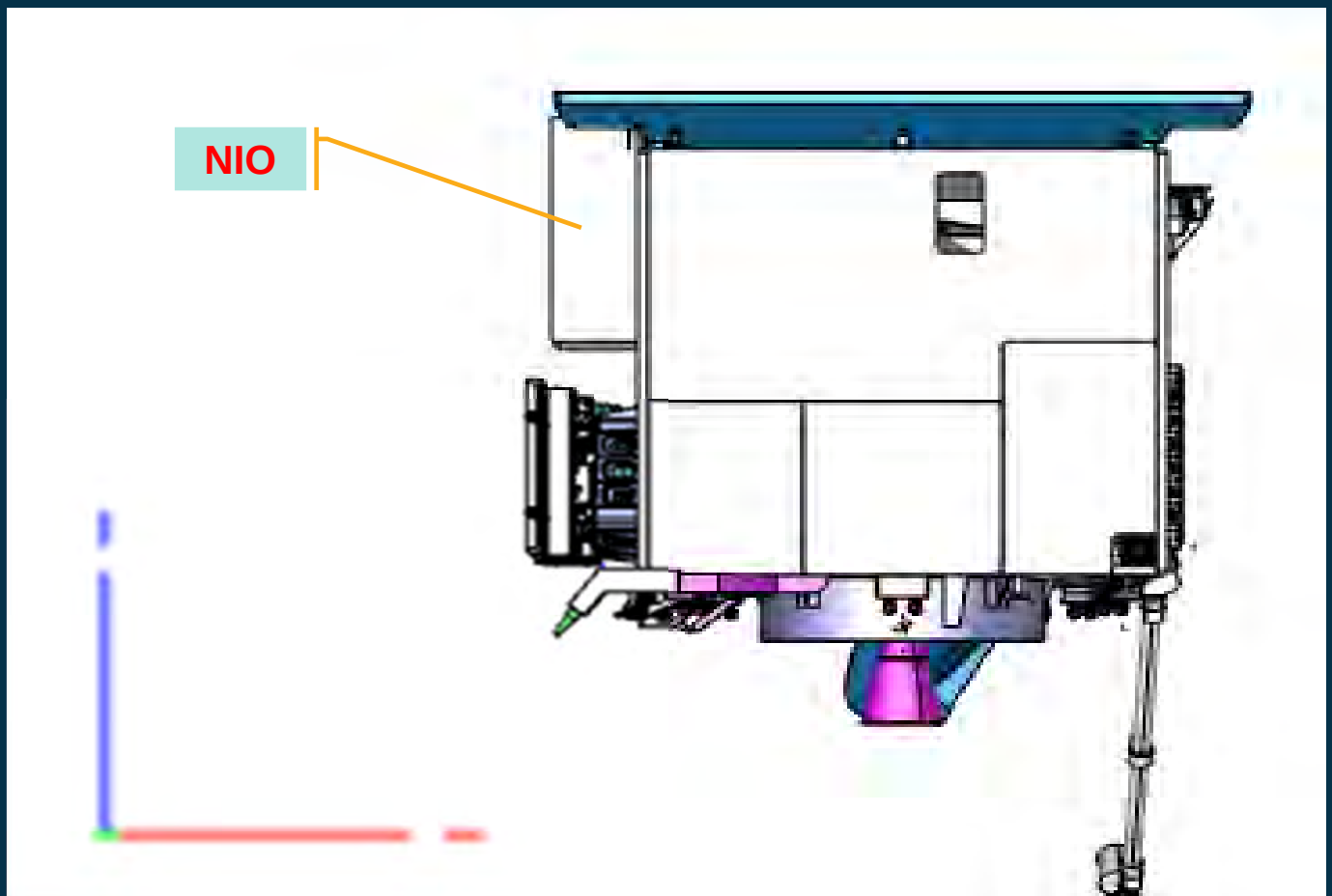
NIO Accommodation



NIO Accommodation



NIO Accommodation



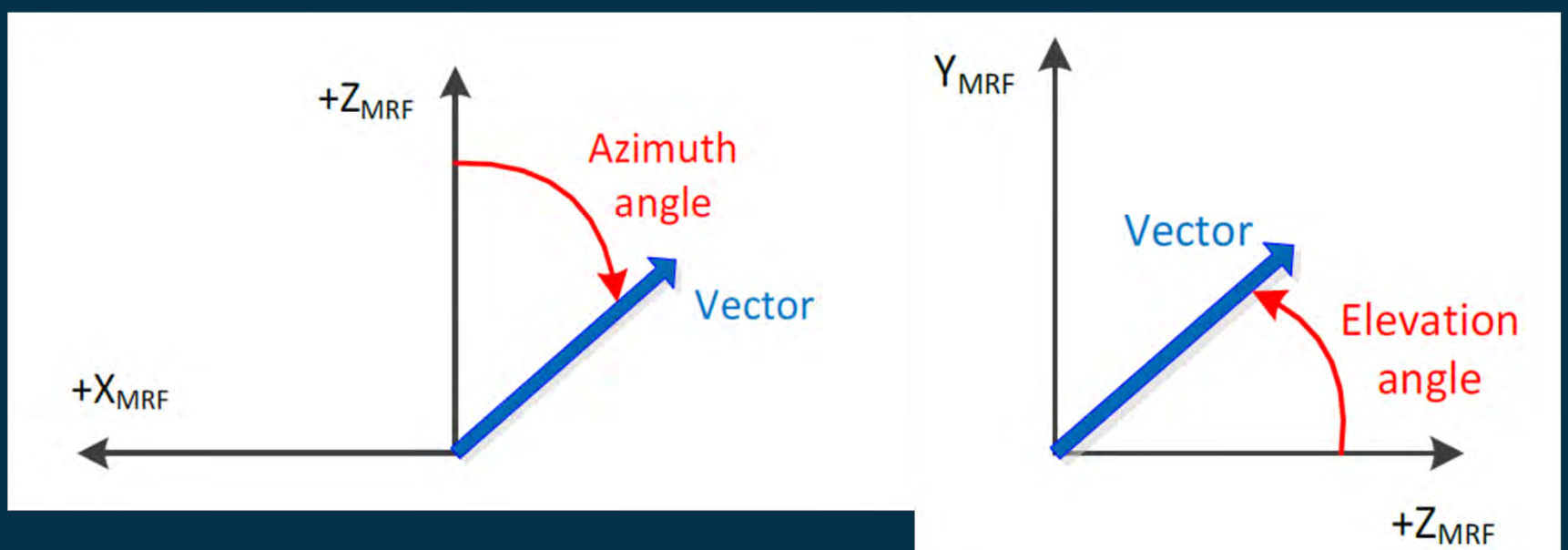
Attitude domains

- **During nominal operations the Vigil spacecraft will maintain a 3-axis stabilised attitude with the $+Z_{MRF}$ axis pointed toward the Sun.**
- **In occasion of trajectory control manoeuvres, high-gain antenna pointing slews, instrument calibrations the spacecraft attitude will deviate from the nominal attitude typically in the following range:**
  - Azimuth angle = 0°, Elevation angle = 180° to 360° where the reference vector is the Sun direction;

    See next slide for the definition of Azimuth and Elevation.
  - Additional attitude domains could be identified during the development phase when the calibration needs of all Vigil instruments will be known.
- **NIO shall be able to survive the resulting environment, without degradation of performance; during this events the instrument is expected to be non-operational.**
  - It is left to the NIO Supplier to indicate any attitude constraint or the need to achieve a specific attitude for instance for calibration purposes.

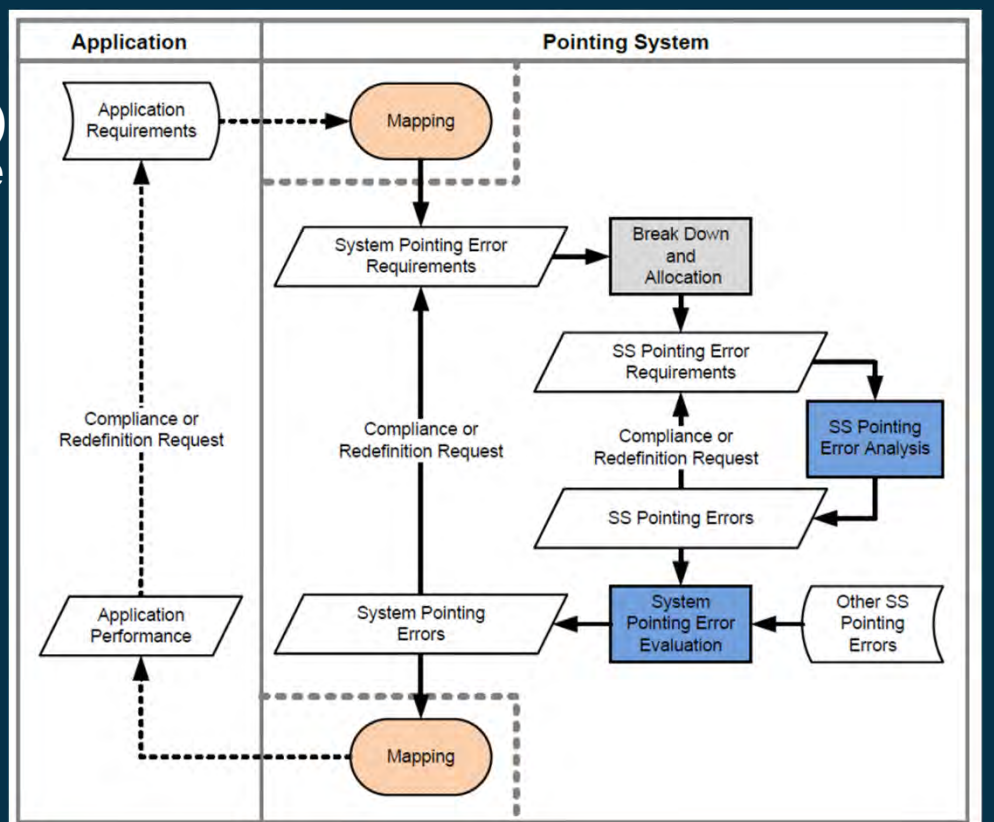
Azimuth and Elevation angles

- **Azimuth and elevation angles are used to define vectors (e.g. antennae boresights, instruments lines of sight) in the REF_{MRF}**
  - Azimuth is defined as the angle between the $+Z_{MRF}$ and the projection of the vector in the X_{MRF} - Z_{MRF} plane. It shall be measured clockwise.
  - Elevation is defined as angle between the X_{MRF} - Z_{MRF} plane and the vector. Positive angles are towards $+Y_{MRF}$



Pointing Errors

- **The NIO IRD presents in s.4.8 allocations for the platform contributions to the main pointing error metrics (APE, AKE, RPE).**
- **The allocations for the windowed metrics (e.g. PDE, KDE) remains TBD until the NIO Suppliers specifies the stability time (e.g. the time between to observations) and the averaging time (e.g. integration time for a single observation).**
  - For the definition and interpretation of the Attitude errors metrics, refer to ECSS-E-ST-60-10C.
- **The derivation of the pointing error requirements and the preparation of the pointing budgets will follow the ESA Pointing Error Engineering Methodology (ESSB-HB-E-003).**
  - ESA will organise and co-chair with NASA pointing workshops with the participation of the Airbus UK and the NIO supplier.



Mechanical Environmental Loads

- **The mechanical environment loads are the expected levels for S/C, based on analysis conducted during Phase B1.**
  - The mechanical loads will be re-assessed once the placement of all units on the S/C is more mature (during implementation phase).

- **Quasi Static Qualification Loads**

  The Instruments (all units whether mounted externally or internally) are to be designed to Quasi Static Qualification loads in accordance with the levels indicated below:

Direction (wrt. Instrument mount plane)	Level [g]
In-plane	±20
Out-of-plane	±20

- **Sine Qualification Loads**

  The loads quoted here are qualification level at the unit's CoG.:

Direction	Level [g]
X_{MRF}	20
Y_{MRF}	18
Z_{MRF}	18

Mechanical Environmental Loads (cont.)

➢ Random Qualification Loads

Axis/ Unit Mass	Frequency (Hz)	Qualification Level
Perpendicular to mounting plane (1 axis)	20 – 80	+3 dB/Oct
	80 – 200	0.5 g2/Hz
	200 – 300	0.3 g2/Hz
	300 – 2000	-8 dB/Oct
	g_{rms}	12.7
Parallel to mounting plane TBD1 axis	20 – 100	+5 dB/Oct
	100 – 500	0.15 g2/Hz
	500 – 2000	-6 dB/Oct
	g_{rms}	11.0
Parallel to mounting plane TBD2 axis	100 – 300	0.3 g2/Hz
	300 – 2000	-7 dB/Oct
	g_{rms}	11.4

➢ For information: Random Qualification Loads for separate internal electronic boxes

It is reminded that NIO shall fit in the specified envelope.

Axis/ Unit Mass	Frequency (Hz)	Qualification Level
Perpendicular to mounting plane (1 axis) Mass < 0.5Kg	20 - 100	+12 dB/Oct
	100 - 250	1.0 g^2/Hz
	250 - 500	1.5 g^2/Hz
	500 - 2000	-8 dB/Oct
	g_{rms}	30.85
Perpendicular to mounting plane (1 axis) Mass < 0.5Kg	20 - 100	+12 dB/Oct
	100 - 300	1.5 g^2/Hz
	300 - 2000	-8 dB/Oct
	g_{rms}	24.3
Perpendicular to mounting plane (1 axis) Mass < 0.5Kg	20 - 80	+ 3dB/Oc
	80 -400	0.5 g^2/Hz
	00 - 2000	-6 dB/Oct
	g_{rms}	18.4
Perpendicular to mounting plane (1 axis) Mass < 0.5Kg	20 - 80	+3 dB/Oct
	80 - 200	0.5 g^2/Hz
	200 - 400	0.3 g^2/Hz
	400 - 2000	-6 dB/Oct
	g_{rms}	15.4
Parallel to mounting plane (2 axis) Any mass	20 – 80	+ 4dB/Oct
	80 – 11000	0.1 g^2/Hz
	1000 – 2000	-3 dB/Oct
	g_{rms}	12.8

Mechanical Environmental Loads (cont.)

- **Acoustic Qualification Loads**
  - The acoustic noise environment is derived from the baseline solution for a launch in with Ariane 6.2.
  - The acoustic levels are applicable to units mounted externally.
  - The same levels apply to the instrument harness (including cables, connector's, back shells, EMC caps, arming/bridging connectors, overall shields, fixation material and any complete MIL-Bus).

Frequency [Hz]	Flight limit level [dB]	Qualification level [dB]
31.5	128	131
63	131	134
125	136	139
250	133	136
500	129	132
1000	123	126
2000	116	119
OASPL	139.5	142.5

Mechanical Environmental Loads (cont.)

- **Shock Qualification Loads**
  - The induced shock environment requirements applicable to NIO are induced by clamp-band separation, boom deployment and HGA reflector deployment.
  - Shock levels shall be applied in all axes.

Frequency [Hz]	Clamp-band Separation [dB]	Boom HDRM [dB]	HGA HDRM [dB]
100	10	10	10
1000	700	700	900
100000	500	700	900

  - Internally mounted Electronic units shall be designed to withstand without degradation the shock loads.

Frequency [Hz]	Clamp-band Separation [dB]
100	20
1000	1000
100000	900

Mechanical Environmental Loads (cont.)

- **Harness Hoisting, Handling & Transportation Limit Loads (Static Accelerations)**
  - Axial and lateral loads shall be considered as acting simultaneously (un-attenuated input to MGSE).

Case	Axial (X_{MRF}) [g]	Lat. (Z_{MRF} or Y_{MRF}) [g]	Lat. (Y_{MRF} or Z_{MRF}) [g]
Hoisting	-2.0/0.0	±0.5	±0.5
On integration fixture	±2.0	±1.5	±1.5
General Transportation	±2.0	-3.0/+2.0	±1.25

- **Harness Transportation Limit Shock Loads**
  - The harness shall withstand without irreversible degradation the limit shock loads.

Direction	Amplitude [g]	Pulse Shape	Half Period [msec]	Nr. of Pulses
$\pm X_{MRF}$	±4.0	Saw Tooth	20	1
$\pm Y_{MRF}$	±4.0	Saw Tooth	20	1
$\pm Z_{MRF}$	±4.0	Saw Tooth	20	1

- **Quasi static and low frequency loads**

Frequency [Hz]	Level [g]
1	50
20	25
100	25

Thermal Environment Cases

➢ **The following cases have been assumed by Airbus UK for their thermal environment analysis.**

Case 1a: 0.98 AU Deployed	
Sun Separation	0.98 AU
SC Orientation	PZ Sun pointing
Applicability	Min range to Sun during instrument operation
Case Type	Steady state

Case 2: 1.09 AU	
Sun Separation	1.09 AU
SC Orientation	PZ Sun pointing
Applicability	Max range to Sun during instrument operation
Case Type	Steady state

Case 3: 1.23AU	
Sun Separation	1.23 AU
SC Orientation	PZ Sun pointing
Applicability	Max range to Sun during instrument non-operation
Case Type	Steady state

Case 1b: 0.98 AU Manoeuvre	
Sun Separation	0.98 AU
SC Orientation	MY Sun pointing
Applicability	Min range to Sun during SC maneuvers
Case Type	Steady state
Additional information	Instruments will need to survive this environment, without degradation of performance, and are expected to be non-operational Any constraints for Sun illumination in the following range shall be raised to Prime: - Azimuth angle = 0° - Elevation angle = 180° to 360°

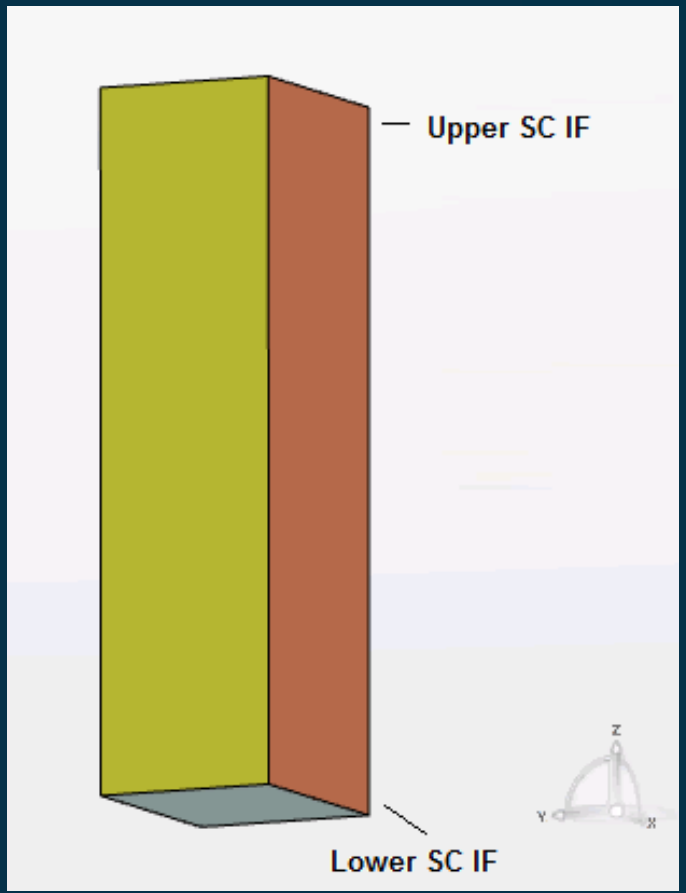
The following parameters may be used to derive further analysis cases such as LEOP

- Solar Constant @1AU: 1361 W/m2
- Uncertainty (measurement + solar cycle variability): 1.5 W/m2
- Earth Albedo: 0.3
- Earth Infrared: Black body at 288K

NIO sink temperatures

Sink Temperature [°C]	Case 1a (0.98AU)	Case 1b (0.98AU)	Case 2 (1.09AU)	Case 3 (1.23AU)
MX	-177.7	-219.6	-202.1	-206.9
PY	-41.3	-117.1	-71.4	-85.7
MY	-71.5	-112.2	-101.2	-111.7
PZ	-228	-240.1	-249.9	-251.9
MZ	4.9	-23.0	-28.6	-43.7

- **The platform MLI forms the radiative interface with the underside of the instruments.**
- **To best represent the interface to the platform it is recommend to couple a geometry node to a mathematical node representing the conductive interface as described below:**
  - GL = 0.019 W/m2K
  - GR = 0.014 m2/m2



NIO CAD model

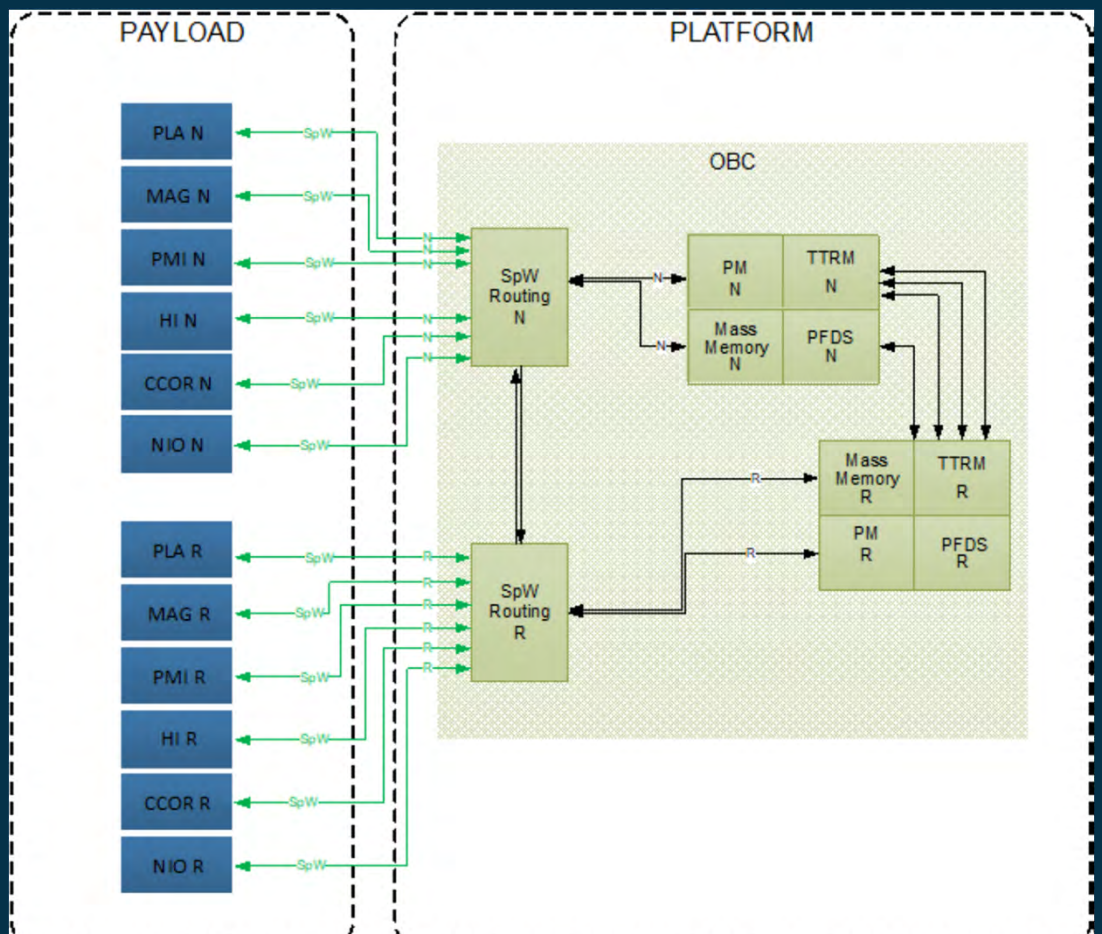
SpaceWire

- **The bus interface of the instrument shall be based on the ECSS SpaceWire standards implemented according to SpaceWire Requirements Specification established by Airbus UK.**
  - Until the Airbus UK specification can be made available, the NIO Supplier is asked to provide a general statement of conformance to the SpaceWire as described by the ECSS (ECSS-E-ST-50-12C Rev.1, ECSS-E-ST-50-51C, ECSS-E-ST-50-53C).

- **The SpaceWire transactions can be partitioned into following components:**
  - SpaceWire links connecting the Instruments to their Control Units (ICU/DPU/CDPU);
  - SpaceWire links connecting the Control Units (ICU/DPU/CDPU) to the OBC;
  - SpaceWire links connecting the Instruments directly to the OBC.
- **All SpaceWire links transfer Telecommands, Telemetry and Operational Telemetry.**

Vigil SpaceWire Network topology

- **Vigil Payload Instruments are connected by SpaceWire interfaces to the OBC either directly or through their Control Units (ICU/DPU/CDPU).**
  - The TM/TC packet routing and multiplexing is centralised within the OBC.
  - An adequate SpaceWire packet acquisition scheme is implemented within the OBC between different types of Payload TM to allow the correct TM processing and avoid long interruptions of on-going TM packet transfers.
  - This approach will give full flexibility to the Payload and allows TM packet transfer to the OBC without any higher level handshake protocol.



PUS-C

- **The instrument Central Data Processing Unit (CDPU) shall use the PUS-C standard for communication, data transfer and interfacing to the Spacecraft according to the Interface Requirements established by Airbus UK.**
  - Until the Airbus UK specification can be made available, the NIO Supplier is asked to provide a general statement of conformance to the PUS-C as described by the ECSS (ECSS-E-ST-70-41C).

- **The PUC-C Interface Requirements are detailed in the following volumes:**
  - Vol.A - Generic Services: sets the common standard for the Core Data Handling System (CDHS) for various Missions/Projects.
  - Vol.B1 - Platform Configuration Tables: it is available as a generic product document, applicable for the equipment which are part of the product.
  - Vol.B2 – Mission Configuration Tables: it is available as a project specific document, applicable for the equipment & instrument which are part of the mission.

PUS-C services applicability

- **The following slides present a summary of the PUS-C services marked as applicable to the Instrument PUS terminals.**
  - The respective service configuration is specified in the documentation established by Airbus UK.
- **The following convention is applied:**
  - M indicates it is a mandatory service/subservice;
  - O indicated it is an optional service/subservice;
  - Blanks indicate that the service/subservice is not required for the instruments;
  - NA indicated the service/subservice is not used by the Vigil mission.
- **In case that a PUS terminal does not provide subservices marked as “mandatory” here, but does provide the requested functionality (for example as private services), a respective waiver shall be raised.**
- **The applicability marks in the tables below are to be read as “mandatory”, i.e. if a terminal provides more subservices than required, it can still state “compliant”.**

Service 1: Request Verification Service

Message Type		Description	Instruments PUS terminals
TM	[1,1]	successful acceptance verification report	M
TM	[1,2]	failed acceptance verification report	M
TM	[1,3]	successful start of execution verification report	M
TM	[1,4]	failed start of execution verification report	M
TM	[1,7]	successful completion of execution verification report	M
TM	[1,8]	failed completion of execution verification report	M
TM	[1,10]	failed routing verification report	

Service 2: Device Access Service

Message Type		Description	Instruments PUS terminals
TC	[2,4]	Distribute CPDU commands	
TC	[2,128]	Distribute MIL-1553 Low-Level Command	
TM	[2,129]	MIL-1553 Low-Level Command Response	
TC	[2,130]	Send SpaceWire raw packet	O
TM	[2,133]	SpW-1355 Low-Level Command Reply	
TC	[2,138]	Distribute SpaceWire RMAP command	NA
TM	[2,139]	SpaceWire RMAP command reply	NA

Service 3: HK and Diagnostic Data Reporting Service

Message Type		Description	Instrument PUS terminals
TC	[3,1]	Create a housekeeping parameter report structure	M
TC	[3,2]	Create a diagnostic parameter report structure	M
TC	[3,3]	Delete housekeeping parameter report structures	M
TC	[3,4]	Delete diagnostic parameter report structures	M
TC	[3,5]	Enable the periodic generation of housekeeping parameter reports	M
TC	[3,6]	Disable the periodic generation of housekeeping parameter reports	M
TC	[3,7]	Enable the periodic generation of diagnostic parameter reports	M
TC	[3,8]	Disable the periodic generation of diagnostic parameter reports	M
TC	[3,9]	Report housekeeping parameter report structures	M
TM	[3,10]	Housekeeping parameter report structure report	M
TC	[3,11]	Report diagnostic parameter report structures	M
TM	[3,12]	Diagnostic parameter report structure report	M
TM	[3,25]	Housekeeping parameter report	M
TM	[3,26]	Diagnostic parameter report	M
TC	[3,27]	Generate a one shot report for housekeeping parameter report structures	M
TC	[3,28]	Generate a one shot report for diagnostic parameter report structures	M
TC	[3,29]	Append parameters to a housekeeping parameter report structure	M
TC	[3,30]	Append parameters to a diagnostic parameter report structure	M
TC	[3,31]	Modify the collection interval of housekeeping parameter report structures	M
TC	[3,32]	Modify the collection interval of diagnostic parameter report structures	M
TC	[3,33]	Report the periodic generation properties of housekeeping parameter report structures	M
TC	[3,34]	Report the periodic generation properties of diagnostic parameter report structures	M
TM	[3,35]	housekeeping parameter report periodic generation properties report	M
TM	[3,36]	diagnostic parameter report periodic generation properties report	M
TC	[3,37]	Apply parameter functional reporting configurations	O
TC	[3,38]	Create a parameter functional reporting definition	O
TC	[3,39]	Delete parameter functional reporting definitions	O

Service 5: Event Reporting Service

Message Type		Description	Instrument PUS terminals
TM	[5,1]	informative event report	M
TM	[5,2]	low severity anomaly report	M
TM	[5,3]	medium severity anomaly report	M
TM	[5,4]	high severity event report	M
TC	[5,5]	enable the report generation of event definitions	M
TC	[5,6]	disable the report generation of event definitions	M
TC	[5,7]	report the list of disabled event definitions	M
TM	[5,8]	disabled event definitions list report	M
TC	[5,128]	trigger event report packet generation	M
TC	[5,131]	Report the generation status of events definition	NA
TM	[5,132]	Generation status of event definition report	NA

Service 6: Memory Management Service

Message Type		Description	Instrument PUS terminals
TC	[6,2]	Load raw memory data areas	M
TC	[6,5]	Dump raw memory data	M
TM	[6,6]	Dumped raw memory data report	M
TC	[6,9]	Check raw memory data	M
TM	[6,10]	Checked raw memory data report	M
TC	[6,11]	Load a raw memory atomic data area in a non-interruptible transaction	O
TC	[6,12]	Abort all memory dumps	O
TC	[6,13]	Enable the scrubbing of a memory	M
TC	[6,14]	Disable the scrubbing of a memory	M
TC	[6,15]	Enable the write protection of a memory	M
TC	[6,16]	Disable the write protection of a memory	M
TC	[6,19]	Load raw memory data areas by reference	O
TC	[6,20]	Dump raw memory data areas to file	O
TC	[6,128]	Copy raw memory data area	NA
TC	[6,160]	Add patches to a memory patches list	M
TC	[6,161]	Apply the patches defined in the memory patch list	M
TC	[6,162]	Clear the memory patches list	M
TC	[6,163]	Report the memory patches list	M
TM	[6,164]	Memory patches list report	M

Service 9: Time Management Service

Message Type		Description	Instrument PUS terminals
TC	[9,1]	Set the time report generation rate	
TM	[9,2]	Time report	
TC	[9,130]	Start time distribution	
TC	[9,131]	Stop time distribution	
TC	[9,129]	Change Spacecraft Elapsed Time using offset	O
TC	[9,132]	Accept Time Update	M
TC	[9,133]	Enable Time Synchronisation	
TC	[9,134]	Disable Time Synchronisation	
TC	[9,135]	Trigger Time Synchronisation Verification	M
TC	[9,150]	Set time synchronisation state	M

Service 12: On-Board Monitoring Service

Message Type		Description	Instrument PUS terminals
TC	[12,1]	Enable parameter monitoring definitions	O
TC	[12,2]	Disable parameter monitoring definitions	O
TC	[12,3]	Change the maximum transition reporting delay	O
TC	[12,4]	Delete all parameter monitoring definitions	O
TC	[12,5]	Add parameter monitoring definitions	O
TC	[12,6]	Delete parameter monitoring definitions	O
TC	[12,7]	Modify parameter monitoring definitions	O
TC	[12,8]	Report parameter monitoring definitions	O
TM	[12,9]	Parameter monitoring definition report	O
TC	[12,10]	Report the out-of-limits	O
TM	[12,11]	Out-of-limits report	O
TM	[12,12]	Check transition report	O
TC	[12,13]	Report the status of each parameter monitoring definition	O
TM	[12,14]	Parameter monitoring definition status report	O
TC	[12,15]	Enable the parameter monitoring function	O
TC	[12,16]	Disable the parameter monitoring function	O
TC	[12,17]	Enable the functional monitoring function	O
TC	[12,18]	Disable the functional monitoring function	O
TC	[12,19]	Enable functional monitoring definitions	O
TC	[12,20]	Disable functional monitoring definitions	O
TC	[12,21]	Protect functional monitoring definitions	O
TC	[12,22]	Unprotect functional monitoring definitions	O
TC	[12,23]	Add functional monitoring definitions	O
TC	[12,24]	Delete functional monitoring definitions	O
TC	[12,25]	Report functional monitoring definitions	O
TM	[12,26]	Functional monitoring definition report	O
TC	[12,27]	Report the status of each functional monitoring definition	O
TM	[12,28]	Functional monitoring definition status report	O
TC	[12,128]	Change the maximum number of transitions for issuing report	O
TC	[12,131]	Modify the repetition number of parameter monitoring definitions	O
TC	[12,132]	Modify the check criteria of parameter monitoring definitions	O
TC	[12,144]	Report Check Transition Report Settings	O
TM	[12,145]	Check Transition Report Settings Report	O
TC	[12,146]	Modify out-of-limits report automatic generation status	O
TC	[12,160]	Reset Functional Monitoring	O

Service 17: Test Service

Message Type		Description	Instrument PUS Terminals
TC	[17,1]	Perform an are-you-alive connection test	M
TM	[17,2]	Are-you-alive test report	M
TC	[17,3]	Perform an on-board connection test	
TM	[17,4]	On-board connection test report	
TC	[17,128]	Perform an Are-you-alive test with pattern	O
TM	[17,129]	Are-you-alive test with pattern report	O

Service 18: On-board Control Procedures

Message Type		Description	Instrument PUS terminals
TC	[18,1]	Direct-load an OBCP	O
TC	[18,2]	Unload an OBCP	O
TC	[18,3]	Activate an OBCP	O
TC	[18,4]	Stop an OBCP	O
TC	[18,5]	Suspend an OBCP	NA
TC	[18,6]	Resume an OBCP	NA
TC	[18,7]	Communicate parameters to an OBCP	O
TC	[18,8]	Report the execution status of each OBCP	O
TM	[18,9]	OBCP execution status report	O
TC	[18,12]	Abort an OBCP	O
TC	[18,13]	Load an OBCP by reference	NA
TC	[18,14]	Activate and execute one OBCP step	NA
TC	[18,15]	Resume and execute one OBCP step	NA
TC	[18,16]	Set the observability level of OBCPs	O
TC	[18,17]	Abort all OBCPs and report	O
TM	[18,18]	Aborted OBCP report	O
TC	[18,19]	Load by reference and activate an OBCP	O
TC	[18,20]	Stop and unload an OBCP	O
TC	[18,140]	Load and activate an OBCP	O
TC	[18,142]	Set OBCP HK TM	O
TC	[18,143]	Send OBCP telemetry	O
TM	[18,144]	OBCP telemetry	O
TC	[18,145]	Report Emergency OBCP queue	O
TM	[18,146]	Emergency OBCP queue report	O
TC	[18,147]	Stop all nominal OBCP	O
TC	[18,148]	Suspend all nominal OBCP	O
TC	[18,21]	Start the OBCP engine	O
TC	[18,22]	Stop the OBCP engine	O

Service 19: Event-Action Service

Message Type		Description	Instrument PUS terminals
TC	[19,1]	Add event-action definitions	M
TC	[19,2]	Delete event-action definitions	M
TC	[19,3]	Delete all event-action definitions	M
TC	[19,4]	Enable event-action definitions	M
TC	[19,5]	Disable event=action definitions	M
TC	[19,6]	Report the status of each event=action definition	M
TM	[19,7]	Event-action status report	M
TC	[19,8]	Enable the event-action function	M
TC	[19,9]	Disable the event-action function	M
TC	[19,10]	Report event action definitions	M
TM	[19,11]	Event action definition report	M

Service 20: Parameter Management

Message Type		Description	Instrument PUS terminals
TC	[20,1]	Report parameter values	M
TM	[20,2]	Parameter value report	M
TC	[20,3]	Set parameter values	M
TC	[20,4]	Change raw memory parameter definitions	M
TC	[20,6]	Report parameter definitions	M
TM	[20,7]	Parameter definition report	M

Service 130: Parameter Extraction Service

Message Type		Description	Instrument PUS terminals
TC	[130,7]	Define Parameter extraction definitions	O
TC	[130,8]	Delete Parameter extraction definitions	O
TC	[130,9]	Report Parameter extraction definitions	O
TM	[130,12]	TM extraction definitions report	O
TC	[130,14]	Clear Parameter extraction definitions	O

Service 148: On Board Macro Procedures Service

Message Type		Description	Instrument PUS terminals
TC	[148,2]	Delete On-Board Macro Procedure	O
TC	[148,3]	Start On-Board Macro Procedure	O
TC	[148,133]	Start On-Board Macro Procedure with interlock	O
TC	[148,4]	Stop On-Board Macro Procedure	O
TC	[148,8]	Report On-Board Macro Procedure summary definitions	O
TM	[148,9]	On-Board Macro Procedure definitions summary report	O
TC	[148,10]	Report list of active On-Board Macro Procedure	O
TM	[148,11]	Active On-Board Macro Procedure list report	O
TC	[148,128]	Add or replace Step in OBMP	O
TC	[148,129]	Delete step from OBMP	O
TC	[148,130]	Report On-Board Macro Procedure detailed definition	O
TM	[148,131]	On-Board Macro Procedure detailed definition report	O
TC	[148,132]	Set OBMP editable status	O
TC	[148,152]	Report OBMP definition checksum	O
TM	[148,153]	OBMP definition checksum report	O
TC	[148,140]	OBMP Logical Decision Directive	O
TC	[148,141]	OBMP Jump Directive	O
TC	[148,142]	OBMP Send Event Directive	O

PUS-C Services not required

PUS Service	Remark
Service 8: Function Management Service	Not required for Vigil
Service 11: Time-based Scheduling Service	Not required to the Instrument PUS terminals
Service 13: Large Packet Transfer	Not required for Vigil
Service 14: Real-time Forwarding Control Service	Not required to the Instrument PUS terminals
Service 15: On-board Storage and Retrieval Service	Not required for Vigil
Service 21: Request Sequencing Service	Not required for Vigil
Service 21b: Request Sequencing File Based Service	Not required to the Instrument PUS terminals.
Service 22: Position-based Scheduling Service	Not required for Vigil
Service 23: File Management Service	Not required to the Instrument PUS terminals
Service 129: Critical Event Log Service	Not required to the Instrument PUS terminals
Service 132: File-based Operations Service	Not required to the Instrument PUS terminals
Service 140: On-board TM/TC Monitoring Service	Not required to the Instrument PUS terminals
Service 145: Spacecraft Information Distribution Service	Not required to the Instrument PUS terminals
Service 170: Thermal Control Service	Not required to the Instrument PUS terminals