DEIMOS 2 Ground Segment

D2 GS

Operations Concept

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2.B	Updated from CDR actions: • CDRV1-DE2GS-RID-10209: To update the document (section 3.1.10). • CDRV1-DE2GS-RID-10211-To update the document (section 4.2). • CDRV1-DE2GS-RID-10222-Add IEC (Injection Error Correction) scenario (section 3.1.3.) • CDRV1-DE2GS-RID-30002: Figure 1 updated. • CDRV1-DE2GS-RID-30005: Clarification added in table 5. • CDRV1-DE2GS-RID-30006: Table 5 corrected. • CDRV1-DE2GS-RID-30008: Example added in 3.1.6. • CDRV1-DE2GS-RID-30010: All tables reviewed. • CDRV1-DE2GS-RID-30045: Clarification added in table 8. • CDRV1-DE2GS-RID-30096: Clarification added in table 8. • CDRV1-DE2GS-RID-30097: Table 14 updated.	05/12/2012	See cover page

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1. INTRODUCTION

This document contains the Deimos-2 Ground Segment high level description of the main processes to be executed.

1.1. Purpose

This document provides an overview on how the D2 GS works and is operated. It complements the GS high level architecture description included in the main GS architecture document [AD 3].

Details on the GS elements individual processes can be found in the corresponding ADDs.

The intended readerships for this document are the GS elements designers and developers that shall understand the context on which the elements shall work and any other person intending to understand how the D2 GS is conceived at its highest level. This document can be used as a starting point to define the final D2 GS operational procedures.

1.2. Scope

This document includes the following sections:

- Nominal Operations. This section describes the main nominal operation flows within the D2 GS.
- Contingency Operations. This section describes the D2 GS high level operation activities for possible system failures or unavailabilities affecting the GS mission critical functionalities.
- Detailed operations shall be documented on the Operational Procedures documents.

1.3. Acronyms and Abbreviations

See reference document [RD 1].

1.4. Definitions

See reference document [RD 1].

2. RELATED DOCUMENTS

2.1. Applicable Documents

The following table specifies the applicable documents that shall be complied with during project development.

Table 1: Applicable documents

Reference	Code	Title	Issue
[AD 1]	DQS	Deimos Quality System	
[AD 2]	D2-DMS-TEC-SRD01	D2 GS - Ground Segment Technical Specification	2.B
[AD 3]	D2-DMS-TEC-ADD01	D2 GS – Architectural Design Document	2.B
[AD 4]	D2GS-DCM-TEC-URD0001	DE-2 GS Ground Segment User Requirements Document	2.F

2.2. Reference Documents

The following table specifies the reference documents that shall be taken into account during project development.

Table 2: Reference documents

Reference	Code	Title	Issue
[RD 1]	D2-DMS-TEC-STA01	Acronyms and Definitions List	1.E

2.3. Standards

The following table specifies the standards that shall be complied with during project development.

Table 3: Standards

Reference	Code	Title	Issue
[STD 1]	ECSS-E-ST-40C	Space Engineering Software	6 March 2009

3. NOMINAL OPERATIONS

The following figure represents the high level D2 GS operations and their main dependencies.

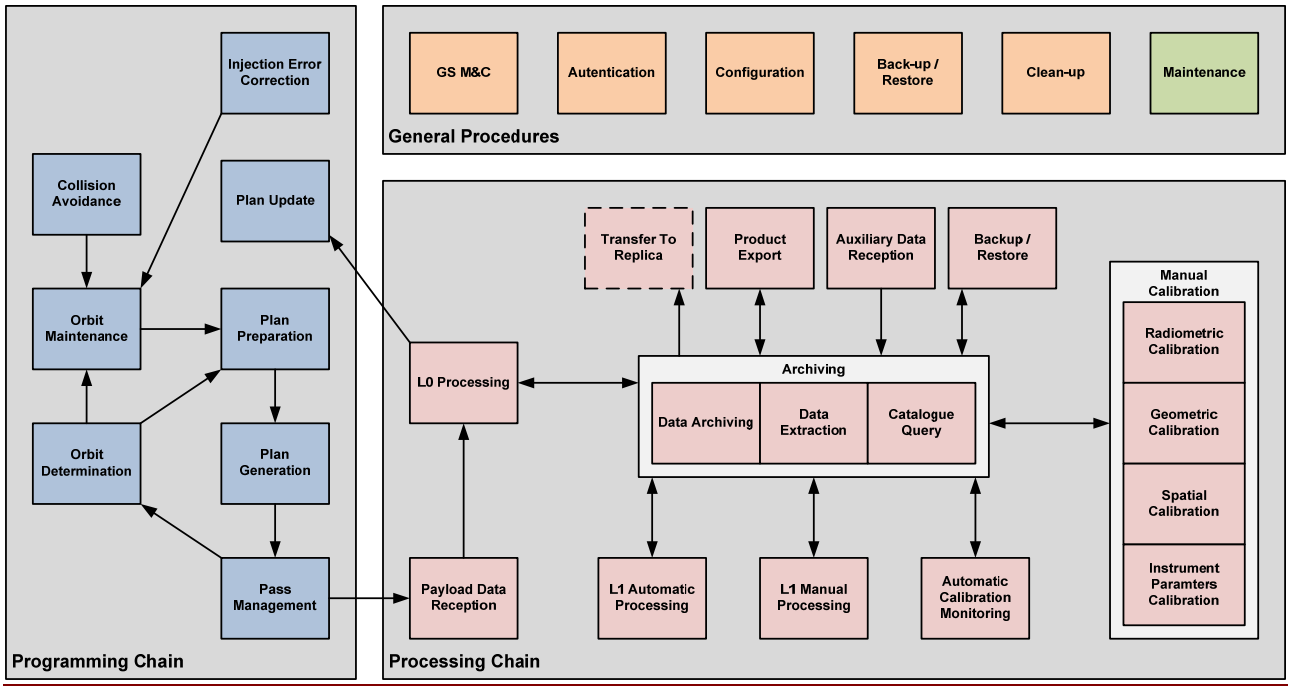

Figure 1: Nominal GS Operations

The operations are divided in three main groups:

1. **Programming Chain**: It contains all the tasks needed to generate and uplink the S/C payload/platform and G/S operations planning.
2. **Processing Chain**: It contains all the tasks needed to ingest, to process, and to archive the payload data downlinked from the S/C up to the required processing level.
3. **General Procedures**: It contains nominal management operations that shall be performed by all the D2 GS elements.

As an overview of the D2 GS nominal operation, the next figure illustrates the basic operations flow for the GS routine operation.

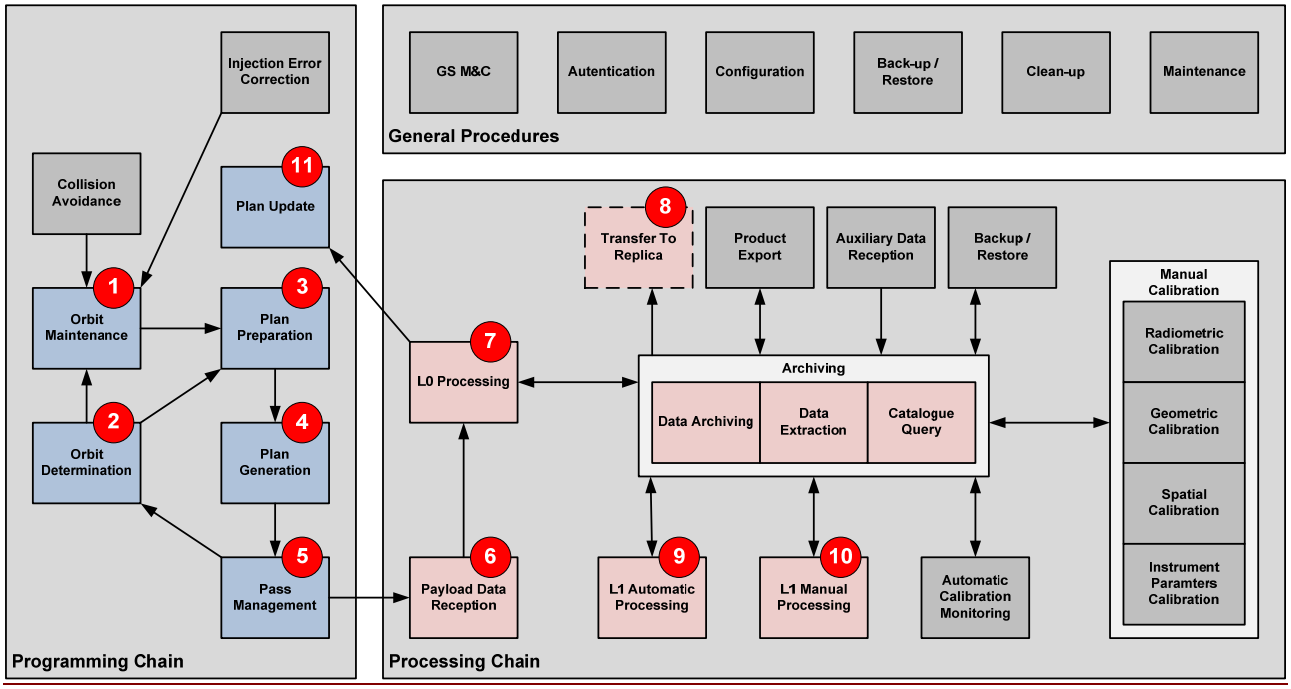

Figure 2: GS Routine Operations

The basic D2 GS routine operations include the following processes involving the programming and processing chains:

1. **Orbit Maintenance**. The FDS generates the plan for the next S/C manoeuvres using the latest orbit data and send it to the MPS.
2. **Orbit Determination**. The FDS generates an update of the D2 orbit parameters from the received external orbital data (External TLEs) and the latest TM from the MCS (GPS Log) and distributes the resulting orbit information to other GS elements.
3. **Plan Preparation**. At the MCS the mission plan containing the payload operations, manoeuvres and G/S schedules is prepared from the inputs introduced by the brokers, the orbit and manoeuvres received from the FDS and the latest cloud coverage information.
4. **Plan Generation**. Periodically the MPS operator checks the overall mission plan and decides to generate the corresponding plan files for the MCS (Payload and FCS Scenarios) and the G/S (Pass Schedules).
5. **Pass Management**. The MCS in coordination with the G/S and based on the received plans from the MPS manages the S/C over the G/S including the G/S configuration and TM/TC data flows. The orbit information (GPS Log) from the TM is extracted by the MCS and sent to the FDS.
6. **Payload Data Reception**. The PDGS checks that new payload data is received at the G/S and retrieves it.
7. **L0 Processing**. The received payload data is processed into L0 products and the corresponding reports are generated, including an acquisition report that is sent to the MPS. The generated L0 products are ingested in the MAC ARC.
8. **Transfer to Replica**. When the L0 products are archived they are also distributed to the GS replica with the corresponding ADFs. (In case that the GS is configured with a replica configuration).
9. **L1 Automatic Processing**. After the generation of a L0 product the L1 automatic processing chain is triggered and the corresponding L1 products generated and archived.

10. **L1 Manual Processing**. After the last automatic L1 product step is performed the operators perform a manual orthorectification process and the generated products are archived.
11. **Plan Update**. The events status in the MPS mission plan are updated with the information received from the PDGS on the Acquisition Report. (Note that this process does not have to wait for the L1 processing operations).

3.1. Programming Chain Operations

3.1.1. Orbit Determination

3.1.1.1. Purpose

This sequence describes the tasks performed by the FOS while executing the Orbit Determination task. This is a routine task that is completely automatic.

3.1.1.2. Relation to other sequences

This sequence interacts with:

- Pass Management. This sequence is processing the telemetry data and extracting the GPS information needed for the Orbit Determination process.

3.1.1.3. Steps

The following diagram depicts the main sequence steps:

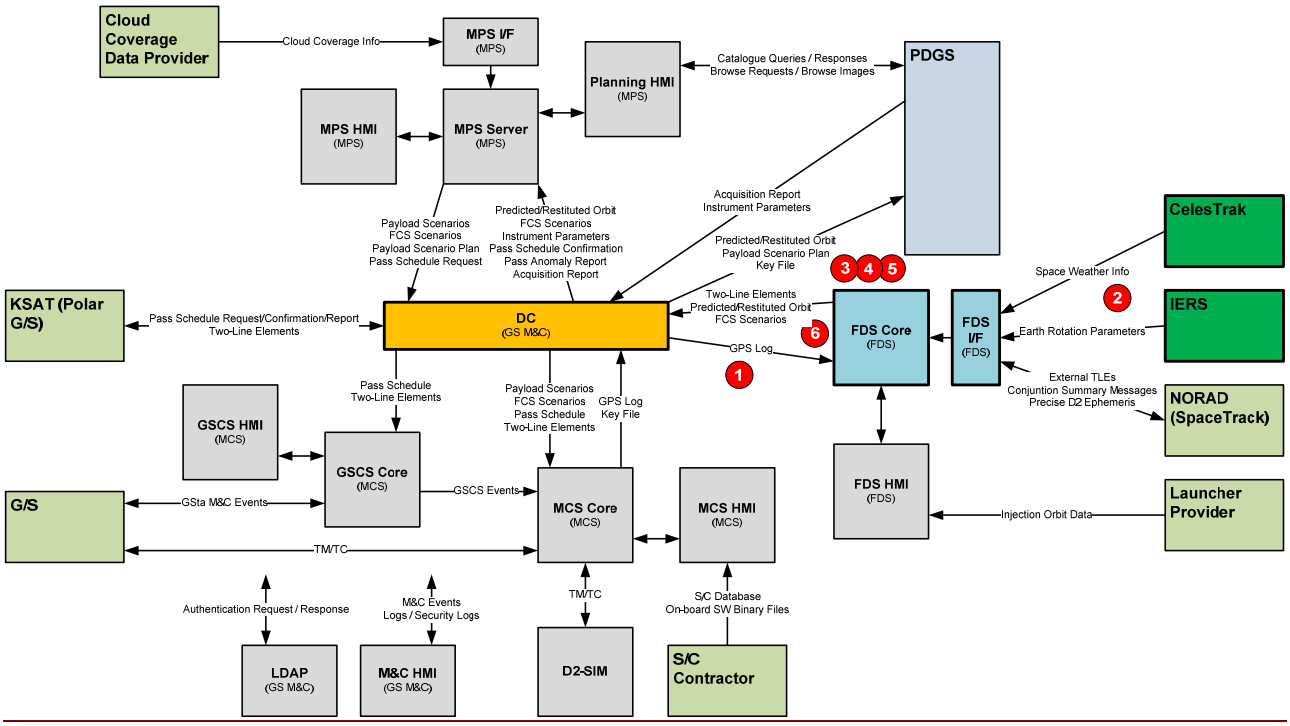

Figure 3: Orbit Determination Sequence

The following table describes each of the steps as well as the relations with other sequences:

Table 4: Orbit Determination Steps

Step	Activity	Actor	Description
1	New GPS Data Query	FDS Core	FDS queries the DC for new GPS Log files.
2	Auxiliary Data Query	FDS Core	FDS queries external providers for SW and ERP, if needed.
3	Reference FDD Query	FDS Core	FDS queries its own database in search for the best orbit reference information available and planned maneuvers that have been executed in the period of data (Flight Dynamics Data).
4	Orbit Determination and Maneuver Calibration	FDS Core	FDS determines the orbit of the satellite and computes the efficiency of the executed maneuvers and generates restituted orbit data.
5	FDD Update	FDS Core	FDS updates its own database with new the newly computed orbit reference (Flight Dynamics Data).
6	New Restituted Orbit Data	FDS Core	FDS provides the PDGS with the new restituted orbit data (Restituted Orbit).

3.1.2. Orbit Maintenance

3.1.2.1. Purpose

This sequence describes the tasks performed by the FOS in while performing the Orbit Maintenance. It continuously checks the predicted orbit against configured thresholds and updates the manoeuvre plan when needed. This sequence is automatic.

3.1.2.2. Relation to other sequences

This sequence interacts with:

- Orbit Determination. This sequence is processing the GPS data and performs the orbit restitution.

3.1.2.3. Steps

The following diagram depicts the main sequence steps:

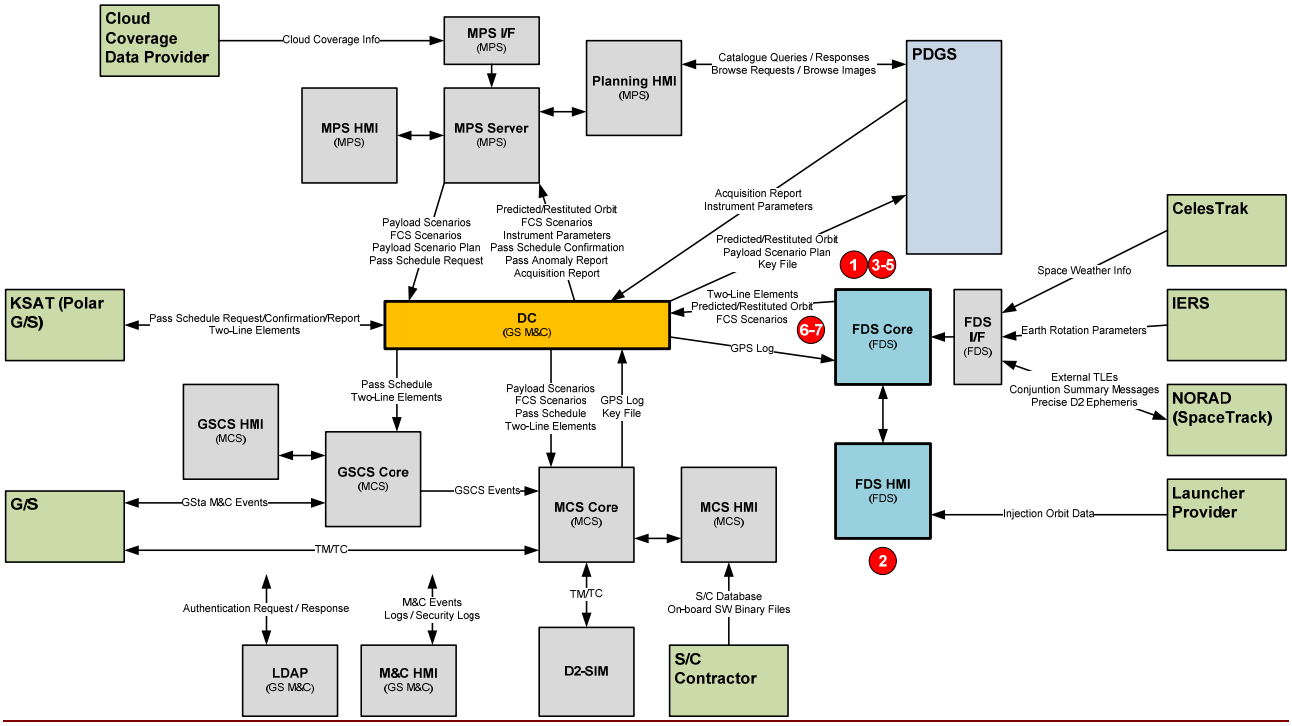

Figure 4: Orbit Maintenance Sequence

The following table describes each of the steps as well as the relations with other sequences:

Table 5: Orbit Maintenance Processing

Step	Activity	Actor	Description
1	Reference FDD Query	FDS Core	FDS queries its own database in search for the best orbit reference information available and planned maneuvers that will be executed in the near future (Flight Dynamics Data).
2	Orbit Target Retrieval	FDS HMI	FDS gets from the User Inputs the bounds to be used for monitoring and control the different orbit parameters (namely, the semi-major axis). This task is related to the process configuration and it is not part of the routine operations (which is automatic).
3	Orbit Maintenance	FDS Core	FDS updates, if needed, the maneuver plan.
4	FDD Update	FDS Core	FDS updates its own database with new the newly computed maneuvers (Flight Dynamics Data) and generates predicted Orbit Data.
5	FD Maneuver Schedule	FDS Core	FDS generates FCS Scenario files to command C/C manoeuvres.
6	New FCS Scenario	FDS Core	FDS provides the DC the new FCS Scenario to be sent to the MPS.
7	New Predicted Orbit Data	FDS Core	FDS provides the DC the new reference orbit data (Predicted Orbit and TLEs).

3.1.3. Injection Error Correction

3.1.3.1. Purpose

This sequence describes the tasks performed by the FOS in while performing the Injection Error Correction. This sequence is manual.

3.1.3.2. Relation to other sequences

This sequence interacts with:

- Orbit Determination. This sequence is processing the GPS data and performs the orbit restitution.

3.1.3.3. Steps

The following diagram depicts the main sequence steps:

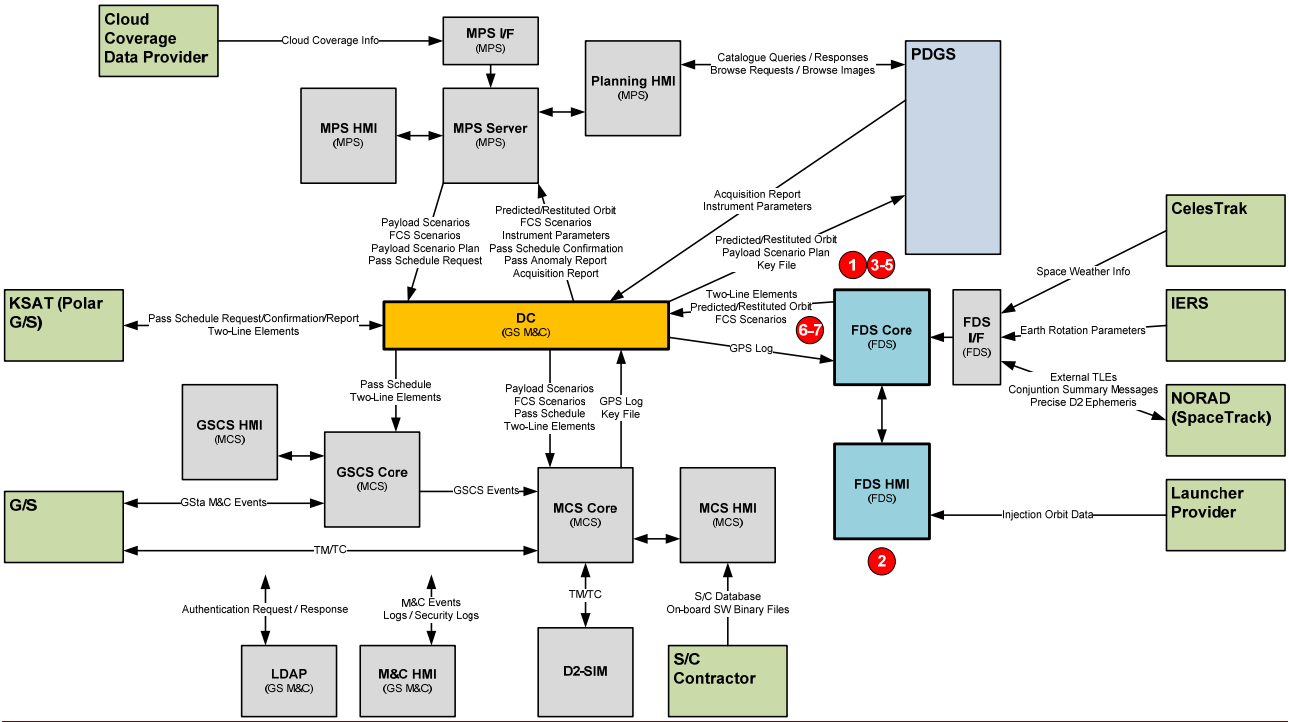

Figure 5: Injection Error Correction Sequence

The following table describes each of the steps as well as the relations with other sequences:

Table 6: Injection Error Correction Processing

Step	Activity	Actor	Description
1	Reference FDD Query	FDS Core	FDS queries its own database in search for the best orbit reference information available.
2	Orbit Target Retrieval	FDS HMI	FDS gets from the User Inputs the bounds to be used for monitoring and control the different orbit parameters
3	Orbit Maintenance	FDS Core	FDS proposes, if needed, the maneuver plan to correct potential deviations of the orbit parameters (in-plane, out of plane)

Step	Activity	Actor	Description
4	FDD Update	FDS Core	After operator selection, the FDS updates its own database with new the selected maneuvers (Flight Dynamics Data) and generates predicted Orbit Data.
5	FD Maneuver Schedule	FDS Core	FDS generates the TC needed to execute the upcoming maneuvers.
6	New FCS Scenario	FDS Core	FDS provides the DC the new FCS Scenario to be sent to the MPS.
7	New Predicted Orbit Data	FDS Core	FDS provides the DC the new reference orbit data (Predicted Orbit and TLEs).

3.1.4. Collision Avoidance

3.1.4.1. Purpose

This sequence describes the tasks performed by the FOS in while performing the Collision Avoidance process. It continuously checks the predicted orbit against the orbits of other catalogued objects and raises timely alarms to the operator (although with a low confidence level) in a first part, completely automatic. The second part is manual and includes the operational procedure to interact with the CSM provider, who is tracking dangerous objects with higher accuracy than what is provided by the catalogue, and includes as many iterations as needed to re-evaluate the risk of collision after different the manoeuvre plans are tested. The second part of the sequence is manual and requires the operator confirmation to implement the evasive manoeuvres (they are expensive and affect both the nominal operations and the expected length of the mission lifetime). All actions taken by the operator are recorded into corresponding log files and kept in the system for future reference.

3.1.4.2. Relation to other sequences

This sequence interacts with:

- Orbit Maintenance.

3.1.4.3. Steps

The following diagram depicts the main sequence steps:

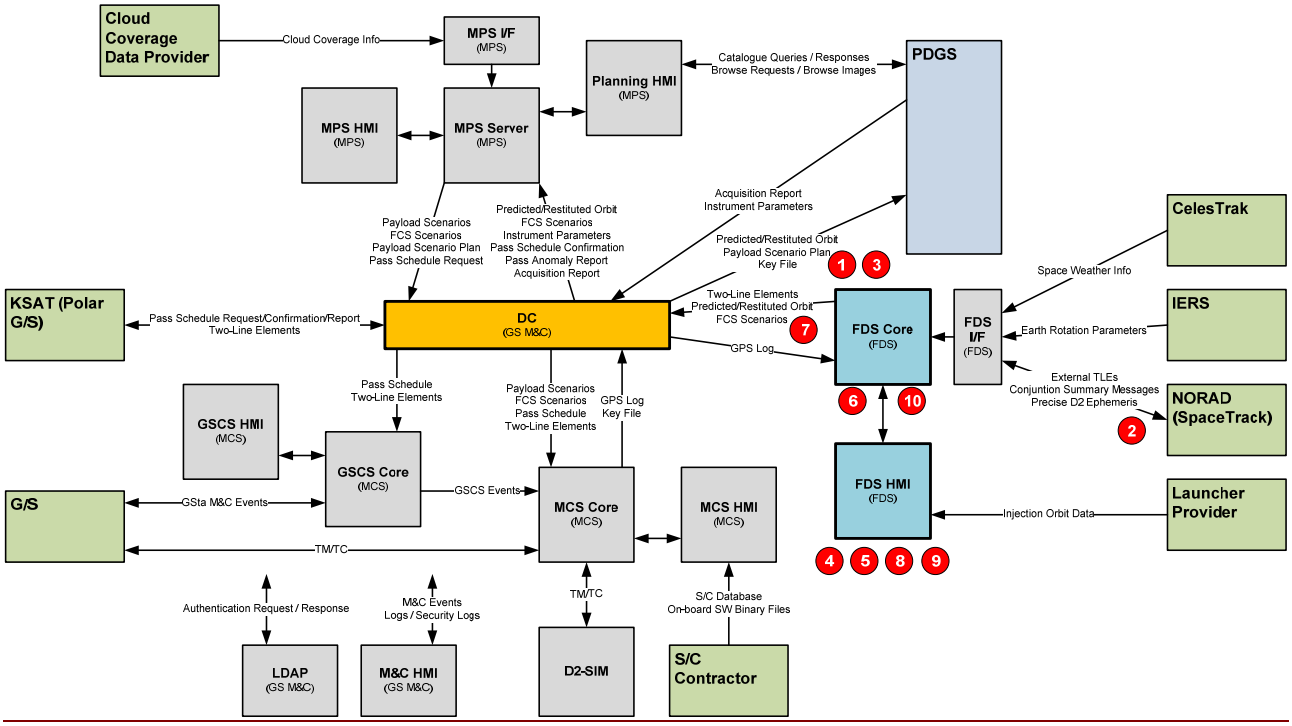

Figure 6: Collision Avoidance Sequence

The following table describes each of the steps as well as the relations with other sequences:

Table 7: Collision Avoidance Processing Steps

Step	Activity	Actor	Description
1	Reference FDD Query	FDS Core	FDS queries its own database in search for the best orbit reference information available and planned maneuvers that will be executed in the near future (Flight Dynamics Data).
2	Query TLE Catalogue	FDS Core	FDS queries external providers for TLE, if needed.
3a	Automatic Preliminary Screening	FDS Core	FDS performs an a priori search for potential threats using low precision information provided by the TLE public data and raises warnings to the operator, if needed.
3b	Manual Preliminary Screening	FDS Core	FDS performs an a priori search for potential threats merging information provided by several TLEs extracted from the TLE public data corresponding to a potentially dangerous object and raises warnings to the operator, if needed.
4	CSM reception	FDS HMI	FDS warns the operator that an alert has been received.
5	Orbit Target change in test mode	FDS HMI	FDS gets from the User Inputs new profile bounds to target a new set of orbit parameters to avoid the collision and to return to operational orbit, test mode.
6	FDD Update in test mode	FDS Core	FDS updates its own database with new the newly computed maneuvers (Flight Dynamics Data) and generates predicted Orbit Data, test mode.

Step	Activity	Actor	Description
7	New Predicted Orbit Data, test mode	FDS Core	FDS provides the DC the new predicted Orbit Data (XML), test mode to be sent to CSM provider to further assessment of the risk of collision.
8	CSM reception	FDS HMI	FDS informs the operator of the new conditions, and the FDS expert decides to either go back to step 5, accept the risk without implementing any maneuver, or implement the collision avoidance maneuver to step 9.
9	Orbit Target change in operational mode	FDS HMI	FDS gets from the User Inputs the profile of orbit parameters to avoid the collision and to return to operational orbit already testes and approved, but now operational mode.
10	Implement the Orbit Maintenance procedure	FDS Core	FDS to compute and schedule the required manoeuvres operationally. The corresponding FCS Scenarios are generated and sent to the MPS.

3.1.5. Plan Preparation

3.1.5.1. Purpose

This sequence describes the tasks performed by the operator (in manual mode) to generate a Mission Plan, compressing the creation of acquisitions requests, the generation of the sensing segments and the solving of conflicts.

Those steps that can be performed by the Scheduler in automatic mode are also identified.

3.1.5.2. Relation to other sequences

This sequence interacts with:

- Authentication.
- Catalogue Query.

3.1.5.3. Steps

The following diagram depicts the main sequence steps:

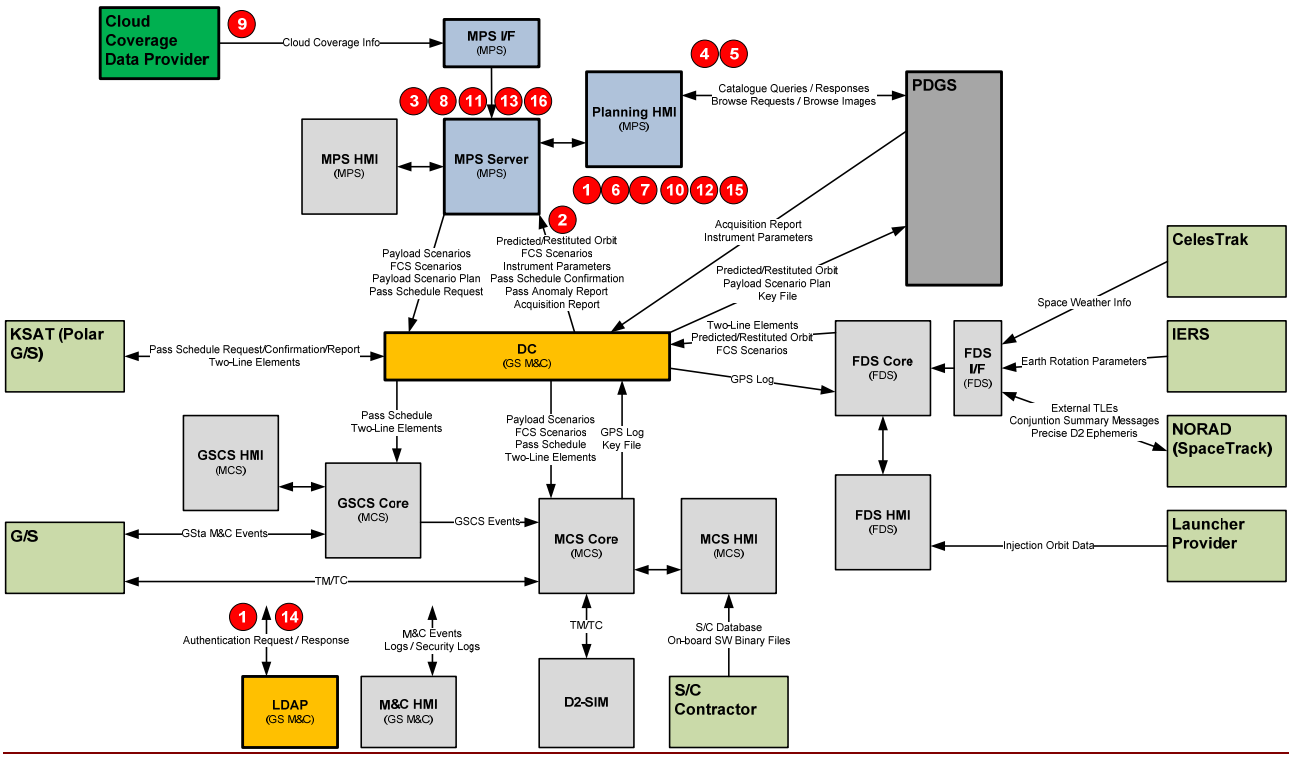

Figure 7: Plan Preparation Sequence

The following table describes each of the steps as well as the relations with other sequences:

Table 8: Plan Preparation Steps

Step	Activity	Actor	Description
1	Load New Interval	Planning HMI	A broker logs in the system (Planning HMI) and loads the interval where the acquisitions are going to be planned. It links with Authentication sequence.
2	Get Orbit Data	MPS Server	The MPS gets (if any) from the shared directory the latest orbit data provided by the FDS and ingests them to load the satellite information. It links with Orbit Determination sequence.
3	Display Interval	Planning HMI	The required interval is displayed into the Planning HMI with the current mission data plan and the orbit track in this epoch.
4	Load Catalogue	Planning HMI	The broker requests the access to the catalogue data to retrieve the acquisitions acquired in the past in order to optimize the new acquisition requests.
5	Catalogue Data Retrieval	MPS Server	The MPS queries the MAC for the catalogue data. It links with Catalogue Query sequence.
6	Displays Catalogue Data	Planning HMI	The MPS displays the mission data archived in the MAC catalogue.
7	Select Browse Image	Planning HMI	The broker selects the desired browse image(s) to be displayed in the Planning HMI.

Step	Activity	Actor	Description
8	Refresh Interval	MPS Server	The MPS loads the interval with the information retrieved from the MAC, showing the covered zones.
9	Load Clouds Layer	Planning HMI	The Broker loads the clouds coverage prediction according to the time where the satellite track can cover area desired. The objective of this operation is to optimize the acquisition quality.
10	Acquisition Request Creation	Planning HMI	The Broker defines a set of requests to be planned, providing for each request the required area and the period validity.
11	Sensing Segments generation	MPS Server	The MPS calculates the time periods where the area(s) requested are covered by the satellite instrument. The sensing segments are displayed in the planning HMI.
12	Sensing Segments planning	Planning HMI	The sensing segments received can be manually modified by the broker. The broker selects the segments to be planned and sends this information to the MPS Server.
13	Plan	MPS Server	The MPS generates the plan: marks the segments that can be planned and detects the conflicts (including attitude and power constraints) which must be solved by the brokers.
14	Master Broker authentication	Planning HMI	A master Broker, with permission to modify all the operations, logs in the system to analyze the final plan. It links with Authentication sequence.
15	Conflicts Resolution	Planning HMI	The master Broker decides the operations to be covered and the ones to be cancelled in order to solve the conflicts (e.g. overlapping of competing acquisitions or insufficient memory capacity).
16	Generate Free Conflict Plan	MPS Server	The MPS plans the operations whose conflicts have been modified and finally generates a free-conflict plan.

3.1.6. Plan Generation

3.1.6.1. Purpose

This sequence describes the tasks performed by the operator (in manual mode) for formatting the Mission Plan data into the pre-defined interfaces.

Those steps that can be performed by the Scheduler in automatic mode are also identified.

3.1.6.2. Relation to other sequences

This sequence interacts with:

- Authentication.
- Pass Management.

3.1.6.3. Steps

The following diagram depicts the main sequence steps:

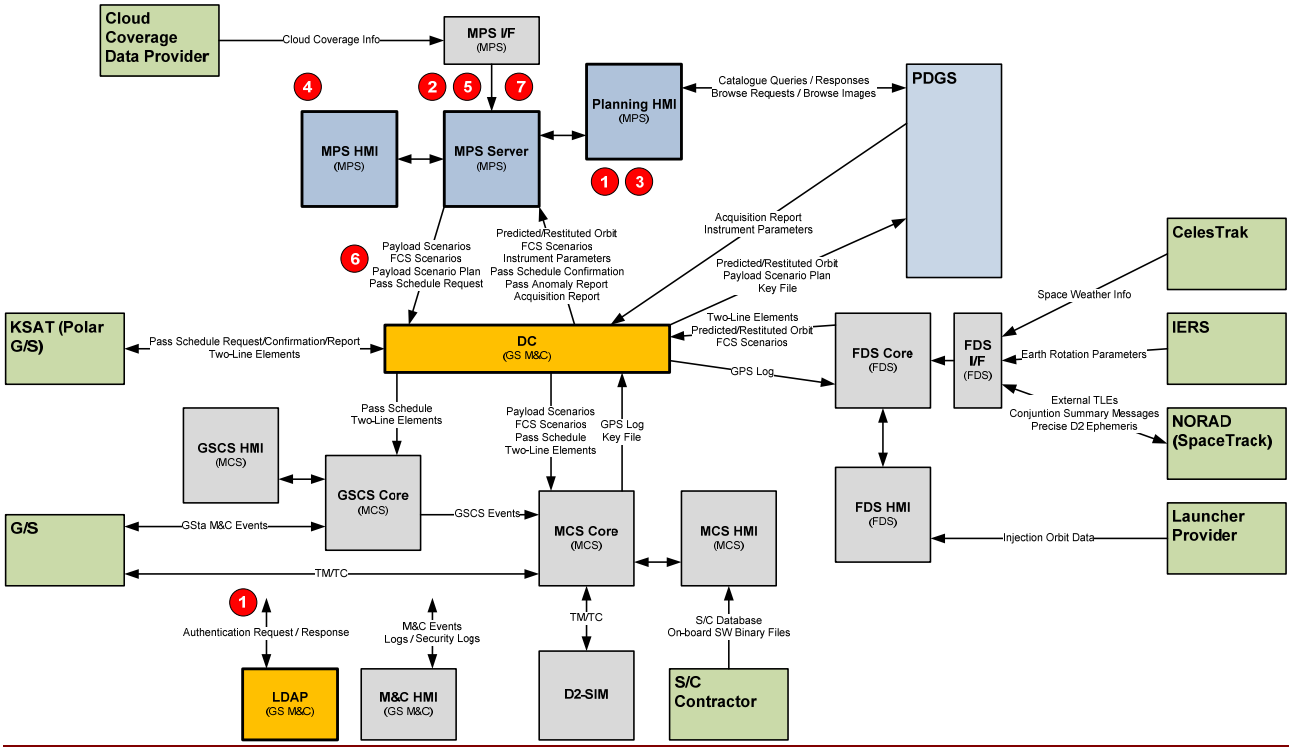

Figure 8: Plan Generation Sequence

The following table describes each of the steps as well as the relations with other sequences:

Table 9: Plan Generation Steps

Step	Activity	Actor	Description
1	Operator authentication	Planning HMI	The operator logs in the Planning HMI to check that the plan is conflict free (only required step in manual mode). It links with Authentication sequence.
2	Load Generated Plan	Planning HMI	The MPS displays the window interval (only required step in manual mode).
3	Check conflicts	Planning HMI	The operator checks the free conflict plan (only required step in manual mode).
4	Operator authentication	MPS HMI	The operator logs in the Processes HMI (only required step in manual mode).
5	Plan Formatting	MPS HMI/ MPS Server	The operator requests the generation of the plan files: Pass Schedule, Payload Scenario Plan and FCS Scenario File. It links with Pass Management sequence. The plan generation can be triggered manually by the operators or automatically by the MPS Server scheduler.
6	Output files transmission	MPS Server	The MPS places the generated files in the specific directories according to the type of the interface. These files are ready to be transferred by the DC to the MCS and GSCS elements.
7	MP Status updating	MPS Server	The MPS updates the status of the events processed in the database.

3.1.7. Plan Update

3.1.7.1. Purpose

This sequence describes the tasks performed by the operator (in manual mode) to update the status of the plan when receiving the Acquisition Report.

Those steps that can be performed by the Scheduler in automatic mode are also identified.

3.1.7.2. Relation to other sequences

This sequence interacts with:

- Authentication.
- Product Monitoring.

3.1.7.3. Steps

The following diagram depicts the main sequence steps:

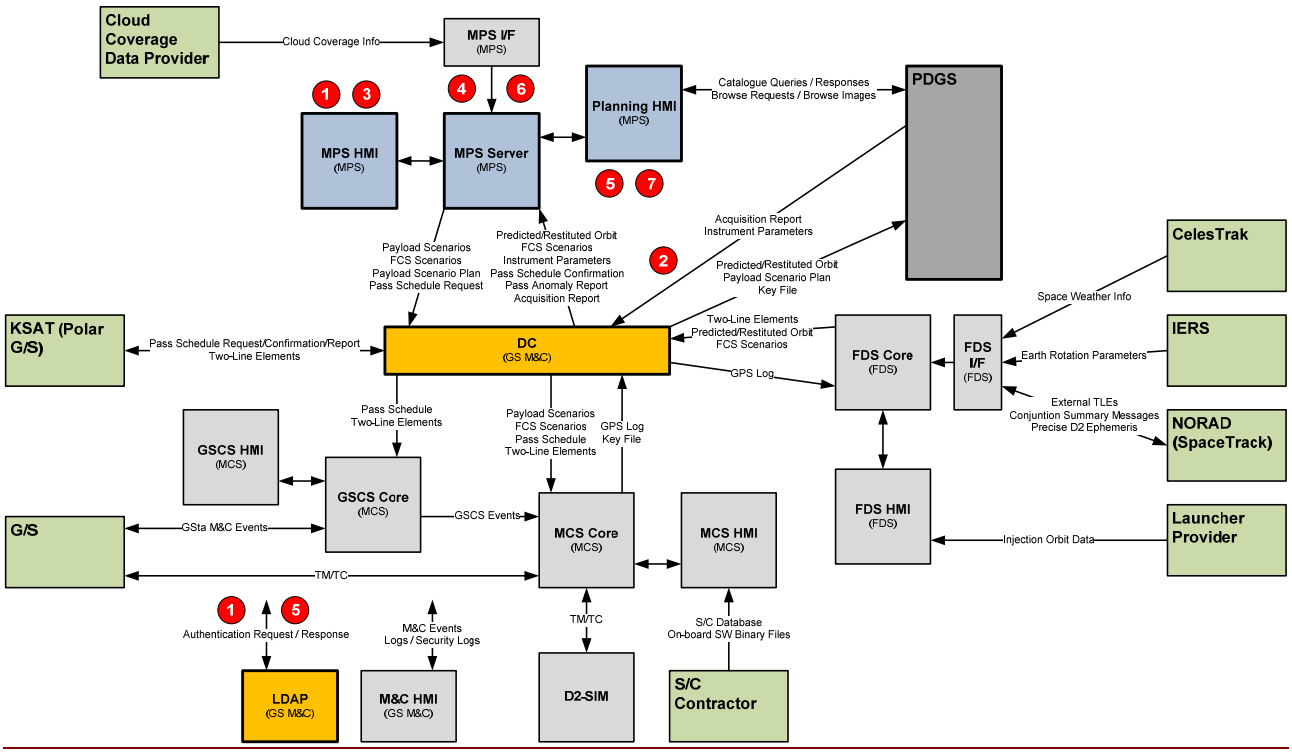

Figure 9: Plan Update Sequence

The following table describes each of the steps as well as the relations with other sequences:

Table 10: Plan Update Steps

Step	Activity	Actor	Description
1	Operator authentication	MPS HMI	The operator logs in the Processes HMI (only required step in manual mode). It links with Authentication sequence.
2	Input files reception	MPS Server	The MPS places the received files in the specific directories according to the type of the interface. These files are transferred by the DC from the external entities (from the Product Monitoring sequence).
3	Acquisition Report processing	MPS HMI/MPS Server	The operator selects the type of file to be processed, the acquisition report. This can also be done automatically by the MPS Server scheduler.
4	MP Status updating	MPS Server	The MPS updates the status of the events in the database.
5	Operator authentication	Planning HMI	An operator logs in the Planning HMI to analyze results on the plan (only required step in manual mode).
6	Load Generated Plan	Planning HMI	The MPS displays the window interval (only required step in manual mode).
7	Check Status	Planning HMI	The operator checks the status of the plan. (Only required step in manual mode).

3.1.8. Pass Management

3.1.8.1. Purpose

This sequence describes the tasks performed by the MCS and the stations during a S/C pass over the stations visibilities.

3.1.8.2. Relation to other sequences

This sequence interacts with:

- Plan Generation.
- Orbit Determination.
- Payload Data Reception.

3.1.8.3. Steps

The following diagram depicts the main sequence steps:

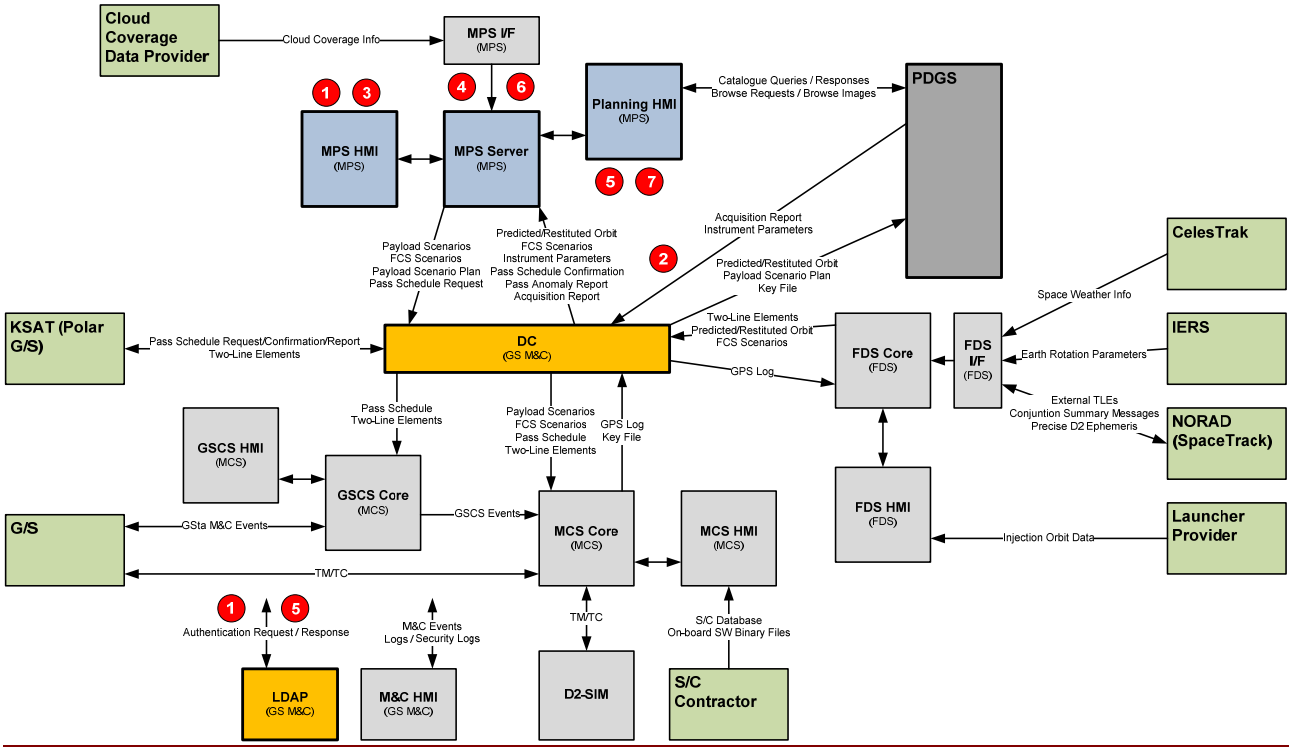

Figure 10: Pass Management Sequence

The following table describes each of the steps as well as the relations with other sequences:

Table 11: Pass Management Sequence Steps

Step	Activity	Actor	Description
1	Configure G/S Equipment	GSCS Core	GSCS will configure the G/S Equipment in preparation for the Pass according to the information contained in the Pass Schedule made available by the MPS. Note: For Svalbard G/S this will be handled by KSAT (Pass Schedule Request).
2	Establishment of required TM/TC links	MCS Core	MCS will establish the required links with the G/S (through MCS I/F) to be able to perform the TM/TC data transfer between the MCS and the S/C
3	S/C Tracking	GSCS Core	The GSCS sends the S/C orbit in TLE format to the ACU and commands the autotracking. The ACU computes the position where the S/C will appear over the horizon and points the antenna to that direction. Once the S/C signal is detected it starts the tracking operation.
4	X-band Data Acquisition	G/S (outside D2 GS)	G/S Equipment will receive and storage the payload data received on the X-band. The data will be stored in binary files whose size is determined by configuration. The number of files created per pass will then be dependent on the amount of payload data downloaded.

Step	Activity	Actor	Description
5	Pass TM and TC operations	MCS Core	MCS will perform the pre-planned commanding operations with the S/C. The nominal commanding operations will include at least: - Uplink and activation of Payload Scenarios& FCS - MCS performs in parallel the TM&TC operations - Uplinks FCS & Payload Scenarios - Downlinks of selected onboard files (WOD's, S/C Logs, etc) Additionally the MCS will process the real-time TM including the responses to the issued commands.
6	Reset G/S Equipment	GSCS Core	GSCS will reset the G/S Equipment. Note: N/A for Svalbard G/S.
7	Park antenna	GSCS Core	GSCS will command the antenna to go the 'parking' configuration. Note: N/A for Svalbard G/S.
8	Disconnect TM/TC links with G/S Equipment	MCS Core	MCS will break the links with the G/S.
9	MCS Pass TM Wrap-up	MCS Core	MCS will archive the received S/C HK TM and log information.
10	MCS Pass TM Delivery	MCS Core	MCS will make available derived TM files to other D2-GS systems (e.g. GPS Log to FDS).

3.1.9. Encryption Key Management

3.1.9.1. Purpose

This sequence describes the tasks performed by the MCS and the rest of the GS for the generation and management of encryption keys.

3.1.9.2. Relation to other sequences

This sequence interacts with:

- L0 Processing.
- Pass Management.
- Plan Preparation.

3.1.9.3. Steps

The following diagram depicts the main sequence steps:

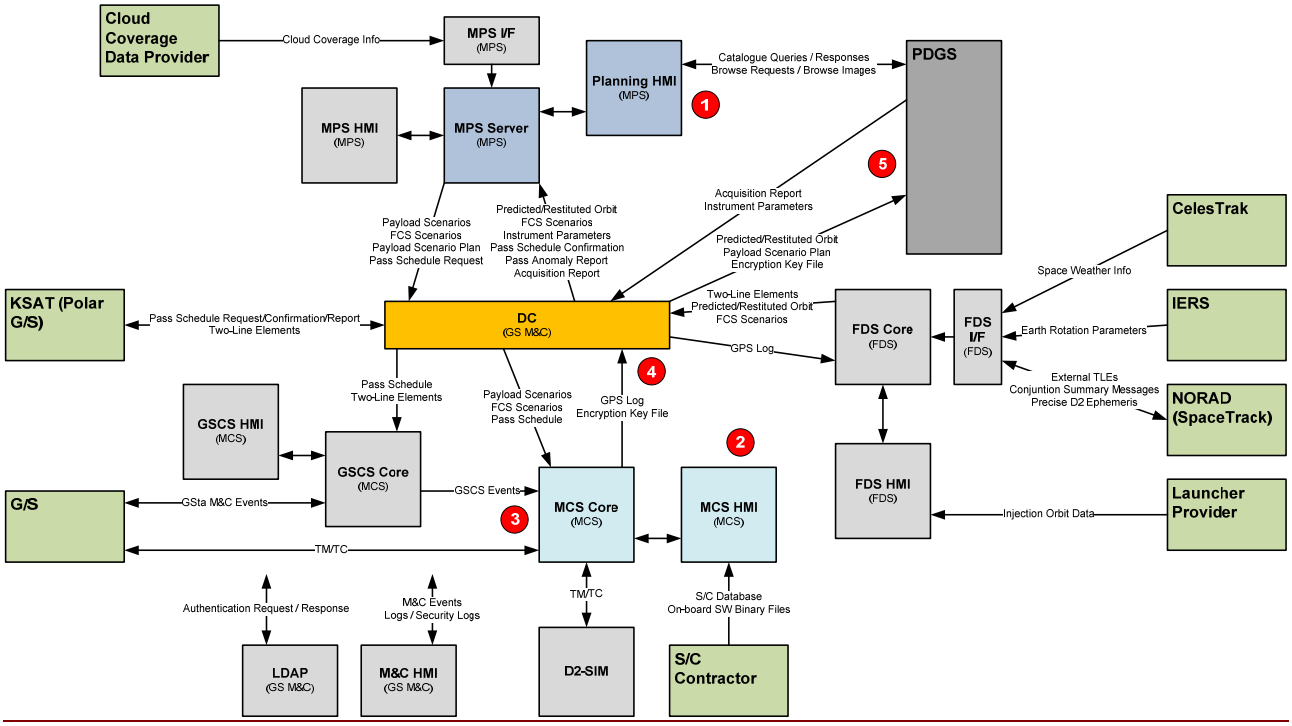

Figure 11: Encryption Key Management Sequence

The following table describes each of the steps as well as the relations with other sequences:

Table 12: Encryption Key Management Sequence Steps

Step	Activity	Actor	Description
1	Plan preparation	MPS Planning HMI	The MPS operator will introduce an unavailability in the plan over the period in which the new key is planned to by uploaded, preventing any acquisition during the key upload process.
2	Key generation	MCS HMI	The MCS operator generates a new key using the MCS HMI.
2	Key upload	MCS HMI/Core	The MCS operator prepares the new key upload to be performed automatically on the planned pass.
3	Key delivery to PDGS	MCS Core/HMI	Upon key update confirmation the new key file will be delivered to the PDGS.
4	Key management at PDGS	MAC / ORC (PDGS)	On the PDGS the new key file will be placed by the DC on the MAC shared area and stored by the MAC. The key file reference will be provided by the ORC to the L0 processor in each Job Order.

3.1.10. Emergency Image Acquisition Requests

The handling of emergency observation requests is expected to follow the same planning cycle as nominal operations, though all the operations. The only aspect that will be different is that all the planning interactions might be manually handle by operators within the MPS software.

The planning concept for the D2 S/C goes around the assumption that no partial plan will be generated, i.e. the MPS will construct the observation scenarios containing both observation requests already uploaded to the S/C in previous passes and new ones.

As part of the pass activities the MCS will remove the scenarios uploaded in previous pass and upload and activate the new ones.

This simplifies the overall operations concept and avoid that by mistake the S/C is left without observation scenarios to be executed.

Obviously it is clear that a fine control of the scenarios onboard is allowed using the appropriate commanding capabilities within the MCS, where the operator can manually remove single observation scenarios, see registered scenarios, etc. The functionality exposed to the MCS operator is limited by the capabilities exposed by the S/C OBC software.

3.2. Processing Chain Operations

3.2.1. Payload Data Reception

3.2.1.1. Purpose

This sequence describes the tasks performed by the PDGS in order to receive Payload Data.

3.2.1.2. Relation to other sequences

This sequence interacts with:

- Pass Management
- L0 Processing

3.2.1.3. Steps

The following diagram depicts the main sequence steps:

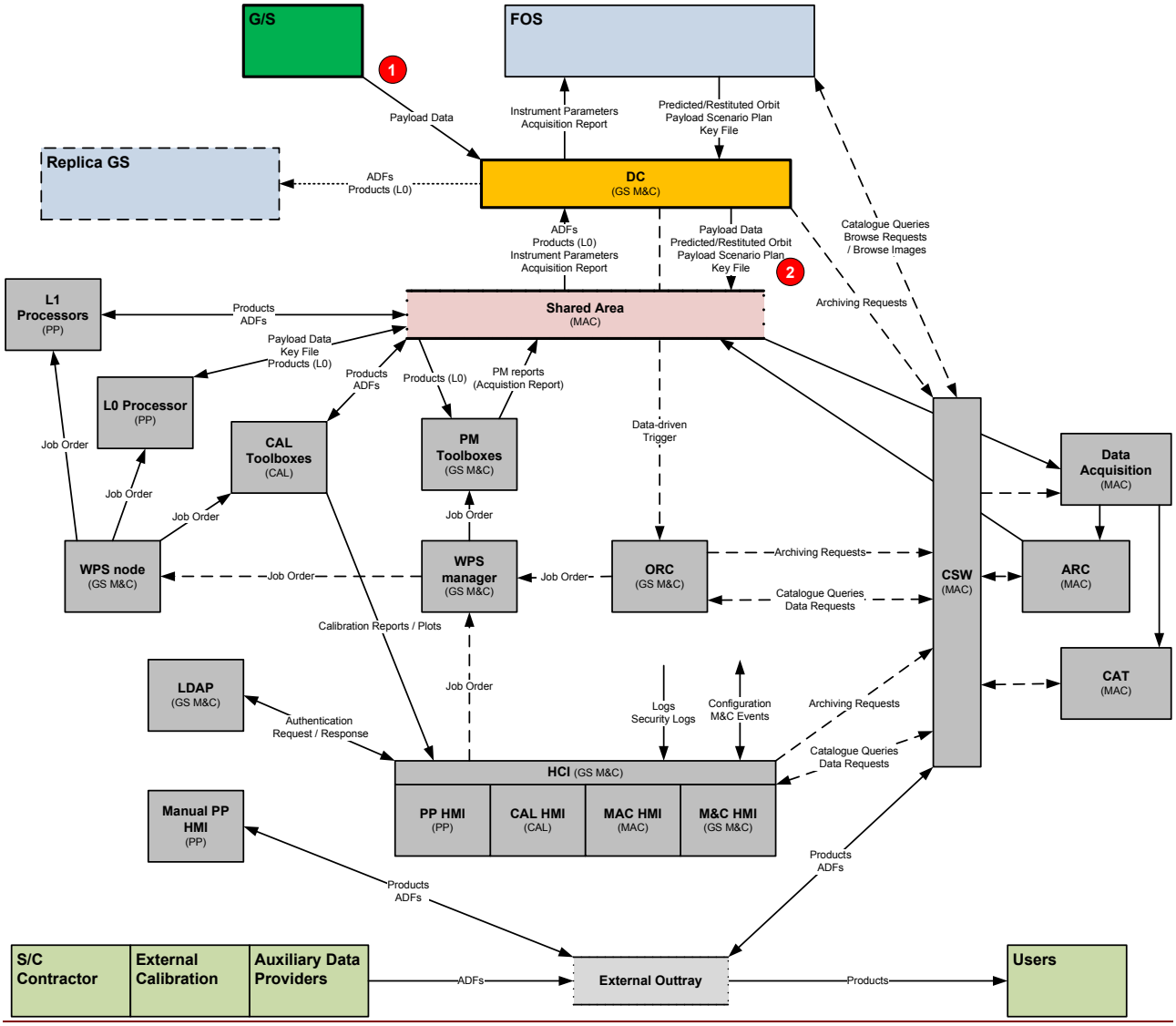

Figure 12: Payload Data Reception

The following table describes each of the steps as well as the relations with other sequences:

Table 13: Payload Data Reception Steps

Step	Activity	Actor	Description
1	Data Circulation from G/S to PDGS	DC	DC detects new Payload data to be moved to the PDGS. This links with Pass Management sequence
2	Storage in Shared Area	DC	DC moves data to the MAC Shared Area. This links with L0 Processing sequence

3.2.2. L0 Processing

3.2.2.1. Purpose

This sequence describes the tasks performed by the PDGS in order to process payload data into Level 0 and generate the telemetry report.

3.2.2.2. Relation to other sequences

This sequence interacts with:

- Payload Data Reception
- Data Archiving
- L1 Processing
- Plan Update
- Transfer to Replica

3.2.2.3. Steps

The following diagram depicts the main sequence steps:

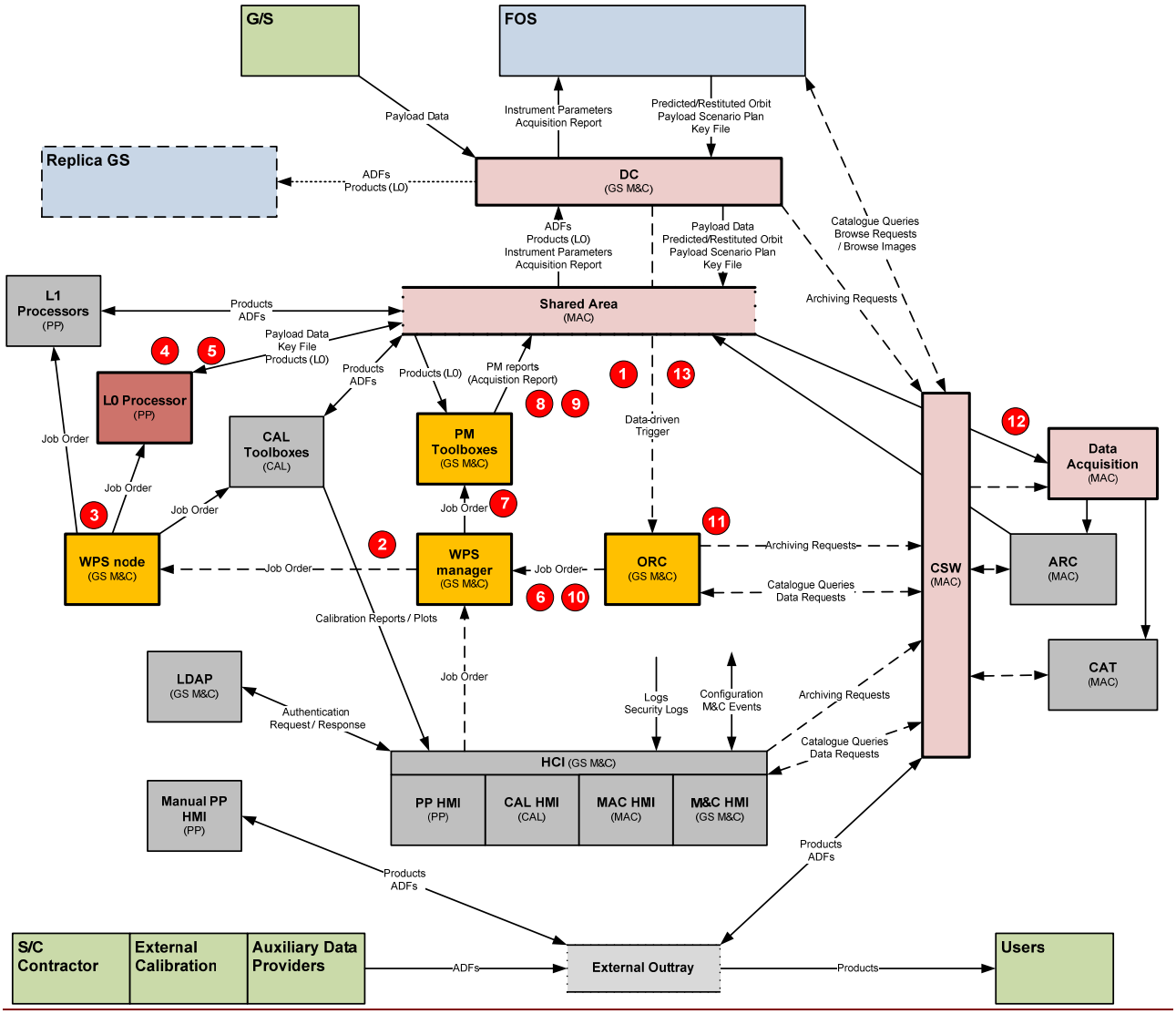

Figure 13: L0 Processing

The following table describes each of the steps as well as the relations with other sequences:

Table 14: L0 Steps

Step	Activity	Actor	Description
1	ORC data driven processing	DC/ORC	The DC automatically polls the shared area looking for new payload data. It links with Payload Data Reception sequence. If new payload data is detected an event is triggered and the ORC is called. The ORC commands the WPS manager to generate a L0 job order and execute it.
2	L0 Job Order Creation	WPS manager	The WPS manager creates the jobOrder and forwards it to the WPS node

Step	Activity	Actor	Description
3	Job order Queue and processor triggering	WPS node	The job order is placed in a queue and when possible the relevant L0 processor is triggered. The processor health is then monitored.
4	L0 Processor execution	L0 Processor	L0 processing is performed.
5	L0 Output data production	L0 Processor	Output products and reports are left in the shared area.
6	The L0 processing ends	WPS	The WPS informs the ORC that the L0 processing has ended.
7	Trigger TLM report generation	ORC / WPS manager	The ORC creates a PM jobOrder and commands the PM toolbox to generate it through the WPS.
8	PM Report (Telemetry Report) generation	PM toolbox	The PM toolbox creates the TLM report (PM Report).
9	TLM generation output	PM Toolbox	Once created the PM toolbox leave the TLM report in the shared area.
10	PM Report generation ends	WPS	The WPS informs the ORC that the PM toolbox processing has ended.
11	Output storage	ORC	The ORC issues an order through the CSW to store the generated L0 product and TLM report into the MAC .
12	Data archival	Data Acquisition	The generated files are stored and catalogued. This links with the Data Archiving sequence.
13	ORC data driven processing	DC / ORC	Again this step is repeated for each Payload data from a pass. When no more payload data is available, the acquisition report is generated (PM report). This links with the ACQ report generation sequence. It also links with the L0R sequence.

3.2.2.4. Acquisition Report Generation

3.2.2.4.1. Purpose

This sequence describes the tasks performed by the PDGS while performing the automatic Acquisition Report generation

3.2.2.4.2. Relation to other sequences

This sequence interacts with:

- L0 Processing
- Data Archiving
- Data Extraction
- Catalogue Query

3.2.2.4.3. Steps

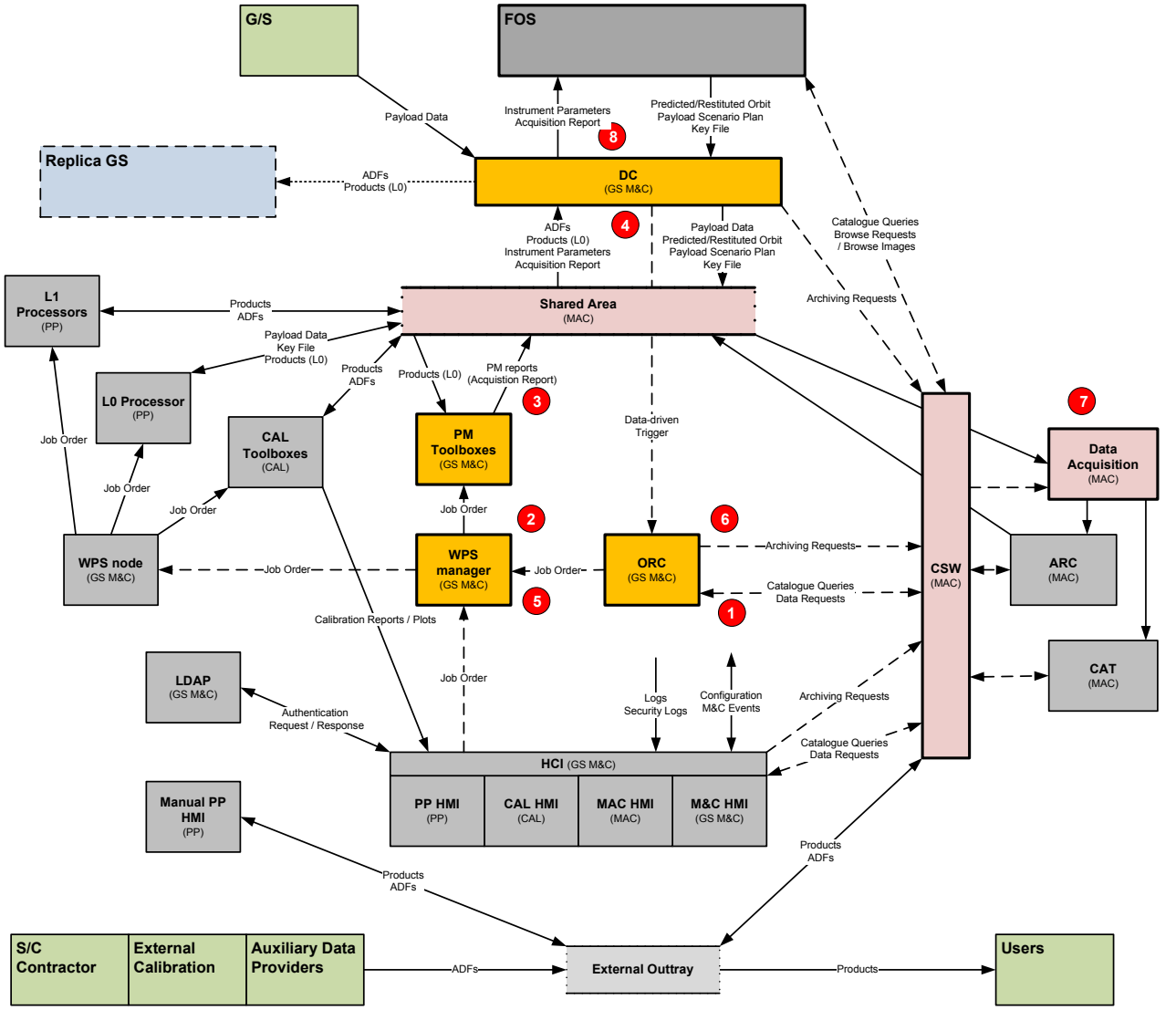

Figure 14: Acquistion Report generation

The following table describes each of the steps as well as the relations with other sequences:

Table 15: Acquistion Report Steps

Step	Activity	Actor	Description
1	New Report Query	ORC	The ORC queries the MAC through the CSW to get the payload scenario file and all the telemetry reports that matches with that payload scenario file. It links with Catalogue Query sequence.
2	Trigger PM report generation	ORC / WPS manager	The ORC creates a PM Job Order and commands the PM toolbox to generate it through the WPS.

Step	Activity	Actor	Description
3	PM Report (Acquisition Report) generation	PM toolbox	The PM toolbox creates the ACQ report.
4	PM generation output	PM Toolbox	Once created the PM toolbox leave the ACQ report in the shard area, and in the outtray to send the report to the MPS facility (FOS).
5	ACQ Report generation ends	WPS	The WPS informs the ORC that the PM toolbox processing has ended.
6	Output storage	ORC	The ORC issues an order to store ACQ report generated into the MAC through the CSW.
7	Data archival	Data Acquisition	The generated file is stored and catalogued. This links with the Data Archiving report sequence.
8	Send report to MPS	DC	The DC send the generate ACQ report to the MPS facility for further analysis.

3.2.2.5. L0R Automatic Processing

3.2.2.5.1. Purpose

This sequence describes the tasks performed by the PDGS while performing the automatic Level 0R processing.

3.2.2.5.2. Relation to other sequences

This sequence interacts with:

- L0 Processing
- Data Archiving
- Data Extraction
- Catalogue Query

3.2.2.5.3. Steps

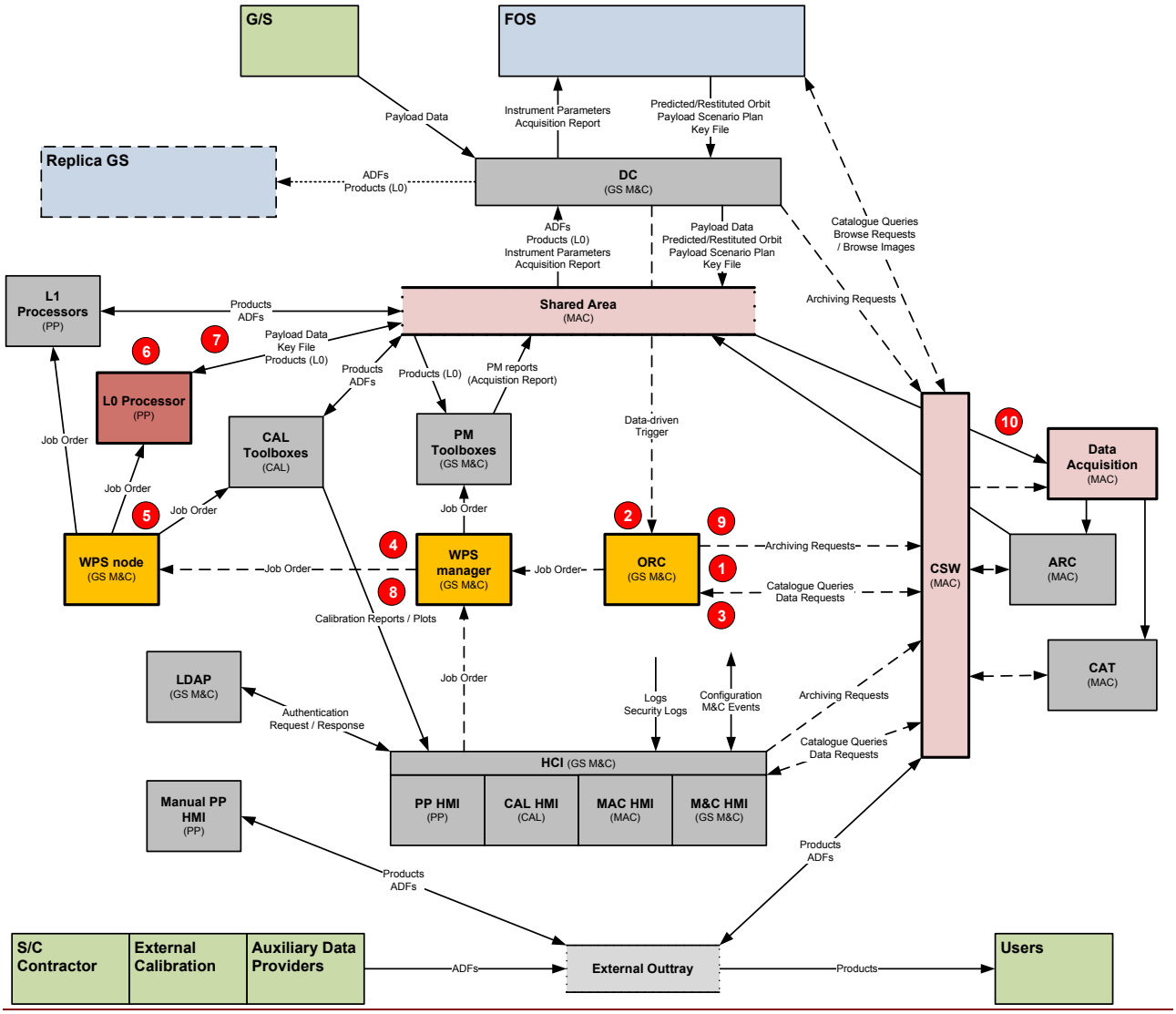

Figure 15: L0R Automatic Processing

The following table describes each of the steps as well as the relations with other sequences:

Table 16: L0R Automatic Processing Steps

Step	Activity	Actor	Description
1	New Product Query	ORC / CSW	ORC queries the MAC through the CSW to find the L0 products of the same acquisition scenario. It links with Catalogue Query sequence.
2	Job Order Creation	ORC	After successful fulfilment of rules, the job order is created.
3	Input data retrieval	ORC	Input data is requested to the MAC and moved to the processors shared area (data could already be there, depending on retention policies). This links with Data Extraction sequence.
4	Processing request	WPS manager	The WPS sends the job order to the WPS node for its execution.

Step	Activity	Actor	Description
5	Job order Queue and processor triggering	WPS	The job order is placed in a queue and when possible the relevant L0R processor is triggered. The processor health is then monitored.
6	L0R Processor execution	L0R Processors	L0R processing is performed.
7	Output data production	L0R Processors	Output products and reports are left in the shared area.
8	Process termination	WPS node	The processing end and the WPS node detects the result of the activity and reports to WPS manager and ORC.
9	Output storage	ORC	The ORC issues an order through the CSW to store the generated L0R product into the MAC
10	Data archival	Data Acquisition	The generated files are stored and catalogued. This links with the Data Archiving sequence.

3.2.3. L1 Automatic Processing

3.2.3.1. Purpose

This sequence describes the tasks performed by the PDGS in while performing the automatic Level 1 processing.

3.2.3.2. Relation to other sequences

This sequence interacts with:

- Payload Data Reception
- Data Archiving
- Data Extraction
- Catalogue Query

3.2.3.3. Steps

The following diagram depicts the main sequence steps:

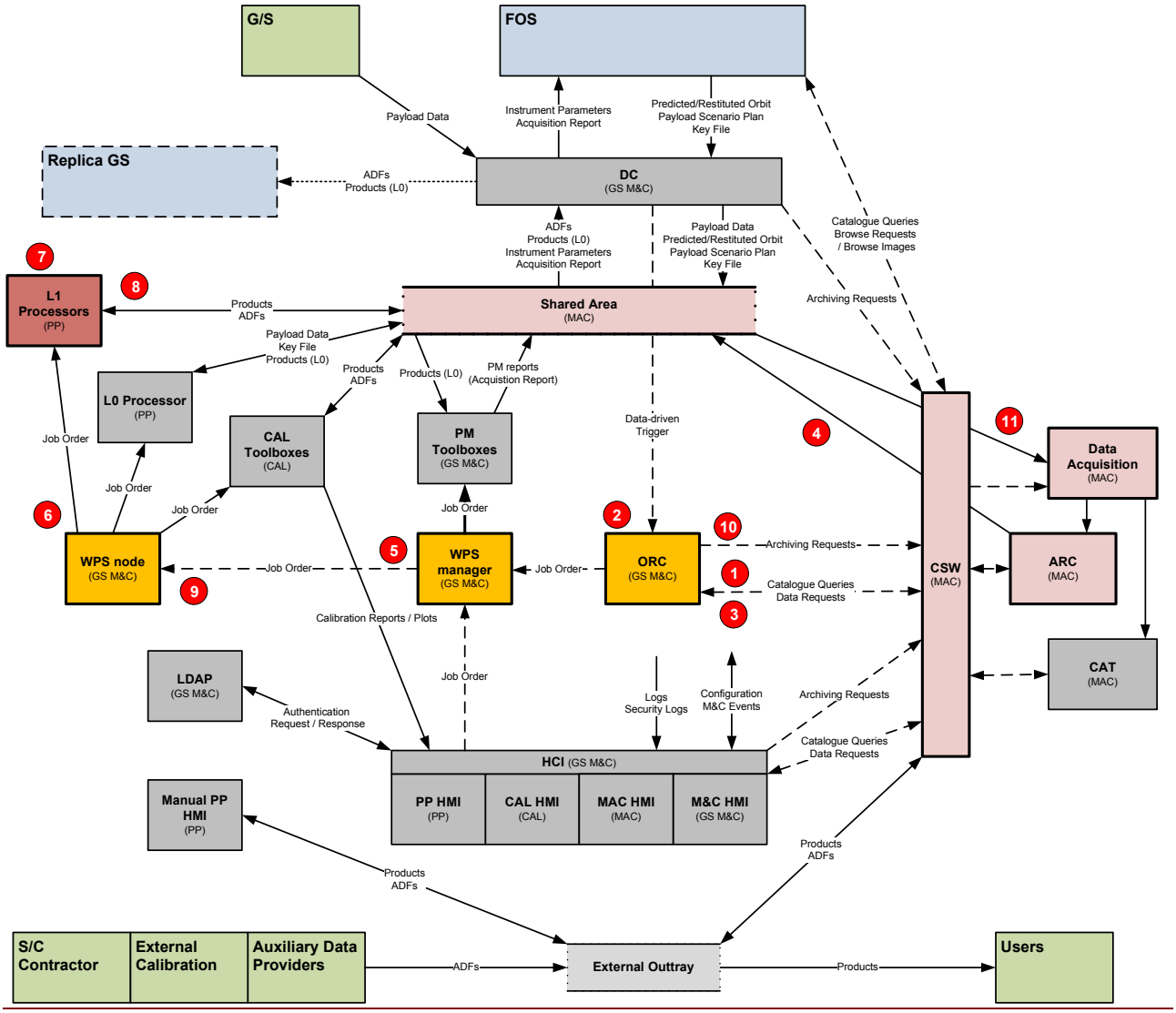

Figure 16: L1 Automatic Processing

The following table describes each of the steps as well as the relations with other sequences:

Table 17: L1 Automatic Processing Steps

Step	Activity	Actor	Description
1	New Product Query	ORC	ORC queries the MAC for new unprocessed files. It links with Catalogue Query sequence.
2	Job Order Creation	ORC	After successful fulfilment of rules, the job order is created.
3	Input data retrieval request	ORC	Input data is requested thought the CSW to the MAC. This links with Data Extraction sequence.
4	Input data retrieval	ARC	The ARC puts the necessary files into the shared area (data could already be there, depending on retention policies).

Step	Activity	Actor	Description
5	Processing request	WPS	The WPS manager sends the job order to the WPS Node for its execution.
6	Job order Queue and processor triggering	WPS Node	The job order is placed in a queue and when possible the relevant L1 processor is triggered. The processor health is then monitored.
7	L1 Processor execution	L1 Processors	L1 processing is performed.
8	Output data production	L1 Processors	Output products and reports are left in the shared area.
9	Process termination	WPS Node	The processing end and the WPS Node detects the result of the activity and reports to WPS manager and ORC.
10	Output storage	ORC	The ORC issues an order through the CSW to store the generated L1 product into the MAC
11	Data archival	Data Acquisition	The generated files are stored and catalogued. This links with the Data Archiving sequence.

3.2.4. L1 Manual Processing

3.2.4.1. Purpose

This sequence describes the tasks within the PDGS to perform Level 1 Manual processing.

3.2.4.2. Relation to other sequences

This sequence interacts with:

- Data Archiving
- Data Extraction
- Catalogue Query

3.2.4.3. Steps

The following diagram depicts the main sequence steps:

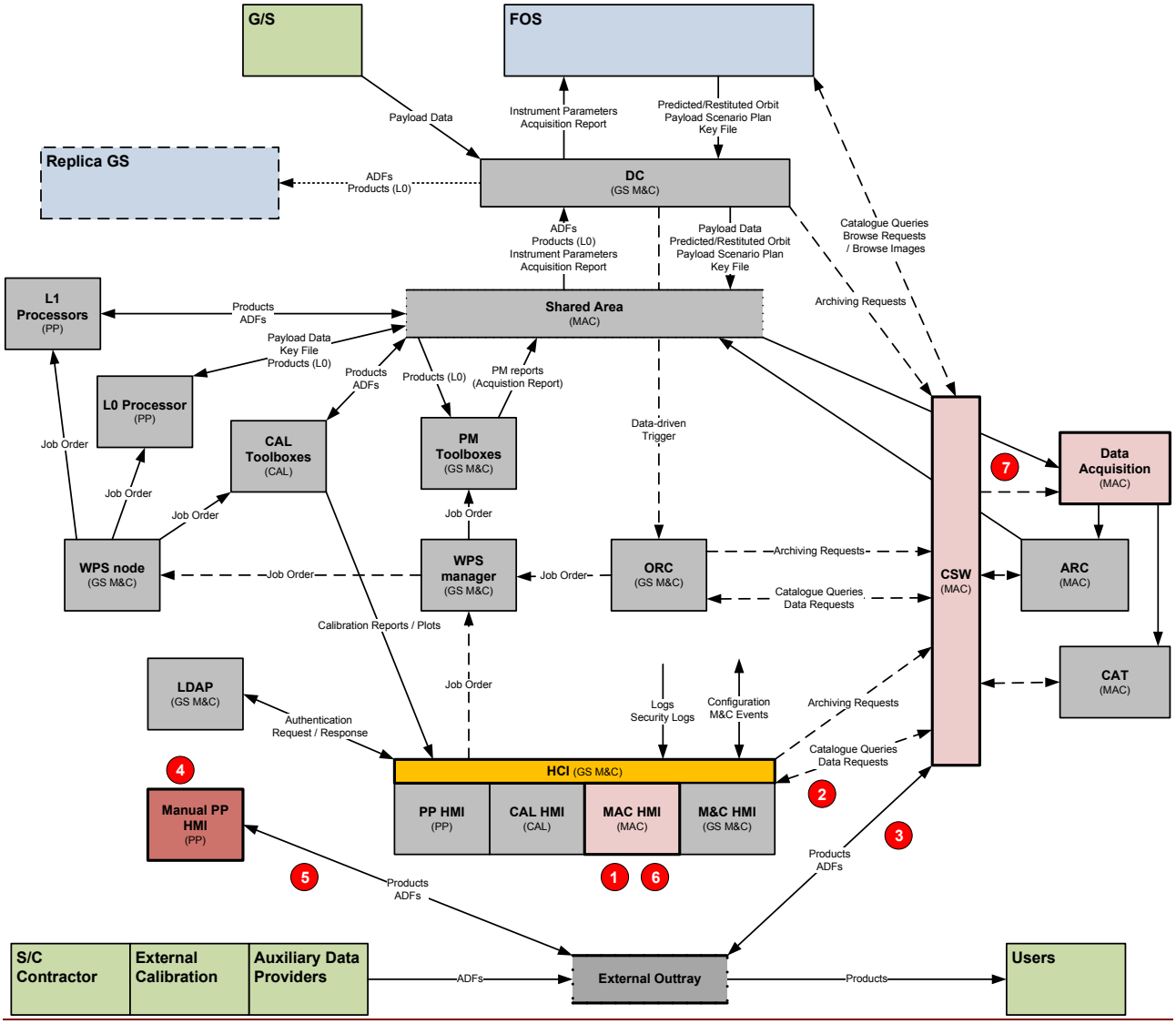

Figure 17: L1 Manual Processing

The following table describes each of the steps as well as the relations with other sequences:

Table 18: L1 Manual Processing Steps

Step	Activity	Actor	Description
1	MAC HMI start	MAC HMI	This activity will only be initiated if required. It is an on-demand activity. The operator starts the MAC HMI.
2	Catalogue query for input products and ADF	MAC HMI	The operator, through the MAC HMI, queries the MAC for the required input products. This includes L1b, reference images (if available), etc. It links with Catalogue Query sequence.

Step	Activity	Actor	Description
3	Input data retrieval to external out tray	MAC HMI / CSW	After operator selection and confirmation, input data is moved to the external out tray. This links with Data Extraction sequence.
4	Manual PP HMI execution	Manual PP HMI	The operator starts the Manual Processor HMI, accessing the external out tray, using also, if needed, references images, and, helped by the tool. First it generates GCP and then triggers the generation of the L1c. This could be an iterative process, until the required accuracy is reached.
5	Output data production	Manual PP HMI	Output products and reports are left in the external out tray.
6	Output data selection	MAC HMI	Through the MAC HMI, the operator selects the products to be stored (linking them to the inputs used) and requests product archival.
7	Data archival	CSW	Output data is archived and the processing task is finally completed. This links with Data Archiving sequence.

3.2.5. Archiving

The Archiving operation sequences give support for all most of the PDGS operations sequences and are basically manage by the MAC element. It includes the following sub-sequences:

- Data Archiving. The MAC receives an Archiving Request from external components at the CSW interface, validates the inputs and ingests the data in the MAC ARC, adding the corresponding metadata on the MAC CAT.
- Data Extraction. The MAC receives a Data Request from external components at the CSW interface, looks for the corresponding data on its ARC component checking if the data is already placed in the MAC Shared Area and copies the data to the requested destination.
- Catalogue Query. The MAC receives a Catalogue Query or Browse Request from external components at the CSW interface and generated the corresponding response from the information stored in the MAC CAT. The response is sent through the same request connection.

The internal mechanism of these MAC operation sequences are described in detail in the MAC ADD and ICD.

3.2.6. Automatic Calibration Monitoring

3.2.6.1. Purpose

This sequence describes the tasks performed by the PDGS to run automatic calibration monitoring functions. It is equivalent to the L1 Automatic Processing chain.

3.2.6.2. Relation to other sequences

This sequence interacts with:

- Data Archiving
- Data Extraction
- Catalogue Query

3.2.6.3. Steps

The following diagram depicts the main sequence steps:

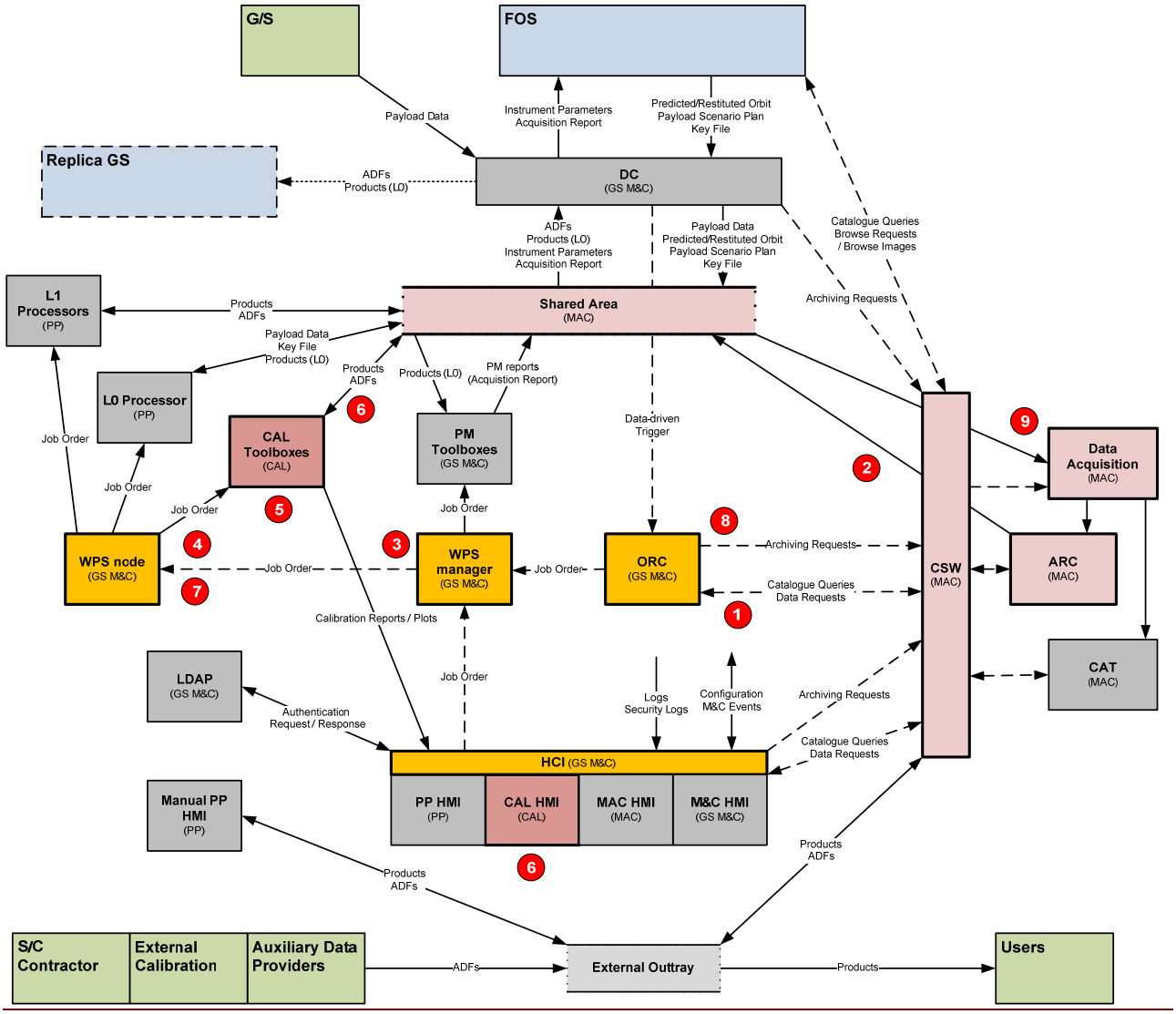

Figure 18: Automatic Calibration Monitoring

The following table describes each of the steps as well as the relations with other sequences:

Table 19: Automatic Calibration Monitoring

Step	Activity	Actor	Description
1	New Product Query	ORC	ORC queries the MAC for the existence of files that could trigger the Automatic Calibration Monitoring function (according to the configured rules, in principle due to an acquisition over calibration sites). It links with Catalogue Query sequence.

Step	Activity	Actor	Description
2	Input data retrieval	MAC	After successful fulfilment of rules, input data is requested to the MAC and moved to the shared area (data could already be there, depending on retention policies). This links with Data Extraction sequence.
3	Job Order Creation	ORC	As a continuation of step 2, the job order is created and sent to the WPS node via WPS manager.
4	Job order Queue and Calibration Toolbox triggering	WPS node	The job order is placed in a queue and when possible the relevant Calibration Toolbox is triggered. The toolbox health is then monitored.
5	Calibration Toolbox execution	Cal Toolboxes	Cal Toolboxes are executed.
6	Output data production	Cal Toolboxes	The result of the toolbox is left in the shared area and reports are also published in the web server (accessed through CAL HMI).
7	Toolbox termination	WPS node	The toolbox ends and the WPS node detects the result of the activity, informing ORC of the result of the execution.
8	Data archival request	ORC	ORC received message from WPS node and collects output data, requesting its storage.
9	Data archival	Data Acquisition	Data Acquisition is commanded by ORC to archive output data, finally completing the calibration task. This links with Data Archiving sequence.

3.2.7. Manual Calibration

3.2.7.1. Purpose

This sequence describes the tasks done within the PDGS to perform manual calibration activities, like the generation of new ADF files.

3.2.7.2. Relation to other sequences

This sequence interacts with:

- Data Archiving
- Data Extraction
- Catalogue Query
- Transfer to Replica

3.2.7.3. Steps

Due to the complexity of the sequence, it has been split in two main steps. In the first one the new ADF will be generated and in the second one it will be validated and inserted into the system. The following diagram depicts the first step:

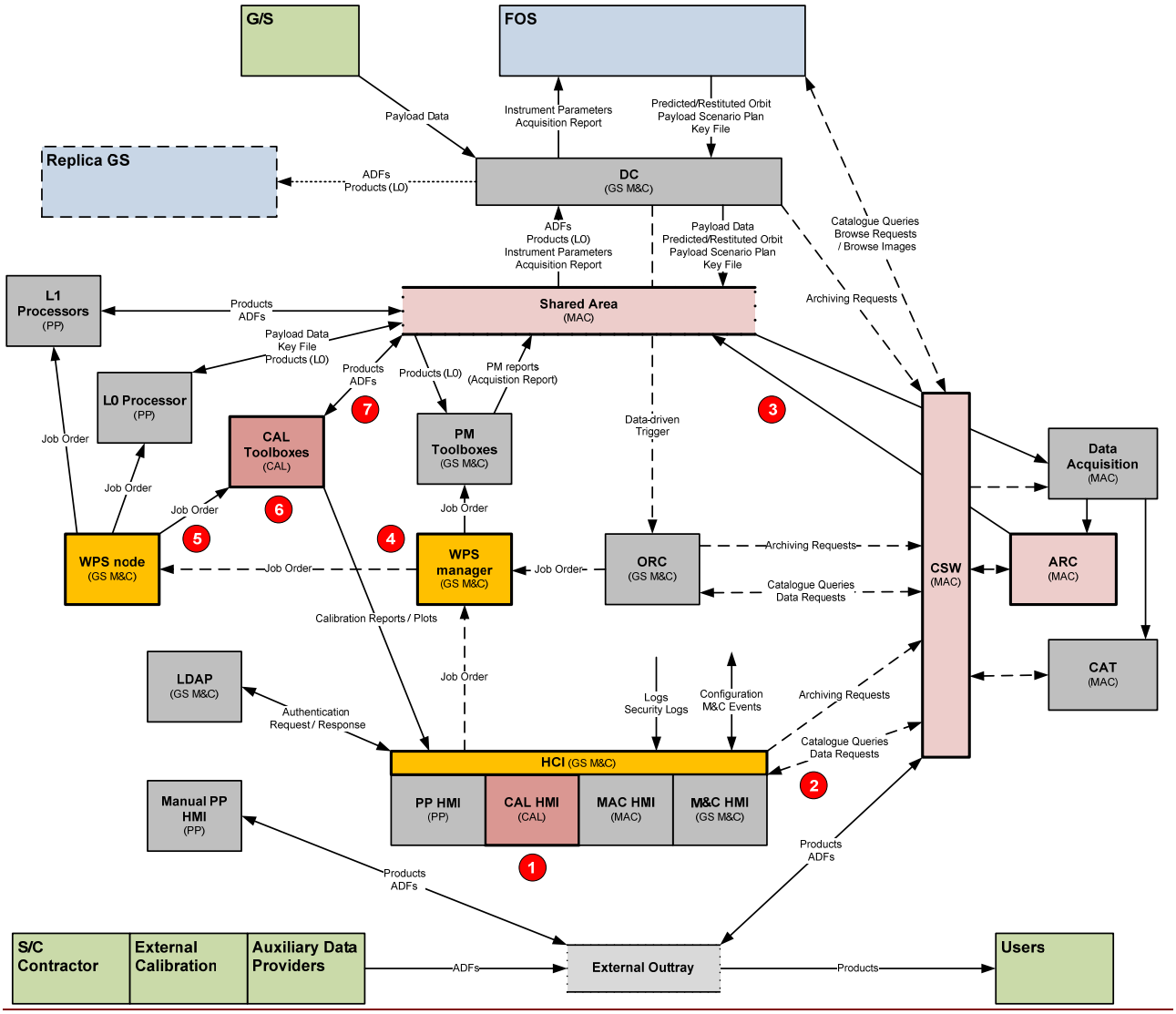

Figure 19: Manual Calibration (1)

The following table describes the figure as well as the relations with other sequences:

Table 20: Manual Calibration (1)

Step	Activity	Actor	Description
1	CAL HMI start	CAL HMI	This activity will only be initiated if required. It is an on-demand activity. The operator starts the CAL HMI.
2	Catalogue query for previous ADF and other input products.	CAL HMI	The operator, through the CAL HMI, queries the MAC for the required input products. This includes previous ADF, L0 or other required inputs. It links with Catalogue Query sequence.
3	Input data retrieval to shared area	MAC	After operator selection and confirmation, input data is moved to the shared area. This links with Data Extraction sequence.

Step	Activity	Actor	Description
5	Job Order Creation	CAL HMI	As a continuation of step 3, the job order is created and sent to the WPS node via WPS manager.
5	Job order Queue and Calibration Toolbox triggering	WPS node	The job order is placed in a queue and when possible the relevant Calibration Toolbox is triggered.
6	Calibration Toolbox execution	Cal Toolboxes	Cal Toolboxes are executed.
7	Output data production	Cal Toolboxes	The result of the toolbox is left in the shared area and reports are also published in the web server (accessed through CAL HMI).

The second step:

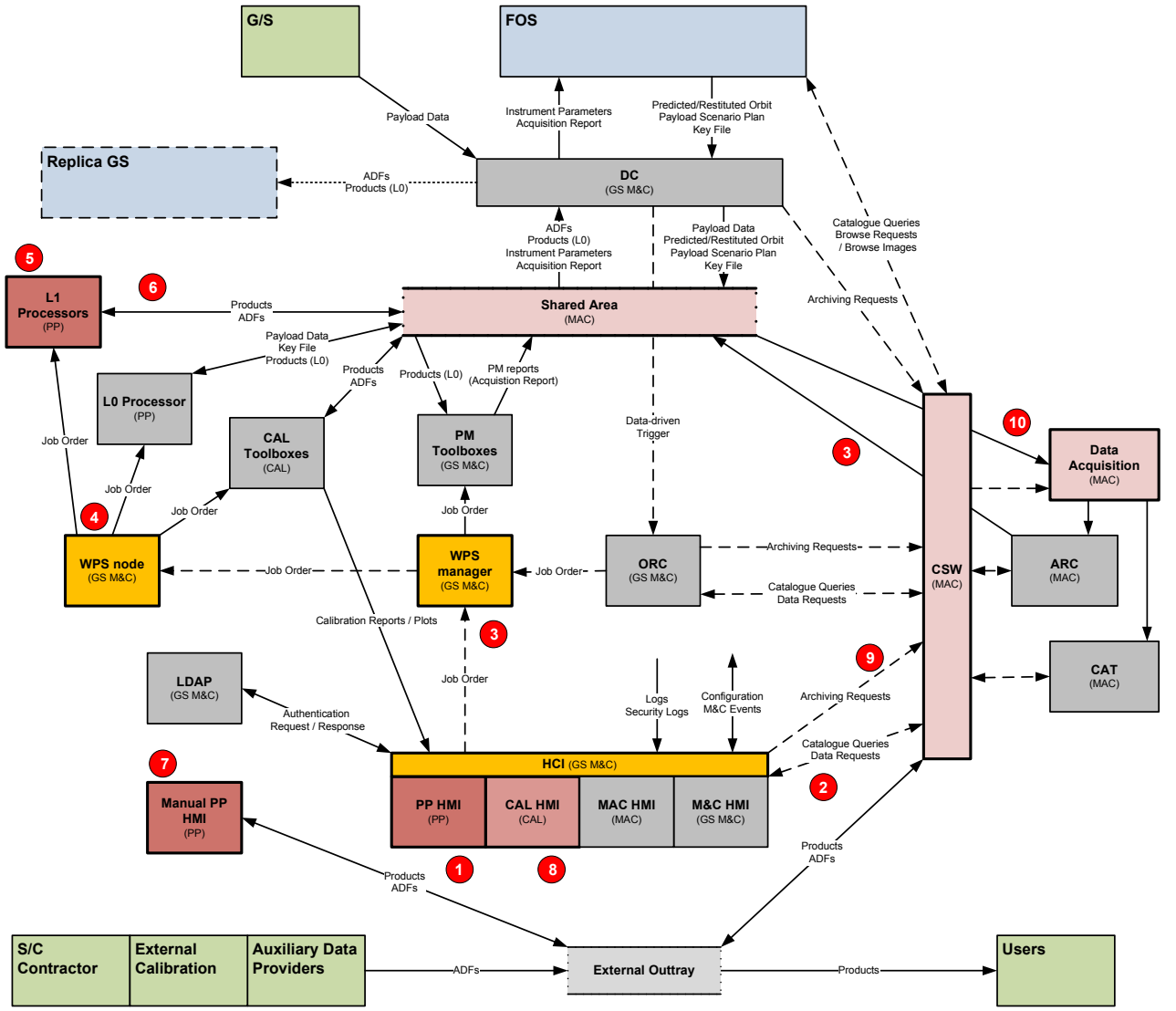

Figure 20: Manual Calibration (2)

The following table describes the figure as well as the relations with other sequences:

Table 21: Manual Calibration (2)

Step	Activity	Actor	Description
1	PP HMI start	PP HMI	Once the result of the toolbox is available (new ADF), the operator starts the PP HMI.
2	Selection of shared area files (new ADF) and catalogue query for other input files.	PP HMI / CSW	The operator, through the PP HMI, selects the processor to be executed as well as the relevant files from the shared area and queries the MAC for other needed input products. It links with Catalogue Query sequence.
3	Input data retrieval to shared area and Job Order Creation	PP HMI	After operator selection and confirmation, input data is moved to the shared area. This links with Data Extraction sequence. The job order is created and sent to the WPS node via WPS manager.
4	Job order Queue and L1 Processor triggering	WPS node	The job order is placed in a queue and when possible the L1 Processor is triggered.
5	L1 Processor execution	L1 Processors	L1 processors are executed.
6	Output data production	L1 Processors	The result of the processing is left in the shared area.
7	Analysis of results	Manual PP HMI	Once the processor has finished, it will be possible to analyse the outputs using the Manual PP HMI.
8	Validation of new ADF	CAL HMI	The new ADF needs to be validated and put under C&C. This is done within the CAL HMI that in the end requests the archival of the new ADF.
9	Data archival request	CAL HMI	A request for output archival is issued from the CAL HMI to the CSW
10	New ADF Archival	Data Acquisition	ADF is archived and the manual calibration task is finally completed. This links with Data Archiving sequence. It also links with Transfer to Replica sequence.

3.2.8. Data Reception

3.2.8.1. Purpose

This sequence describes the tasks performed by the PDGS to insert new ADFs received externally.

3.2.8.2. Relation to other sequences

This sequence interacts with:

- Data Archiving

3.2.8.3. Steps

The following diagram depicts the main sequence steps:

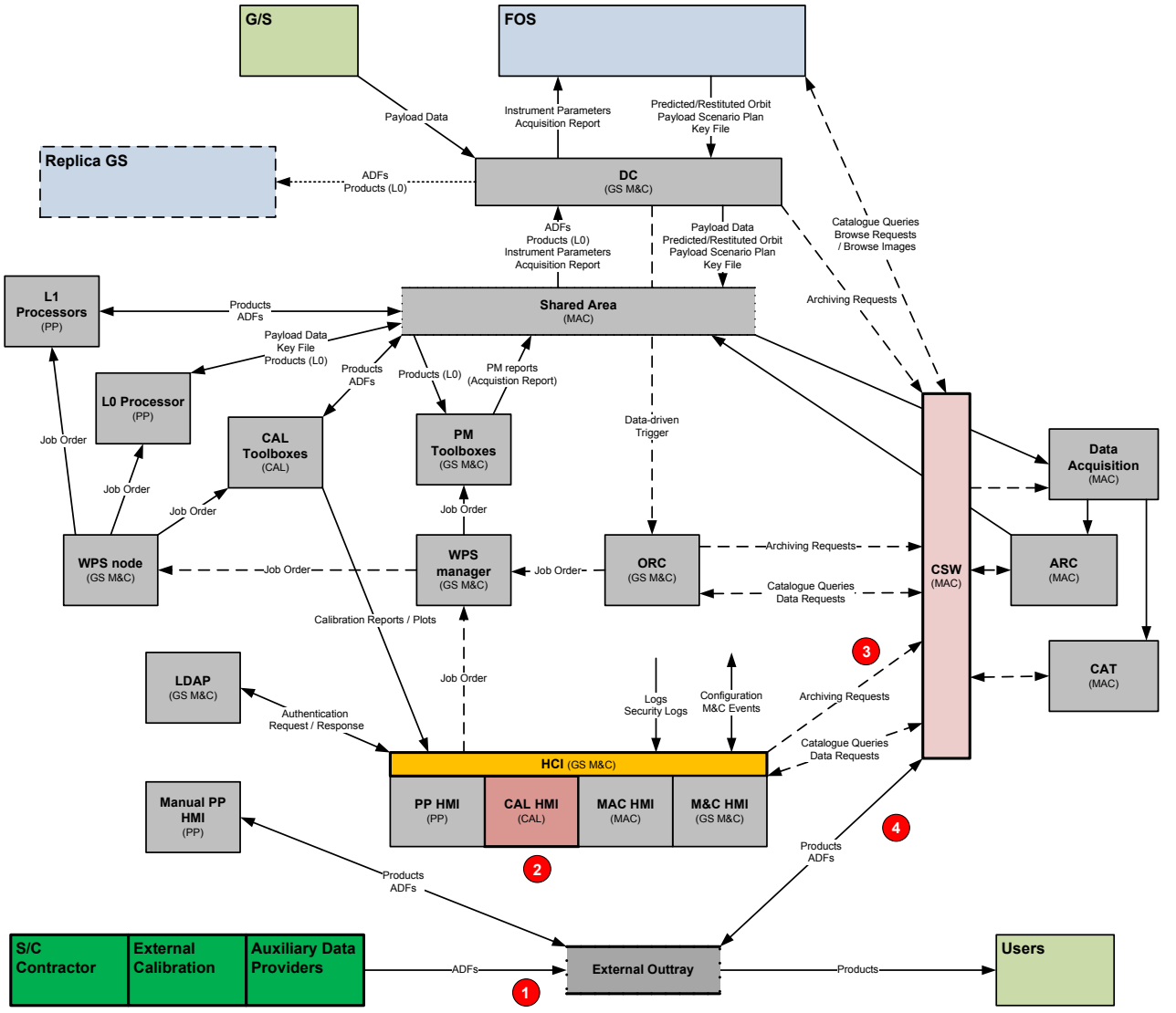

Figure 21: Auxiliary Data Reception

The following table describes each of the steps as well as the relations with other sequences:

Table 22: Auxiliary Data Reception Steps

Step	Activity	Actor	Description
1	New ADF moved to external out tray	Operators	New ADF is placed in the external out tray.
2	Validation of new ADF	CAL HMI	The new ADF needs to be validated and put under C&C. This is done within the CAL HMI, which in the end requests the archival of the new ADF.
3	New ADF archival request	CAL HMI	A request for new ADF archival is issued from the CAL HMI to the CSW

Step	Activity	Actor	Description
4	New ADF Archival	Data Acquisition	ADF is archived. This links with Data Archiving sequence.

3.2.9. Product Export

3.2.9.1. Purpose

This sequence describes the tasks performed by the PDGS to extract data from the MAC.

3.2.9.2. Relation to other sequences

This sequence interacts with:

- Catalogue Query
- Data Extraction

3.2.9.3. Steps

The following diagram depicts the main sequence steps:

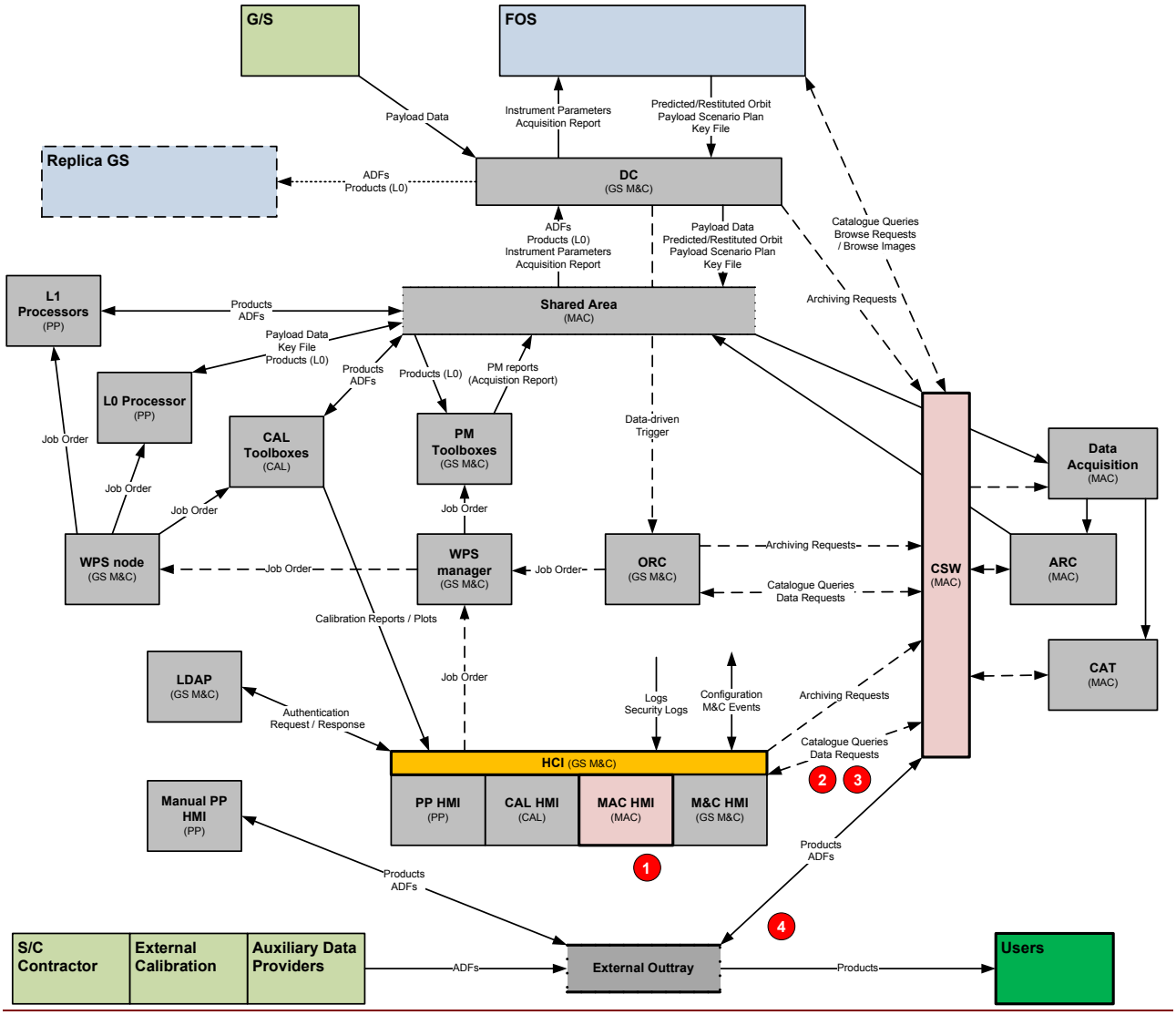

Figure 22: Product Export

The following table describes each of the steps as well as the relations with other sequences:

Table 23: Product Export Steps

Step	Activity	Actor	Description
1	MAC HMI start	MAC HMI	This activity will only be initiated if required. It is an on-demand activity. The operator starts the MAC HMI
2	Catalogue query for requested products	MAC HMI	The operator, through the MAC HMI, queries the MAC for the required product(s) to be exported. It links with Catalogue Query sequence

Step	Activity	Actor	Description
3	Product retrieval to external out tray	MAC HMI	After operator selection and confirmation, requested product is moved to the external out tray. This links with Data Extraction sequence.
4	External file available to external users	Users	The file is available to external users.

3.2.10. Transfer to Replica

3.2.10.1. Purpose

This sequence describes how the PDGS delivers L0 and ADF data to the replica (optional process, depending on the GS deployment configuration).

3.2.10.2. Relation to other sequences

This sequence interacts with:

- L0 Processing
- Manual Calibration

3.2.10.3. Steps

The following diagram depicts the main sequence steps:

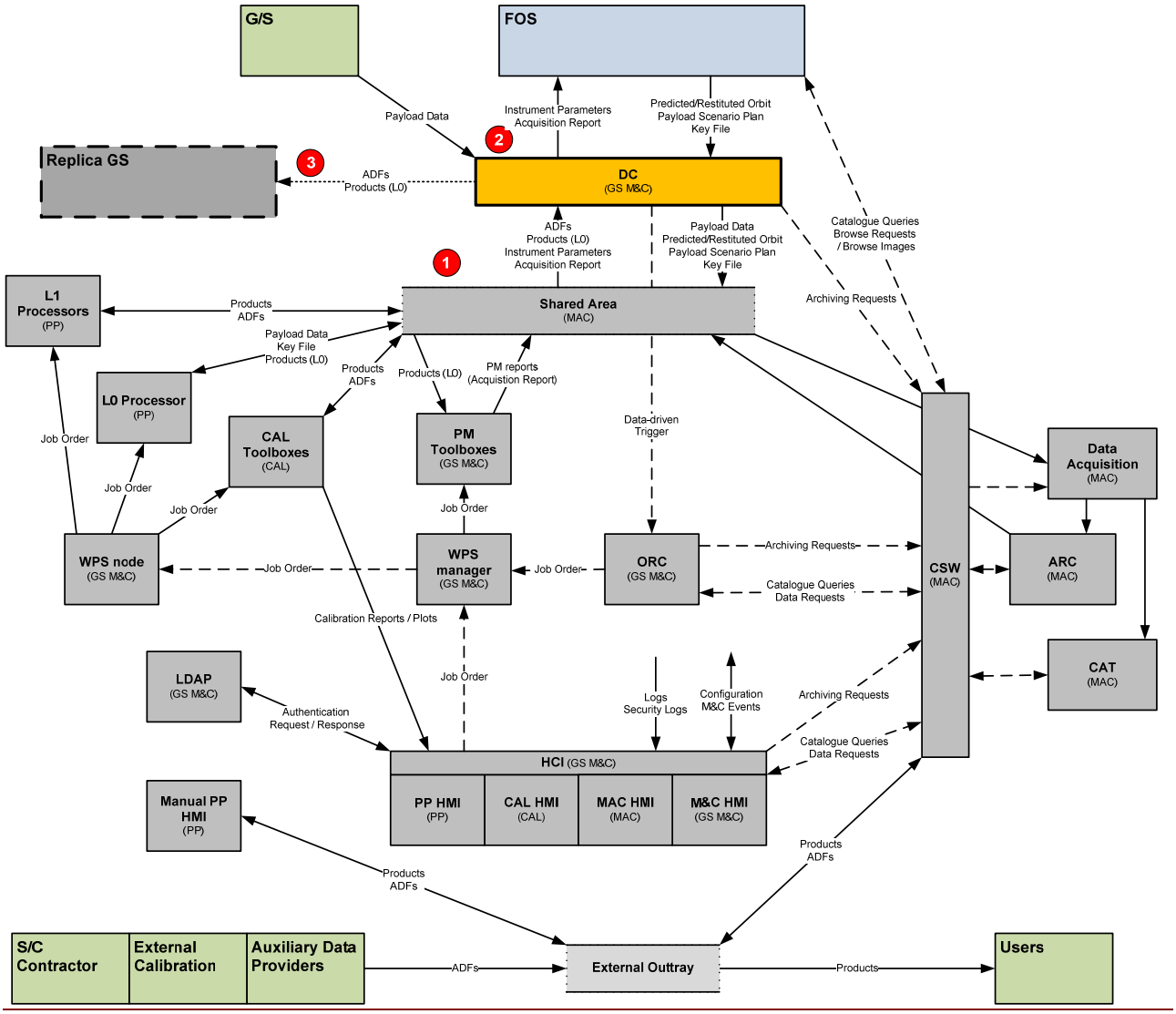

Figure 23: Transfer To Replica

The following table describes each of the steps as well as the relations with other sequences:

Table 24: Transfer To Replica Steps

Step	Activity	Actor	Description
1	L0 or ADF data left in special shared area	DC	L0 and ADF files are available in shared area, as outputs of L0 Processing sequence and Manual Calibration sequence.
2	Data Distribution polling for data to be replicated	DC	The DC polls the shared area for new data to be replicated to the Replica GS
3	Product delivery to replica	DC	Upon detection of files to be replicated the Data Distribution delivers them to the Replica GS

3.3. General Operations

It contains nominal management operations that shall be performed by all the D2 GS elements.

3.3.1. GS M&C

All GS elements shall report their status to the G/S M&C element at two different levels:

- Issuing messages on their own logs. These logs are read by the GS M&C and presented to the operators. For critical events those messaged can be configured to be sent to the operators through email and sms.
- Issuing monitoring events from the elements equipment from the installed snmp agents reporting the status of the equipment and main processes. These events are also displayed on the GS M&C HMI.

External monitoring events from the GS environment infrastructure can also be reported to the GS M&C. In the same way selected GS monitoring events can be sent to the external GS environment infrastructure.

3.3.2. Authentication

Each GS element shall grant access to its functionality after login in their HMI. The login process connects with the LDAP component reporting the operator user and password and where it is authenticated.

3.3.3. Configuration

The GS M&C HCI and the FOS elements HMIs have access to the elements configuration files and provides tools for its edition. It maintains the configuration and control of the different elements configuration files.

3.3.4. Back-up / Restore

Each GS element shall include a set of routine operations to backup their data and configuration, so their status can be restore in case of possible lost of data due to any system failure.

3.3.5. Clean-up

Each GS element shall implement a clean up procedure deleting their obsolete data, both in files and databases.

3.3.6. Maintenance

Each GS element shall implement a maintenance procedure to stop the system and install new element updates (HW SW or configuration) and restart it.

4. CONTINGENCY OPERATIONS

4.1. GS – G/S Communications Failures For S-band Operations

This scenario describes the processing of raw TM files recorded in Cortex in case of communications failure between MCS and G/S equipment (either SVB or PLL).

Any unavailability of the communications link between the MCS and the G/S (either PLL or SVB) will result in the impossibility to receive the HK TM from the S/C during the pass.

To avoid the lost of any S/C TM the G/S equipment will be configured for each pass to record al the TM received in a file. In case of communication failure the MCS will be able to retrieve the file with the recorded TM data (via FTP) to be replayed in the MCS to process all the data as if it were part of a pass. This is an offline manual activity.

In the case of the PLL FTP access to retrieve the file with the HK TM data is expected.

In the case of the SVB, the contract with KSAT is supposed to grant this service, and a FTP access point from which recover the file with the HK TM data (maybe not the BB Equipment) is expected.

Once the error has occurred the following steps are to be executed manually by the operator:

- Re-establish communications with G/S.
- Retrieve the file with the pass HK TM data from ftp site (either PLL o SVB).
- Replay file into MCS.
- During file replay MCS performs in parallel the TM&TC operations:
  - Real-time HK TM processing.
  - Uplinks FCS & Payload Scenarios.
  - Downlinks of selected onboard files (WOD's, Logs, etc).
- After file replay:
  - MCS archives downloaded onboard files and file with real-time HK TM for later offline processing and use.
  - MCS makes GPS Log (if any) available to FDS.

4.2. Orbit Maintenance in case of MPS Unavailability

In case of MP unavailability the D2 GS operator will have to retrieve FCS Scenarios for orbit maintenance (or in case of required emergency manoeuvre) from the FDS system and to provide those files to the MCS.

For this case the FOS configuration shall be changed to forward the FCS Scenario files directly to the MCS from the FDS instead of through the MPS.

From there, regular pass activities will handle the upload and activation of the FCS scenario files according to the nominal pass operations.

4.3. Onboard SW Update

Binary files containing "patches' to onboard equipment (OS, onboard tasks, CAN nodes firmware, etc) will be received from SI as response to required updates in the software or as result of bug fixes.

This operation is understood to be critical and is expected to be handled "manually" by the operator. In this case "manually" means manual execution of pre-created scripts (direct manual commanding by operators is also possible but no recommended).

4.4. S/C Contingencies According to S/C FDIR Scenarios

The GS will be able to identify any S/C anomaly that is reported within the HK TM data (as realtime TM or within the various WODs or log files created onboard).

The way to identify such anomalies is reported within the DM2SE33B10 (FMECA & FDIR Table) document.

Once detected the anomaly will be reported within the MCS environment, and if so configured, it will be reported as well within the GS M&C system (e.g. alarm is raised, operator is notify by SMS or whichever other mechanisms that is associated to that anomaly).

No automatic recovery for S/C anomalies is implemented within the D2 GS. Any recovery action will have to be triggered or executed by an operator using the required GS components.

These recovery actions will be documented as part of operational procedures that are outside the scope of the D2 GS development activity to be written by the operations team.

4.5. GS Mission Critical Equipment Failures

The GS FOS elements (FDS, MPS, MCS and GSCS) implement the GS mission critical functions that are vital for the maintenance of the S/C in a safe state.

In case of failure of any equipment (HW) where those critical elements are run, there are several possibilities according to the concerned element:

- All FOS elements. These elements are installed in virtual servers. It will be possible to reinstall these elements on replacement HW within the time constraints specified in the technical requirements. The element status at the time of the failure can be recovered from the element data backups (configuration, databases) regularly performed and then restart the operations.
- MCS. There is a second instance of the MCS installed at Svalbard. This installation receives all the input data (scenarios and orbit data) that is received at the nominal MCS. In case that the operation from the nominal MCS is not possible this second installation can be activated and configured to command the Svalbard station. It will be possible from this secondary MCS to upload the latest scenarios and also manually command the S/C.
- FDS. For the FDS it is possible to use any external FDS installation to generate the required information (manoeuvres and orbit data) using the same inputs than the nominal FDS instance. The produced results can then be inserted manually on the GS.
- GSCS. The GSCS is only used for the PLL station. In case of problems with it, the GS can continue operating using the Svalbard station.

These recovery actions will be documented as part of GS operational procedures or user manuals to be part of the D2 GS documentation.