30th June 2013

SAR Formation Flying

Annex 11. Detailed Requirements Analysis of the Garada Mission

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Revision History

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V01_00	30th June 2013	Dr Gordon Roesler	Initial Release

1. Preface

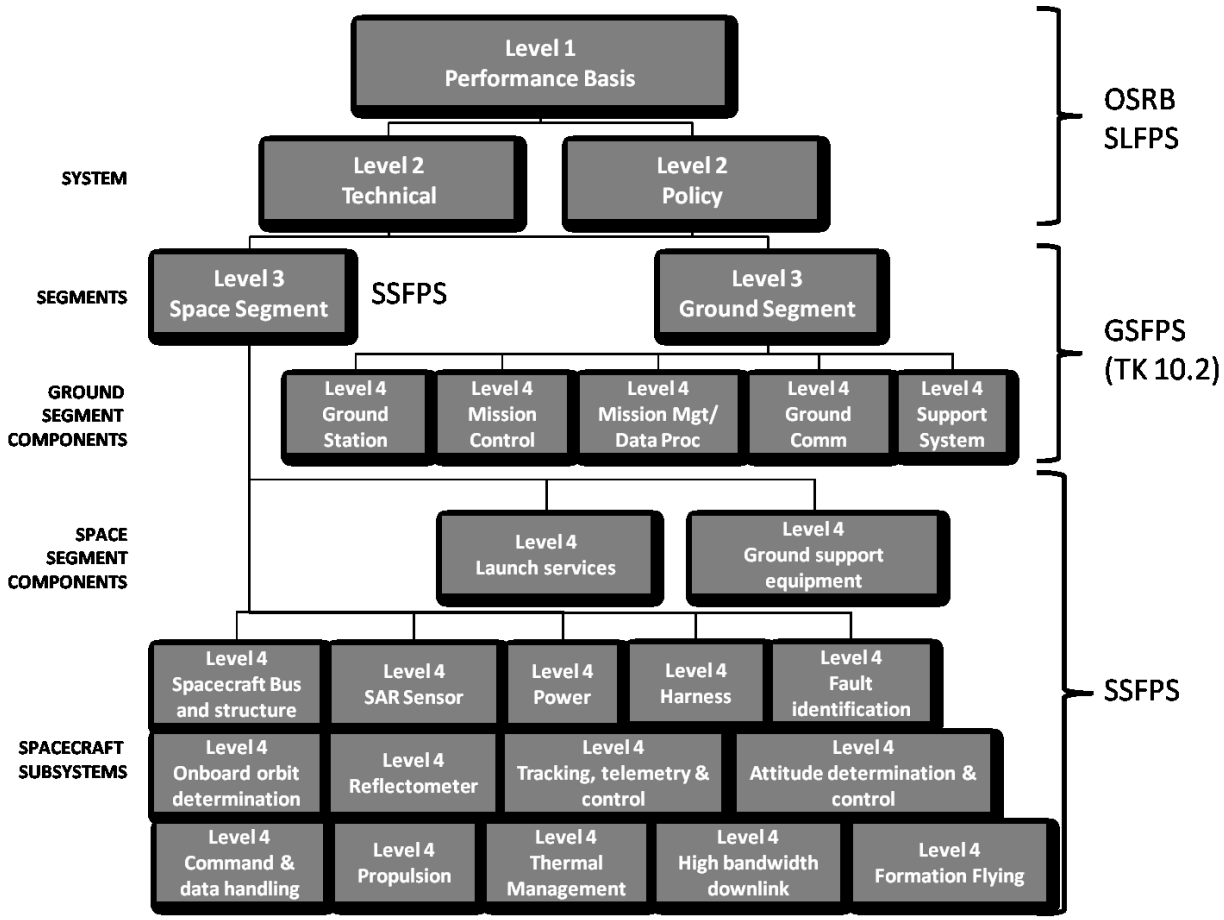
This annex contains four documents:

1. The Objective System Requirements Baseline (OSRB). This was the first system-wide requirements compilation prepared for the Garada Synthetic Aperture Radar (SAR) project. It was intended to function as the starting point for the acquisition of a space system, in a future phase, capable of performing the Garada mission. It contains requirements at three levels:
    a. The customer performance specifications (Level 1 requirements). Since no actual Garada customer exists, these were established based on projected system performance and potential user needs as determined from interviews.
    b. Top-level system technical requirements (Level 2T). These were derived from Level 1 using engineering knowledge of space systems, results of Garada analyses, and inputs from Garada team members.
    c. Legal and policy requirements applicable to the Garada system (Level 2P). These consist of international space agreements, radio frequency regulations, and other regulatory matters.
2. The System Level Functional Performance Specification (SLFPS). This system-wide document was completed as the final performance specification at the end of the Garada program. It is similar in scope to the OSRB, but contains additional requirements that emerged as the baselining process proceeded during the program.
3. The Space Segment Functional Performance Specification (SSFPS). This requirements document was prepared by UNSW. The primary approach for preparing this requirements deck was familiarity with space systems performance. Significant input was received from EADS Astrium, who provided a generic radar satellite functional performance specification as a template. TK 10.2 was also used to generate requirements for the space segment, by identifying space segment-ground segment interfaces.
4. The Ground Segment Functional Performance Specification (GSFPS). This requirements document was prepared as TK10.2 Functional Performance Specification by BAE Systems, and is the functional specification for the ground system down to the subsystem level. It is included in this Annex for completeness.

This requirements set is of the maturity that would be expected after the initial requirements generation process by a systems engineering team. The next step in an actual spacecraft acquisition would be requirements validation, which entails discussions between the systems engineering team and the design team. Ultimately, the goal would be to conduct a System Requirements Review with the spacecraft customer.

It is important to note that this requirements set was derived without the specific algorithm for soil moisture measurement having been selected. The actual specification of soil moisture-related requirements (e.g. SAR parameters, look angles, calibration procedures, orbits) should be determined in coordination between the spacecraft/SAR design team and the development team for the soil moisture algorithms.

Graphically, the hierarchy of the documents in the requirements set is shown below:



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OBJECTIVE SYSTEM REQUIREMENTS BASELINE

3. Introduction

The Garada SAR Formation Flying project was a Phase 0 design study funded by the Australian Space Research Program (ASRP). The mission baseline for the Garada SAR Formation Flying mission is described in [1]. To implement that mission, an objective Garada system would be designed and built. This document contains the highest 3 levels of requirements for that objective system, and the level 4 requirements for the SAR sensor. Incorporated in the current baseline are the sensor-centric performance requirements of [2]. The performance embodied in [2] is critical to achieving the system objectives, but there are numerous other system-level properties that must be captured and incorporated in an eventual system design. Those form the balance of the present document.

4. Background

At the time the business case described in [3] was being prepared, the Garada SAR Formation Flying mission had examined applications in flood monitoring, forest change detection and high spatial resolution soil moisture mapping, all using spaceborne Synthetic Aperture Radar (SAR). In the ensuing months, development of requirements, specifications and designs have concentrated on the soil moisture application.

The Garada team committed to developing the objective system requirements baseline using standard systems engineering procedures for space systems. This activity had several benefits to the project:

- It ensured that the 11 work packages of the Garada project are working to common objectives.
- It facilitated communication among Garada team members at multiple organizations.
- It assisted in the development of a risk reduction plan for subsequent phases, which was submitted as part of the final Garada report.

Were a SAR spacecraft program to commence in the out-years, requirements definition would be one of the first activities to undertake. In a typical spacecraft program, higher level requirements are developed in the first 1-3 months, and reviewed with the customer at the System Requirements Review. But in no sense are the requirements “complete” or “fixed” at that point. Requirements for subsystem and component performance begin to be specified then. Trade studies, risk reduction activities, and other analyses proceed throughout the preliminary design phase, and may have significant impacts on the requirements baseline. Requirements evolve iteratively, as improved understanding of performance limitations ramifies to the various parts of the system. Approval of the system requirements baseline is typically an exit criterion of the Preliminary Design Review. Changes to the requirements baseline during the detailed design phase are uncommon but can be accepted with the approval of design leads, the program manager, and the system engineer.

5. Applicable Documents

[1] Garada Mission Baseline, 1 August 2012

[2] Garada Requirements Summary, 1 August 2012

[3] TK 1.2 Garada SAR Formation Flying Business Case for Implementation, 31 January 2012

[4] Garada proposal, "Earth Environment Monitoring Using Formation Flying SAR (EERMUFFS)," March 2010

[5] TK 10.1 Operational Concept Document, 31 March 2012

[6] ASRP Guidelines, October 2009

[7] Australian Government Information Security Manual, September 2012, http://www.dsd.gov.au/publications/Information_Security_Manual_2012_Controls.pdf?&updatedNov12

[8] TK 1.1 User Requirements, Risk Analysis, Mission Baseline Report, 6 July 2011

[9] TK 3.3 SAR System Specification Final Issue, 30 June 2012

[10] TK 2.2 SAR Hardware and Methods Description and Specification, 30 September 2011

[11] TK 10.2 Ground Segment Functional Performance Specification, 29 June 2012

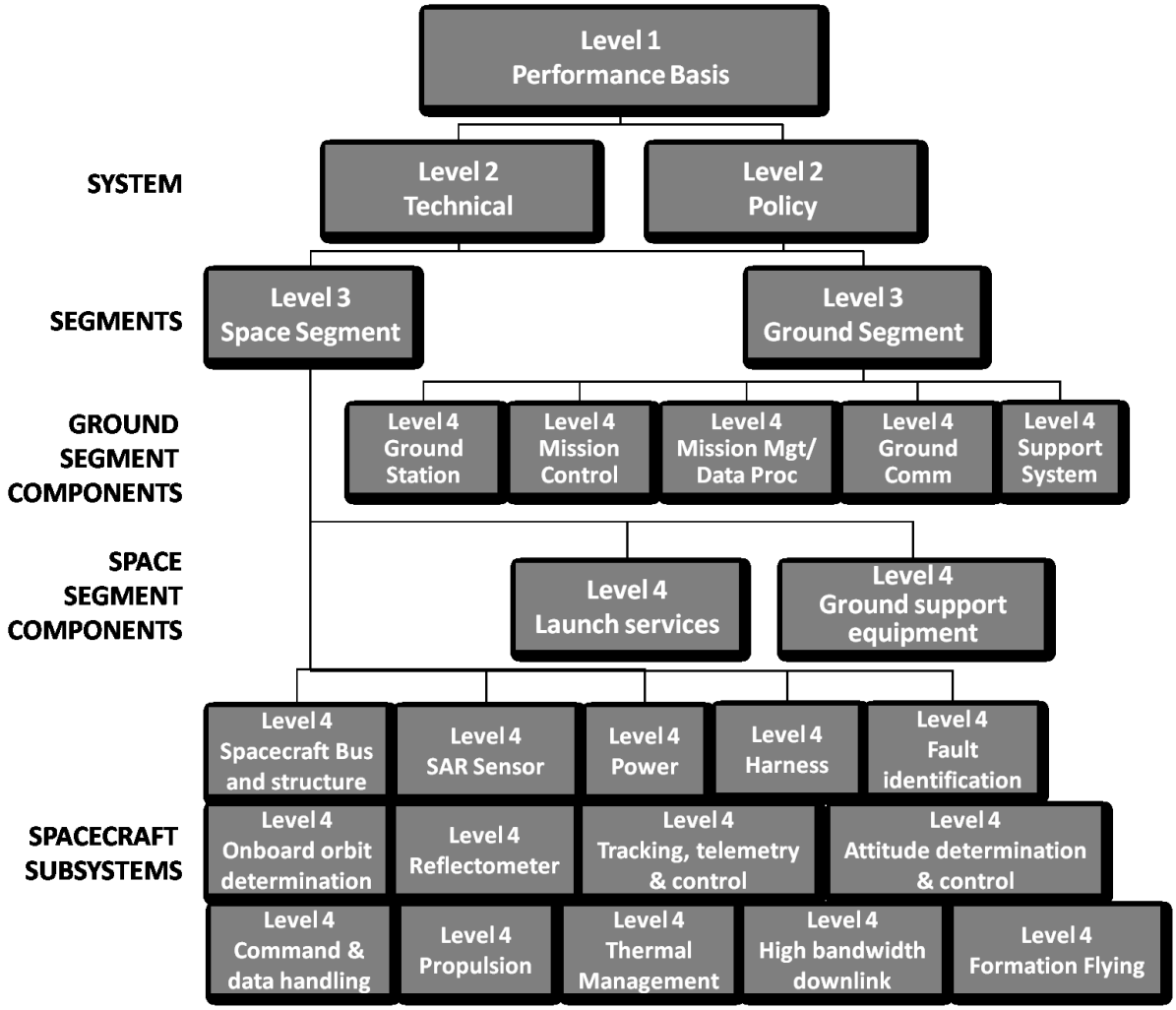
6. Objective System Requirements Baseline

Continued Garada research activities may impact the requirements baseline, particularly at the lower (more detailed) levels. However, the higher level requirements can be considered relatively stable, in that (1) the mission has been defined, and many requirements derived from that; (2) sensor requirements have been laid out for a plausible approach, around which many other of the high level requirements have been defined; and (3) many drivers of the high level requirements, such as policies, international agreements and national needs, are largely stable.

At the present time, one area of uncertainty that affects lower level requirements is the development of algorithms for the extraction of soil moisture levels from SAR radar data. The Garada team enlisted an advisory group of Australian experts in this area. Their analysis of the problem at hand contributed to the maturity of the requirements baseline, particularly at the subsystem level.

The final version of the requirements baseline is at approximately the state of maturity expected for a spacecraft System Requirements Review. Some of the Garada work packages yielded more detailed understanding of projected performance; this improved the validity and stability of the requirements baseline.

6.1. Requirements structure



6.2. Level 1 Requirements

Level 1 requirements are essentially the customer expectations for the performance of the system. Since the customer for Garada is hypothetical at this point, several steps have been taken to baseline a reasonable set of Level 1 requirements:

- Interviews of potential end users, such as those identified in [5] and [8]
- Maintaining consistency with the ASRP guidelines and the proposed research
- Establishment of a User Advisory Group, whose requirements for SAR data are representative of a scientific customer
- Incorporation of Level 1 requirements that are typical for other space systems

NOTE: for all levels of requirements, some numerical values still await the results of analysis. Those are denoted either by a variable label such as XX, or by TBD (to be determined).

No.	Requirement	Reference
1.1	The Garada system shall be capable of obtaining radar measurements reflected from the Earth at a rate sufficient to fulfill the data needs of the soil moisture and forest biomass user communities.	[4]
1.2	The Garada system shall support the measurement of various properties of and conditions on the Earth's surface through post-processing of its received radar signals.	[4]
1.3	The Garada system shall provide a radar data stream of known characteristics.	[9]
1.4	The Garada spacecraft shall test the ability to obtain data on various properties of and conditions on the Earth's surface through exploitation of received GNSS signals in a bistatic mode.	[4]
1.5	The Garada system shall distribute data to end users for post-processing.	[5]
1.6	The Garada system shall support the diffusion of knowledge to the agricultural sector and to environmental agencies and organizations.	[6]
1.7	The Garada system shall be capable of altering its operations to facilitate the imaging and interferometric use of its radar data.	[5]
1.8	The Garada system shall maintain a data archive capable of retaining all data received for the life of the mission.	[5]
1.9	The Garada system shall consider both single-spacecraft and multi-spacecraft solutions.	[4]
1.10	The Garada on-orbit mission lifetime shall be no less than YY years and features that support continued operations beyond YY years if the space segment health permits.	[6]
1.11	The Garada system shall be designed to collect data on Australia as the primary area of interest.	[6]
1.12	The Garada system coverage requirement shall be capable at a minimum of full radar coverage of the Murray Darling Basin every three days if two spacecrafts are in orbit.	[5], [6]
1.13	The Garada spacecraft shall incorporate light-weight and low-cost satellites, advanced technologies and techniques to the maximum extent practicable to provide the equivalent capabilities of conventional satellite designs.	[10]
1.14	The Garada spacecraft shall use Australian capabilities, products and expertise to the maximum extent possible.	[6]
1.15	The Garada system design basis shall be the measurement of soil moisture data.	[3]
1.16	The latency of Garada data from on-orbit collection over Australia to delivery to a near-real-time user within Australia using the National Broadband Network shall be no more than HH hours.	[5], [6]
1.17	The Garada system shall support the collection and dissemination of data in areas of the world beyond Australia on an ad hoc basis.	[6]

1.18	The Garada system shall provide satellite based SAR and GNSS reflectometry data to users via the National Broadband Network.	[5], [6]
1.19	The Garada system shall maintain an effective cyber security posture.	[7]
1.20	The Garada system shall support measurements of forest biomass.	
1.21	The Garada system shall support assessment of climate change effects and the efficacy of climate change interventions that are related either to soil moisture or to biomass.	
1.22	The Garada system shall support interferometric imaging, for such applications as forestry, elevation maps, coherent change detection, and deformation detection.	
1.23	The Garada system design shall include a cost-benefit metric.	[6]
1.24	The Garada system shall include features to mitigate the effect of terrestrial sources of radio frequency interference in the radar signal.	
1.25	The Garada system shall have a design availability in excess of AA %.	
1.26	The Garada system design shall incorporate the best practices of the aerospace industry for safety and reliability.	
1.27	The Garada system shall implement a capability for onboard orbit determination.	[4]
1.28	The Garada system shall incorporate information obtained from conjunction assessment services to enable safe operation in the event of a predicted conjunction.	
1.29	The average time from data collection to download of data from the spacecraft shall be no greater than two orbit periods.	

6.3. Level 2 Technical Requirements

There are two distinct sets of Level 2 requirements. The set in this section contains the technical requirements that apply to the system as a whole. The other Level 2 requirements, called “policy,” are explained and listed in the next section.

Derivation of Level 2 Technical from Level 1 requirements requires engineering interpretations of the Level 1 performance expectations. Engineering experience and knowledge are used to assign technical approaches for achieving that performance, i.e., the Level 2 Technical requirements.

No.	Requirement	Reference	Flowdown
2T.1	The Garada system will be based on satellite in low Earth orbit.		1.1
2T.2	The primary Garada system sensor shall be Synthetic Aperture Radar (SAR).		1.1
2T.3	The Garada spacecraft shall provide for data downlink at	[5]	1.5

	least once per orbit after collecting data on the Australian land mass.		
2T.4	The Garada spacecraft orbit will be a six day repeat orbit.		1.1
2T.5	The Garada system shall establish interfaces with the data customers for receiving of requests for data.	[5], [6]	1.5, 1.6
2T.6	The Garada system shall establish interfaces with the data customers for delivery of data.	[5], [6]	1.5, 1.6
2T.7	The Garada system shall support upgrading selected spacecraft software while on orbit.		1.7
2T.8	The Garada system shall enable modifications to ground-based processing software for implementing new applications.		1.7
2T.9	The Garada system shall include the capability of automatic archiving of downlinked radar data.	[5]	1.8
2T.10	The Garada system shall include sufficient number of spacecraft in appropriate orbits to achieve complete imaging of the Murray Darling Basin every three days.		1.12
2T.11	The Garada system shall implement a risk reduction program to qualify light-weight materials and low-cost components for incorporation into the spacecraft design.		1.13
2T.12	The Garada system shall use a quad polarization L band radar.		1.15
2T.13	The Garada system shall employ processing techniques for radar data that maximize the accuracy of soil moisture estimates.		1.15
2T.14	The Garada system shall be designed with an Australian ground station as the primary downlink site.		1.16
2T.15	The Garada system shall include the option of downlinking data to ground stations outside of Australia.	[5], [6]	1.16
2T.16	The Garada system shall establish an interface for receiving requests for Garada data from users worldwide.		1.17
2T.17	The Garada system shall establish a communication interface for worldwide delivery of processed Garada data.		1.17
2T.18	The Garada spacecraft shall incorporate onboard navigation using GNSS signals.	[4]	1.27
2T.19	The Garada system shall incorporate features intended to preclude malicious interference with spacecraft command and control.	[7]	1.19
2T.20	The Garada system design shall incorporate features intended to identify and/or prevent tampering with or malicious corruption of downlinked data received from the spacecraft.	[7]	1.19
2T.21	The Garada system design shall incorporate features	[7]	1.19

	intended to identify and/or prevent malicious corruption of, or introduction of malicious code into, data delivered to users.		
2T.22	The Garada System design shall implement applicable portions of the Australian Government Information and Communications Technology Security Manual (ISM).	[7]	1.19
2T.23	The Garada system shall provide for internal calibration of the SAR sensor.	[9]	1.2, 2T.1
2T.24	The Garada system shall provide for external calibration of the SAR sensor.	[9]	1.2, 2T.1
2T.25	The design basis of the Garada system shall incorporate a cost-benefit metric that accounts for improvements to Australian agriculture and environmental restoration in addition to system cost.	[6]	1.23
2T.26	The Garada system shall process raw data from the spacecraft and provide usable data to end users.		1.6
2T.27	The Garada system shall respond to commands that alter the mode, operating parameters and data collection area of the SAR sensor.		1.7, 1.17
2T.28	The Garada system design shall utilise components that support an on-orbit operational lifetime of YY years		1.10
2T.29	The Garada Ground Segment shall contain processors and interfaces for post-processing of SAR data to produce maps of soil moisture and forest biomass.		1.2
2T.30	The Garada system shall include GNSS circuitry antenna and processors for the reception and measurement of bistatic GNSS signals.		1.4
2T.31	The Garada Ground Segment shall support applications that convert radar data to maps and other formats for various users.		1.6
2T.32	The Garada Ground Segment shall be able to update its software for imaging and interferometric applications of its radar data.		1.7
2T.33	The Garada system shall be able to control and determine orbit position with sufficient accuracy and repeatability to support interferometric radar applications.		1.7
2T.34	The Garda system shall have support for formation flying in multi-spacecraft solution.		1.9
2T.35	The Garada system segments shall incorporate components and operating procedures that lead to a design lifetime no less than YY years.		1.10
2T.36	The Garada system shall include spacecraft consumables to support mission lifetime of no less than YY years.		1.10
2T.37	The Garada system shall have solar arrays that support mission lifetime of no less than YY years.		1.10
2T.38	The Garada system shall have the capability to avoid space debris collision to support an on-orbit mission lifetime of no less than YY years.		1.10

2T.39	The Garada system shall prioritise the collection of data on Australia.		1.11
2T.40	The Garada System shall be capable of restricting its transmissions to prevent unacceptable interference with RF-sensitive equipment, such as the Deep Space Network site at Tidbinbilla.		1.11
2T.41	The Garada System ground station shall be sited such as not to require simultaneous SAR operation and downlink when collecting data over Australia.		1.11
2T.42	The Garada sensor shall support full coverage of the Murray Darling basin area from a six-day repeat orbit.		1.12
2T.43	The Garada spacecraft shall incorporate components produced by Australian capabilities, products and expertise to the maximum extent possible.		1.14
2T.44	The choice of ground station location for the Garada system shall support delivery of data to an Australian user in no more than HH hours.		1.16
2T.45	The Garada system shall be capable of collecting data over areas outside Australia on ad hoc basis.		1.17
2T.46	The Garada system shall incorporate commands for collecting data on areas other than Australia when required.		1.17
2T.47	The Garada system shall be able to collect SAR data on at least 3,000 kilometres along each orbit.		1.17
2T.48	The Garada system shall be able to downlink SAR data of at least 3,000 kilometres in a single pass over the ground station.		1.17
2T.49	The Garada system shall be capable of preventing the operation of malicious command that may deteriorate the functionality of the spacecraft.		1.19
2T.50	The Garada system shall provide high level of data security to prevent it being corrupted or altered during data delivery to its end user.		1.19
2T.51	The Garada system shall be capable of preventing any unauthorised use of the spacecraft.		1.19
2T.52	The Garada sensor shall be capable of transmitting and receiving signals that can detect changes to forest biomass.		1.20
2T.53	The Garada system shall support the transmission of relevant data to forest biomass users.		1.20
2T.54	The Garada system data archive shall support long-term data comparisons for climate change assessment and interventions.		1.21
2T.55	The Garada system shall be capable of orbit control precision that supports interferometric imaging.		1.22
2T.56	The Garada system shall support transmission of interferometric data relevant to forestry, elevation maps, coherent change detection and deformation detection.		1.22
2T.57	The Garada system shall have the capability to filter out out-of-band radio frequency to mitigate any possible interference to the radar signal.		1.24
2T.58	Garada system shall have the capability to localise sources of in-band radio frequency interference.		1.24

2T.59	The Garada system shall have equipment capable of failure identification, detection and recovery to minimising system downtime when it occurs.		1.25
2T.60	The Garada system components shall support a combined availability higher than AA%		1.25
2T.61	The Garada system design and manufacturing shall be executed by credible aerospace industry to ensure its safety and reliability.		1.26
2T.62	The Garada system components shall be tested in compliance with an Assembly, Integration and Verification (AIV) plan prepared prior to assembly and launch to ensure its safety and reliability in Operational Phase.		1.26
2T.63	The Garada system data archive shall be interfaced with the Australian National Data Service.		1.8

6.4. Level 2 Policy Requirements

Spacecraft operations are governed by a number of international treaties and conventions. In addition, spacecraft must comply with some aspects of Australian law. There are also policies of the Australian Government that must be incorporated into the requirements. All of these, and some others, are at Level 2 because they affect the entire system, but are not at the level of customer performance requirements.

Because they originate from laws, treaties, etc. rather than from customer performance expectations, Level 2 Policy requirements do not necessarily flow down from Level 1.

Lest there be any doubt, Level 2 Policy requirements can have significant impacts on the technical design of the system. One example is the requirement for a deorbit capability if the orbit lifetime exceeds 25 years, embodied in a United Nations convention. This impacts at least the propulsion system of the spacecraft. Another example is the frequency allocation for radar measurements provided by the International Telecommunications Union. Reference [9] contains an analysis of how this allocation affects radar resolution.

No.	Requirement	Reference	Flowdown
2P.1	The Garada spacecraft shall comply with the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.	[5]	
2P.2	The Garada spacecraft shall comply with the Convention on International Liability for Damage Caused by Space Objects.	[5]	
2P.3	The Garada system shall comply with the Convention on Registration of Objects Launched into Outer Space.	[5]	
2P.4	The Garada spacecraft shall comply with the UN Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space.	[5]	

2P.5	The Garada spacecraft shall comply with the UN Principles Relating to Remote Sensing of the Earth From Outer Space.	[5]	
2P.6	The Garada spacecraft shall comply with the UN Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries.	[5]	1.17
2P.7	The Garada spacecraft shall comply with the "Radio Regulations Edition of 2008", International Telecommunication Union.	[5]	
2P.8	The Garada system shall comply with the Commonwealth of Australia Space Activities Act 1998.	[5]	
2P.9	The Garada spacecraft shall comply with the Commonwealth of Australia Radiocommunications Act 1992.	[5]	
2P.10	The Garada System design will support ownership and operation by the Australian Government.	[5]	
2P.11	The Garada System shall comply with the Australian Government Information Security Manual.	[7]	1.19

6.5. Level 3 Requirements

The Garada system has been divided, for the purpose of establishing requirements, into two major divisions:

- The space segment, which includes:
  - The spacecraft delivered to orbit, with sensors and all internal subsystems;
  - Mechanical and electrical ground support equipment; and
  - Launch activities, which include the launch vehicle, spacecraft/launch vehicle integration, launch procedures, and range activities.
- The ground segment, which includes
  - A Ground Station System (GSS) that undertakes the reception of payload and telemetry data and the transmission of command data to the Garada Spacecraft;
  - A Mission Control System (MCS) that undertakes the monitoring and control of the spacecraft and payloads, operations planning and scheduling, and GSS monitoring and control;
  - A Mission Management and Data Processing System (MMDPS) that undertakes the calibration and processing of the SAR and GNSS payloads, interpretation of imagery, receiving of customer requests and distribution of processed products to customers. This also includes any requirements on the processing algorithms and systems associated with determination of soil moisture levels from radar data;
  - A Communications System (CS) that handles all voice and data communications between the systems and with the outside world; and
  - A Support System (SS) that provides hardware and software maintenance and upgrades to the Ground Segment.

Derivation of Level 3 requirements from higher levels requires an engineering understanding of the capability of various alternatives to achieve the higher level requirements. This engineering understanding resides within the Garada team, supplemented by consultations with outside experts when required. Through this process, Level 3 requirements will continue to evolve for all system segments during the remainder of the project. For that reason, references and flowdowns for Level 3+ will be incorporated in a subsequent version of this document.

6.5.1. Level 3 Space Segment requirements (3.1.x)

No.	Requirement	Reference	Flowdown
3.1.1	The Garada space segment shall support orbit maintenance with a LTAN variation of no more than TBD and an altitude variation of no more than TBD km.		
3.1.2	Orbit maintenance of the Garada spacecraft shall support the mission design lifetime.		
3.1.3	The Garada space segment shall be capable of independent determination of orbital parameters.		
3.1.4	The Garada space segment shall be capable of collecting data in areas other than Australia as long as electrical power and data capacity do not preclude it.		
3.1.5	The Garada space segment shall support the launch, operation, calibration, and commanding of a SAR sensor that is optimized for soil moisture measurements.		
3.1.6	The Garada orbits shall support imaging the entire MDB at 1 km (multilooked) resolution every 2 weeks in Quad Pol and every 3 days in Dual Pol.		
3.1.7	The Garada space segment shall support obtaining radar returns from the Earth's surface at high spatial resolution.		
3.1.8	The Garada orbits shall provide for the same azimuth angle of data collection (a pass made in ascending node must be revisited by an ascending node pass, a descending node pass must be revisited by a descending node pass) with elevation angle differences of no more than 5°.		
3.1.9	The Garada orbit shall provide for data collection at 6 AM [due to the thermal equilibrium between soil/air/vegetation, the capillary moisture raise in the top soil layer, and the minimum of Faraday rotation in the ionosphere].		
3.1.10	The radar duty cycle of the Garada spacecraft shall be no less than that required to cover the longest linear dimension of the entire Murray-Darling basin.		
3.1.11	The Garada space segment shall provide the capability of controlled deorbit at end of mission.		
3.1.12	The Garada space segment shall receive uplinked commands in encrypted form.		
3.1.13	The Garada space segment shall provide for encryption of its downlink.		

3.1.16	The Garada space segment shall be compatible with the Falcon 9 launch vehicle of Space Exploration Corporation.		
3.1.17	The Garada space segment shall be compatible with the Delta IV Medium launch vehicle of the Boeing Corporation.		
3.1.18	The Garada space segment shall be capable of delivering all spacecraft required to meet data collections requirements in 1 or 2 launches.		
3.1.19	The Garada space segment design shall consider proposed secondary payloads to the extent that they will not jeopardize the primary mission.		
3.1.20	The Garada space segment shall support an operational mode of two spacecraft operating in formation (close proximity) to evaluate bistatic radar operation.		
3.1.21	The Garada space segment shall support the periodic adjustment of orbits for the performance of interferometric imaging.		

6.5.2. Level 3 Ground Segment requirements (3.2.x)

A highly detailed requirements development process for the ground segment has been documented in [11]. Additional high level requirements having been identified since its production, some reconciliation with the present baseline will be conducted in due course. That reconciliation will take the form of an update to [11] and updates of this document.

No.	Requirement	Reference	Flowdown
3.2.1	The Garada ground segment shall provide for the downlink of the data volume supporting reimaging the entire MDB at 1 km (multilooked) resolution every 2 weeks in Quad Pol.		
3.2.2	The Garada ground segment shall provide for the downlink of the data volume supporting reimaging the entire MDB at 1 km (multilooked) resolution every 3 days in Dual Pol		
3.2.3	The Garada ground segment shall provide for the downlink of the data volume generated by imaging a swath of 3,000 km each orbit in high resolution (250m multilooked) in Quad Pol		
3.2.4	The Garada ground segment shall support the external calibration of the SAR sensor.		
3.2.5	The Garada ground segment shall include a data archive capability for all downlinked radar data.		
3.2.6	The Garada ground segment shall provide for data		

	dissemination to end users.		
3.2.7	The Garada ground segment shall provide for receipt of data requests from customers.		
3.2.8	The Garada ground segment shall transmit encrypted commands to the spacecraft.		
3.2.9	The Garada ground segment shall decrypt the downlink from the spacecraft.		
3.2.10	The Garada ground segment shall include cyber intrusion detection features.		
3.2.11	The Garada ground segment shall be designed such that uplink and downlink can be provided by existing fixed Australian ground sites in addition to dedicated Garada ground stations.		
3.2.12	The Garada ground segment shall support the distribution of data to users via the National Broadband Network.		

6.5.3. Soil Moisture Data Processing requirements

Requirements for data post-processing will be included in the Mission Management and Data Processing System of the Ground Segment, to the extent that such processing is considered part of the Garada system. It is envisioned that much of that processing will be performed by users to whom data is provided, but who are outside the system proper. These requirements will evolve significantly as the Garada team interacts with its user advisory group of soil moisture measurement experts.

No.	Requirement	Reference	Flowdown
	The Garada system shall support one or more computational algorithms that can estimate soil moisture content from SAR radar returns.		
	The Garada system shall include processes for minimizing the effects of vegetation in the determination of soil moisture.		
	The Garada system shall include processes for minimizing the effects of surface roughness in the determination of soil moisture.		
	The Garada system shall include processes for minimizing the effects of dew in the determination of soil moisture.		
	The Garada system shall include processes for compensation for Faraday rotation of polarization vectors in the ionosphere.		

6.6. Level 4 and 5 Requirements

Levels 4 and 5 requirements for the Garada system are still largely under development. However, two subsystems—the ground segment and the space-based SAR sensor—have been considered in relative detail. Again, Level 4 and 5 requirements are only beginning to be defined at this stage, and it is anticipated that this list will expand considerably through the remainder of the project.

6.6.1. Level 5 SAR Sensor Requirements (4.1.x)

No.	Requirement	Reference	Flowdown
5.1.1	The radar shall operate in the L band [to minimize the contributions of surface roughness and overlying vegetation to the radar echo, and yet take advantage of the larger bandwidth allocation in L band compared to P band].	[2]	
5.1.2	The radar design shall be based on coherent quad polarization operation to allow for correction of Faraday rotation in the ionosphere, in support of soil moisture measurement from space.	[2]	
5.1.3	The radar shall provide a stripmap mode with ability to resolve 250m parcels after multilooking.	[2]	
5.1.4	The radar shall provide a scanSAR mode with ability to resolve 1000m parcels after multilooking.	[2]	
5.1.5	The Garada radar shall provide a radiometric resolution capable of distinguishing a TBD% difference in reflectivity between two parcels of multilooked pixels.	[2]	
5.1.6	The Garada radar design shall be capable of segmented operation (left-right, or other segmentation approaches) to support investigations of its use in other applications.		
5.1.7	The Garada radar design thermal baseline shall be anti-Sun-looking 6 AM passes, but shall include Sun-looking passes when necessary to avoid imaging when the nadir is over water.		

6.6.2. Ground segment Level 4+ requirements

The Garada team, specifically BAE Systems, have developed an extensive requirements set for the ground segment. Those requirements are listed in [11] and will not be repeated here.

7. Future development of system requirements baseline

Systems engineering best practices for the development of requirements baselines can follow different paths. If there is a customer with clear objectives in mind, the requirements flow from those objectives by the application of engineering expertise in the different disciplines. Another approach is to begin with an initial “straw man” design, a “technology push” approach so to speak. The latter approach is being pursued in the Garada project. Through the various analyses, trade studies, design team interactions, collaborations with other experts, and literature searches, a set of requirements will emerge. The SAR system described in [9], and being further developed by Garada team analyses, is a portion of that initial “straw man” design. The process will result in a well-engineered, self-consistent requirements baseline, through Level 4.

One aspect of the “straw man” design that has shifted markedly since the beginning of the project was the importance of formation flying for the required performance. The present mission requirement, with two spacecraft on opposite sides of an orbit ring, does not require precision formation flying. However, some potential users are still interested in a bistatic mode of operation. Accordingly, requirements are being developed for a formation flying phase to investigate this mode; this phase would likely occur near the end of the operational mission.

SYSTEM LEVEL FUNCTIONAL PERFORMANCE SPECIFICATION

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-43	**1 Scope**	Heading		
SLFPS-44	***1.1 Identification***	Heading		
SLFPS-45	This is the System Level Functional Performance Specification (FPS) for the Garada Synthetic Aperture Radar (SAR) Formation Flying system. This document will be included in the Garada final report to be delivered to Australia Space Research Program (ARSP). This document is derived from Garada Objective System Requirements Baseline (OSRB), Astrium Preliminary Spacecraft Requirements Specification (SRS) and TK 10.2 Functional Performance Specification.	Information		
SLFPS-46	***1.2 System Overview***	Heading		
SLFPS-47	Garada, funded under the Australian Space Research Program (ASRP), is a collaborative space engineering research project at the Australian Centre for Space Engineering Research. Garada is investigating the design of a low cost L-Band Formation Flying SAR satellite system for monitoring regional deforestation and forest degradation, soil moisture mapping, flood and disaster monitoring. Consortium members include the University of New South Wales, EADS Astrium, Curtin University of Technology, TU Delft, BAE Systems and General Dynamics Corporation.	Information		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-48	This System Level functional performance specification contains the highest level technical requirements on the system. Those requirements must flow down to either the Garada System Ground Segment, Space Segment or both. Separate functional performance specifications for the Ground and Space Segments will contain more detailed requirements. The Ground Segment consists of: 1. Ground Station System (GSS) 2. Mission Control System (MCS) 3. Mission Management and Data Processing System (MMDPS) 4. Communications System (CS) 5. Support System (SS) The Space Segment is comprised of sixteen subsystems: I. Spacecraft Bus and Structure (SBAS) II. SAR Sensor (SAR) III. Electrical Power Subsystem (EPS) IV. Attitude Determination and Control System (ADACS) V. Command and Data Handing (CADH) VI. Onboard Orbit Determination (OOD) VII. Harness (HAR) VIII. Tracking, Telemetry and Control (TTAC) IX. GNSS Reflectometry Sensor (GNSS-R) X. Propulsion (PROP) XI. High Bandwidth Downlink (HBDL) XII. Launch Services (LS) XIII. Mechanical and Electrical Ground Support Equipment (MGSE/EGSE) XIV. Support for Formation Flying (SFF) XV. Thermal Management (TM)	Information		
SLFPS-49	The Garada Space Segment is composed of one spacecraft or two separate but identical spacecraft, flying in tandem in the same orbital plane and housing the identical SAR imaging instrument.	Information		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-50	The L-band radars are downward looking Synthetic Aperture Radar Instruments.	Information		
SLFPS-51	When assigned, the Garada Spacecraft contractor will be responsible for In-Orbit Delivery (IOD) of the Garada Spacecraft against the Garada Spacecraft requirements. Implicit in this is the responsibility of the Garada Spacecraft contractor to source an appropriate Launch Service.	Information		
SLFPS-52	When assigned, the Garada System Prime Contractor is responsible for the verification (against the Garada Operational and Performance Requirements or System Specification) and delivery (IOD of the whole Garada System to the Customer) at 'level 0', the Garada System. When assigned, the Garada Spacecraft Prime Contractor would be responsible for the verification (against the Garada Spacecraft Requirements Spec) and delivery (again IOD, but to the Garada System prime) at 'level 1', the Garada Spacecraft.	Information		
SLFPS-53	**1.3 Document Overview**	Heading		
SLFPS-68	This document specifies the system level requirements for the Garada System.	Information		
SLFPS-54	**2 Applicable Documents**	Heading		
SLFPS-55	**2.1 Normative References**	Heading		
SLFPS-56	Garada Spacecraft - Ground Segment Interface Control Document (ICD)	Requirement		Prepare during design phase
SLFPS-57	Garada Spacecraft - Launch Vehicle Interface Requirements Specification	Requirement		Prepare during design phase
SLFPS-58	**2.2 Informative References**	Heading		
SLFPS-59	Garada System Design and Interface Document	Requirement		Prepare during design phase
SLFPS-60	Prime Launch Vehicle User Manual (Falcon 9)	Requirement		
SLFPS-61	Backup Launch Vehicle User Manual (Delta IV)	Requirement		
SLFPS-62	International Telecommunications Union (ITU) RR-98 Radio Regulations, Article S5, Section IV	Requirement		
SLFPS-63	International Space Debris Safety Requirements, W.Flurry	Requirement		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-64	**2.3 Standards**	Heading		
SLFPS-65	European Co-operation for Space Standardisation (ECSS) Space Engineering - System Engineering	Requirement		
SLFPS-66	Metallic Materials and Elements for Aerospace Vehicle Structures	Requirement		
SLFPS-67	ECSS Space Engineering - Thermal Control	Requirement		
SLFPS-136	**2.4 Garada Documents**	Heading		
SLFPS-137	Garada Mission Baseline	Information		
SLFPS-138	Garada Requirements Summary	Information		
SLFPS-139	TK 1.2 Garada SAR Formation Flying Business Case for Implementation	Information		
SLFPS-140	TK 10.1 Operational Concept Document	Information		
SLFPS-141	Australian Government Information Security Manual	Information		
SLFPS-142	TK 3.3 SAR System Specification Final Issue	Information		
SLFPS-143	TK 2.2 SAR Hardware and Methods Description and Specification	Information		
SLFPS-144	TK 10.2 Ground Segment Functional Performance Specification	Information		
SLFPS-114	**2.5 Australian Standards**	Heading		
SLFPS-115	AS 1319:1994 - Safety Signs for the Occupational Environment	Requirement		
SLFPS-116	AS 1657:1992 - Fixed platforms, walkways, stairways and ladders - Design, construction and installation	Requirement		
SLFPS-117	AS/NZS 1680:2006 - Interior and workplace lighting	Requirement		
SLFPS-118	AS/NZS 1768:2007 - Lightning protection	Requirement		
SLFPS-119	AS/NZS 2211.2:2006 - Safety of laser products - Safety of optical fibre communication systems (OFCS)	Requirement		
SLFPS-120	AS 4024.1604:2006 - Safety of machinery Part 1604: Design of controls, interlocks and guarding - Emergency stop - Principles for design	Requirement		
SLFPS-121	AS 4024.1702:2006 - Safety of machinery Part 1702: Human body measurements – Principles for determining the dimensions required for openings for whole body access into machinery.	Requirement		
SLFPS-122	AS 4024.1904:2006 - Safety of machinery Part 1904: Displays, controls, actuators and signals - Indication, marking and actuation - Requirements for visual, auditory and tactile signals	Requirement		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-123	AS/NZS 3000:2007 - Wiring Rules	Requirement		
SLFPS-124	AS/NZS 3100:2009 - Approval and test specification - General requirements for electrical equipment	Requirement		
SLFPS-125	AS/NZS 4443:1997 Office Panel Systems— Workstations	Requirement		
SLFPS-126	AS/NZS 5070.1:2008 - Siting and operation of radio communications facilities - General guidelines for fixed, mobile and broadcasting facilities including fixed location satellite earth stations independent of the operating frequency	Requirement		
SLFPS-127	AS/NZS 60950.1:2011 - Information technology equipment - Safety - General requirements Requirement	Requirement		
SLFPS-128	AS/CA S003.1:2010 Requirements for Customer Access Equipment for connection to a Telecommunications Network	Requirement		
SLFPS-129	**2.6 Other Documents**	Heading		
SLFPS-130	Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Requirement		
SLFPS-131	DEF(AUST)5168 The climactic and environmental conditions affecting the design of military materiel.	Requirement		
SLFPS-132	DI-IPSC-81431A Data Item Description: System/Subsystem Specification (SSS) (10 JAN 2000)	Requirement		
SLFPS-133	ISO/IEC 15445:2000 Information technology -- Document description and processing languages -- HyperText Markup Language (HTML)	Requirement		
SLFPS-134	NOHSC:2011 (1994) - Preparation of Material Safety Data Sheets	Requirement		
SLFPS-135	OH&S (Safety Standards) Regulations 1994.	Requirement		
SLFPS-37	**3 Requirements**	Heading		
SLFPS-38	**3.1 Required States and Modes**	Heading		
SLFPS-39	**3.2 System Capability Requirements**	Heading		
SLFPS-40	***3.2.1 Customer Level Requirements***	Heading		
SLFPS-13	The Garada system shall support the measurement of various properties of and conditions on the Earth's surface through post-processing of its received radar signals.	Requirement	OSRB v02_00 1.2	
SLFPS-22	The Garada system shall distribute data to end users for post-processing.	Requirement	OSRB v02_00 1.5	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-14	The Garada system shall support the diffusion of knowledge to the agricultural sector and to environmental agencies and organizations.	Requirement	OSRB v02_00 1.6	
SLFPS-1	The Garada system shall be capable of altering its operations to facilitate the investigation of potential new applications of its radar data.	Requirement	OSRB v02_00 1.7	
SLFPS-15	The Garada system shall maintain a data archive capable of retaining all data received for the life of the mission.	Requirement	OSRB v02_00 1.8	
SLFPS-2	The Garada system shall be designed to collect data on Australia as the primary area of interest.	Requirement	OSRB v02_00 1.11	
SLFPS-5	The Garada system coverage requirement shall be capable at a minimum of full radar coverage of the Murray Darling Basin every three days.	Requirement	OSRB v02_00 1.12	
SLFPS-6	The Garada system shall enable the measurement of soil moisture data that is relevant to agricultural and environmental concerns of Australia.	Requirement	OSRB v02_00 1.15	
SLFPS-20	The latency of Garada data from on-orbit collection over Australia to delivery to a near-real-time user within Australia using the National Broadband Network shall be no more than HH hours.	Requirement	OSRB v02_00 1.16	
SLFPS-3	The Garada system shall support the collection and dissemination of data in areas of the world beyond Australia on an ad hoc basis.	Requirement	OSRB v02_00 1.17	
SLFPS-4	The design basis of the Garada system shall incorporate a cost-benefit metric that accounts for improvements to Australian agriculture and environmental restoration in addition to system cost.	Requirement	OSRB v02_00 1.18	
SLFPS-9	The Garada system shall maintain an effective cyber security posture.	Requirement	OSRB v02_00 1.19	
SLFPS-25	The Garada system shall support measurements of forest biomass.	Requirement	OSRB v02_00 1.20	
SLFPS-26	The Garada system shall support assessment of climate change effects and the efficacy of climate change interventions that are related either to soil moisture or to biomass.	Requirement	OSRB v02_00 1.21	
SLFPS-27	The Garada system shall support interferometric imaging , for such applications as forestry, elevation maps, coherent change detection, and deformation detection.	Requirement	OSRB v02_00 1.22	
SLFPS-28	The Garada system shall ensure that its end-to-end processes result in timely delivery of data to time-sensitive users within Australia.	Requirement	OSRB v02_00 1.23	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-29	The Garada system shall have a design availability in excess of TBD %.	Requirement	OSRB v02_00 1.24	
SLFPS-30	The Garada system design shall incorporate the best practices of the aerospace industry for safety and reliability.	Requirement	OSRB v02_00 1.25	
SLFPS-93	The Garada system shall consider both single-spacecraft and multi-spacecraft solutions.	Requirement	OSRB v02_00 1.9	
SLFPS-94	The Garada on-orbit mission lifetime shall be no less than YY years.	Requirement	OSRB v02_00 1.10	
SLFPS-95	The Garada spacecraft shall incorporate light-weight and low-cost satellites, advanced technologies and techniques to the maximum extent practicable to provide the equivalent capabilities of conventional satellite designs.	Requirement	OSRB v02_00 1.13	
SLFPS-96	The Garada spacecraft shall use Australian capabilities, products and expertise to the maximum extent possible.	Requirement	OSRB v02_00 1.14	
SLFPS-108	The Garada system shall be capable of obtaining radar measurements reflected from the Earth at a rate sufficient to fulfill the data needs of the soil moisture and forest biomass user communities.	Requirement	OSRB v02_00 1.1	
SLFPS-109	The Garada spacecraft shall carry equipment for obtaining data on various properties of and conditions on the Earth's surface through exploitation of received GNSS signals in a bistatic mode.	Requirement	OSRB v02_00 1.4	
SLFPS-110	The Garada system shall provide a radar data stream of known characteristics.	Requirement	OSRB v02_00 1.3	
SLFPS-41	***3.2.2 System Technical Requirements***	Heading		
SLFPS-21	The Garada system design basis shall be the measurement of soil moisture data.	Requirement	OSRB v02_00 2T.2	
SLFPS-23	The Garada system shall provide satellite based SAR data to users via the National Broadband Network.	Requirement	OSRB v02_00 2T.4	
SLFPS-16	The Garada system shall establish interfaces with the data customers for receiving of requests for data.	Requirement	OSRB v02_00 2T.5	
SLFPS-17	The Garada system shall establish interfaces with the data customers for delivery of data.	Requirement	OSRB v02_00 2T.6	
SLFPS-18	The Garada system shall include the capability of automatic archiving of downlinked radar data.	Requirement	OSRB v02_00 2T.7	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-10	The Garada system design shall incorporate features intended to identify and/or prevent tampering with or malicious corruption of downlinked data received from the spacecraft.	Requirement	OSRB v02_00 2T.10	
SLFPS-11	The Garada system design shall incorporate features intended to identify and/or prevent malicious corruption of, or introduction of malicious code into, data delivered to users.	Requirement	OSRB v02_00 2T.11	
SLFPS-19	The Garada System design shall implement applicable portions of the Australian Government Information and Communications Technology Security Manual (ISM).	Requirement	OSRB v02_00 2T.12	
SLFPS-31	The Garada system shall process raw data from the spacecraft and provide usable data to end users.	Requirement	OSRB v02_00 2T.16	
SLFPS-32	The Garada system shall respond to commands that alter the mode, operating parameters and data collection area of the SAR sensor.	Requirement	OSRB v02_00 2T.17	
SLFPS-33	The Garada system design shall support an on-orbit operational lifetime of YY years, and features that support continued operations beyond YY years if the space segment health permits.	Requirement	OSRB v02_00 2T.18	
SLFPS-34	The Garada system shall support upgrading selected spacecraft software while on orbit.	Requirement	OSRB v02_00 2T.19	
SLFPS-35	The Garada system shall incorporate information obtained from conjunction assessment services to enable safe operation in the event of a predicted conjunction.	Requirement	OSRB v02_00 2T.20	
SLFPS-36	The average time from data collection to download of data from the spacecraft shall be no greater than two orbit periods.	Requirement	OSRB v02_00 2T.21	
SLFPS-69	The Operational Phase for the Garada spacecraft shall commence on System Handover to the Customer, and conclude with the start of the Disposal Phase of the Garada spacecraft.	Definition	Astrium SRS 5.1.3.5	
SLFPS-70	The Garada spacecraft shall provide the capability to be commanded from the ground.	Requirement	Astrium SRS 5.3.1	
SLFPS-71	The Garada System shall support monitoring spacecraft data in real-time when in contact with the spacecraft.	Requirement		
SLFPS-72	The Garada System Processor shall be capable of generating interferometric image products by imaging an area of ground with overlapping swaths acquired from different ground tracks.	Requirement	Astrium SRS 5.4.1	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-73	The Garada System shall provide a Data Quality Check Product for each raw data set, which shall contain at least: a) Raw data statistics (including downlink quality). b) Doppler centroid, ambiguity number. c) Auxiliary data (i.e. instrument mode, antenna pattern). d) Geographic localisation, incidence angle range, incidence angle and sensor look angle at centre of raw data set. e) Chirp replica power.	Requirement	Astrium SRS 5.4.1	
SLFPS-74	The Data Quality Check Product shall be available within 3 days (TBD) to allow compensation/rescheduling of subsequent observations in case of unsatisfactory expected basic product quality.	Requirement	Astrium SRS 5.4.1	
SLFPS-75	The Garada System Processor shall generate a Browse Image for all the acquired SAR data after reception of the SAR raw data.	Requirement	Astrium SRS 5.4.1	
SLFPS-76	Ground Processed products shall be available in various range and azimuth multilooking variants.	Requirement	Astrium SRS 5.4.1	
SLFPS-77	For all the Basic Products, the system shall provide for online checks to verify that there have been no system malfunction. Supported online checks shall include: a) raw data analysis(to check for transmission errors and presence of an echo) b) auxiliary data check (to monitor instrument and platform data) c) visual check (quick check for gross errors such as: incomplete images, generally not in good focus, absence of ghosting and banding, absence of visible artefacts)	Requirement	Astrium SRS 5.4.1	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-78	The system shall provide for Offline Quality Control. Supported offline quality control checks shall include the ability to: a) monitor the instrument performance (e.g. antenna elevation/azimuth gain pattern, resolution , side-lobes, integrated side-lobes). b) analyse in detail a sample of images of reference areas (e.g. correctness of image format and annotation, range/azimuth resolution, absolute location accuracy, Ne□o, equivalent number of looks, ambiguity ratio, phase errors, co/cross polar isolation) c) investigate the trend analysis of Basic Quality parameters (e.g. are values within expected range, are parameters fluctuation within expected range, is there an identifiable trend) d) investigate reported anomalies	Requirement	Astrium SRS 5.4.1	
SLFPS-79	The Garada spacecraft and its respective Garada Ground Processor shall support the generation of the following Basic Products: 1. Basic Products based on SAR images and quality data obtained by processing of Garada Stripmap and ScanSAR Mode 2. Basic Products based on SAR images and quality data obtained by processing of Garada Low Resolution Mode 3. Multi-band based on SAR images and quality data obtained by processing of Garada Stripmap Mode	Requirement	Astrium SRS 6.1.1	
SLFPS-80	In Stripmap Mode the Garada Spacecraft and Garada Ground Processor shall support the generation of Basic Products with reduced range resolution by: • switching of the chirp-bandwidth (instrument) • reduction of processing bandwidth (ground processor) Reduced range resolution shall be selectable in at least 3 steps.	Requirement	Astrium SRS 6.1.2	
SLFPS-81	Each data acquisition (scene) shall be assigned onboard with a unique identification number (ID).	Requirement	Astrium SRS 6.2.5	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-82	The Garada system shall ensure the availability of the following timing information for processing of SAR raw data: • Onboard Time (OBT), synchronised to GPS time (HK data stream) • Garada instrument time in the datation of SAR packets (synchronised to GPS time, SAR Data stream) • Event report regarding the synchronisation event OBT – GPS also including the values of OBT and GPS time (HK data stream) • Event reports regarding the synchronisation event Garada instrument time – GPS also including the values of instrument and GPS time (HK data stream)	Requirement	Astrium SRS 6.2.6	
SLFPS-83	The Garada system shall establish a high bandwidth data downlink of no less than 700 Mbps.	Requirement	Astrium SRS 7.2	
SLFPS-84	For uplink and downlink communications with the dedicated Garada ground stations, the Garada spacecraft shall be equipped with a TTAC system operating in the S-Band range.	Requirement	Astrium SRS 7.2	
SLFPS-85	Deleted			
SLFPS-86	The Garada system shall establish the following link margin and bit error rate for the high bandwidth downlink: Up-link margin 3db Maximum up-link bit error rate 10^{-7} Down-link margin 3db Maximum down-link bit error rate 10^{-6}	Requirement	Astrium SRS 7.3	
SLFPS-88	Garada measurement data, orbit and ephemeris data and auxiliary data shall be transmitted to ground with either a telemetry, tracking and control downlink or a high data rate communications system.	Requirement	Astrium SRS 7.4	
SLFPS-89	Deleted			
SLFPS-90	Deleted			
SLFPS-92	The Ground Support Equipment (GSE) items shall be capable of supporting System Validation Tests via external communications channels to the Ground Segment without prevention of local monitoring of operations.	Requirement	Astrium SRS 8.5	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-101	The Garada system shall provide for internal calibration of the SAR sensor.	Requirement	OSRB v02_00 2T.13	
SLFPS-102	The Garada system shall provide for external calibration of the SAR sensor.	Requirement	OSRB v02_00 2T.14	
SLFPS-104	The Garada system design shall incorporate features intended to preclude malicious interference with spacecraft command and control.	Requirement	OSRB v02_00 2T.9	
SLFPS-111	The Garada system shall provide for data downlink at least once per orbit after collecting data on the Australian land mass.	Requirement	OSRB v02_00 2T.3	
SLFPS-112	The Garada system shall be capable of downlinking data to ground stations outside of Australia.	Requirement	OSRB v02_00 2T.8	
SLFPS-113	The Garada system shall implement a capability for onboard orbit determination.	Requirement	OSRB v02_00 2T.15	
SLFPS-105	The Garada system shall incorporate onboard navigation using GNSS signals.	Requirement	OSRB v02_00 2T.18	
SLFPS-42	***3.2.3 System Legal and Policy Requirements***	Heading		
SLFPS-24	The Garada system shall comply with the Convention on Registration of Objects Launched into Outer Space.	Requirement	OSRB v02_00 2P.3	
SLFPS-7	The Garada system shall comply with the Commonwealth of Australia Space Activities Act 1998.	Requirement	OSRB v02_00 2P.8	
SLFPS-8	The Garada System design will support ownership and operation by the Australian Government.	Requirement	OSRB v02_00 2P.10	
SLFPS-12	The Garada System shall comply with the Australian Government Cyber Security Strategy.	Requirement	OSRB v02_00 2P.11	
SLFPS-87	The Consultative Committee for Space Data Systems (CCSDS) protocol for packetised commanding and telemetry shall be implemented.	Requirement	Astrium SRS 7.3	
SLFPS-91	The measurement data stream shall be compliant with the CCSDS standard.	Requirement	Astrium SRS 7.4	
SLFPS-97	The Garada system shall comply with the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.	Requirement	OSRB v02_00 2P.1	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-98	The Garada system shall comply with the Convention on International Liability for Damage Caused by Space Objects.	Requirement	OSRB v02_00 2P.2	
SLFPS-99	The Garada system shall comply with the UN Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space.	Requirement	OSRB v02_00 2P.4	
SLFPS-100	The Garada system shall comply with the UN Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries.	Requirement	OSRB v02_00 2P.6	
SLFPS-103	The Garada system shall comply with the UN Principles Relating to Remote Sensing of the Earth From Outer Space.	Requirement	OSRB v02_00 2P.5	
SLFPS-106	The Garada system shall comply with the "Radio Regulations Edition of 2008", International Telecommunication Union.	Requirement	OSRB v02_00 2P.7	
SLFPS-107	The Garada system shall comply with the Commonwealth of Australia Radiocommunications Act 1992.	Requirement	OSRB v02_00 2P.9	
SLFPS-145	**3.3 Segment External Interface Requirements**	Heading		
SLFPS-146	***3.3.1 Interface Identification and Diagrams***	Heading		
SLFPS-147	***3.3.1.1 Interface Diagram***	Heading		
SLFPS-148	The Garada System external interfaces are TBD.	Requirement	TK. 10.2 FPS	Prepare system external interface drawing during design
SLFPS-149	***Deleted***			
SLFPS-150	***Deleted***			
SLFPS-151	***Deleted***			
SLFPS-152	***Deleted***			
SLFPS-153	***Deleted***			
SLFPS-154	***3.3.1.3 Customer Interfaces***	Heading		
SLFPS-155	***3.3.1.3.1 E07 Requests for Data***	Heading		
SLFPS-156	Requests from the customer shall be received electronically and shall be in the format specified by the Ground Segment design contractor.	Requirement	TK. 10.2 FPS	
SLFPS-157	Requests shall contain at a minimum, the area to be scanned, data type, data format, SAR mode, interpretation, date and time of scan.	Requirement	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-158	***3.3.1.3.2 E09 Data Products***	Heading		
SLFPS-159	Data products shall be provided electronically.	Requirement	TK. 10.2 FPS	
SLFPS-160	***3.3.1.3.3 E08 Invoicing and Payment***	Heading		
SLFPS-161	Invoicing and payment shall be in formats specified by the Garada Program.	Requirement	TK. 10.2 FPS	
SLFPS-162	***Deleted***			
SLFPS-163	Deleted			
SLFPS-164	***Deleted***			
SLFPS-165	Deleted			
SLFPS-166	***3.3.1.6 E04 Email and Web Access***	Heading		
SLFPS-167	The interface with the internet shall be a minimum of 10Mbps upload and download.	Requirement	TK. 10.2 FPS	
SLFPS-168	***3.3.1.7 E06 Public Web Access***	Heading		
SLFPS-169	Access to the Ground Segment public web site shall be in accordance with ISO/IEC 15445:2000.	Requirement	TK. 10.2 FPS	
SLFPS-170	***3.3.1.8 E10 Earth Observation Data***	Heading		
SLFPS-171	The Garada System shall receive earth observation data from external databases in the following formats: a) GeoTiff, b) CCRS, c) CEOS, d) EOSAT, e) Fast7a and f) HDF	Requirement	TK. 10.2 FPS	
SLFPS-172	***3.3.1.9 Conjunction Assessment Service***	Heading		
SLFPS-173	Interface E02 Orbital data shall be provided as NORAD two line element sets.	Requirement	TK. 10.2 FPS	
SLFPS-174	Interface E03 Conjunction assessment data shall be in vendor format.	Requirement	TK. 10.2 FPS	
SLFPS-175	***3.3.1.10 E11 Flight Software Vendors***	Heading		
SLFPS-176	Flight software shall be provided in vendor format with, at a minimum, documentation that describes the configuration and use of the software.	Requirement	TK. 10.2 FPS	
SLFPS-177	***3.3.1.11 E12 Ground Software Vendors***	Heading		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-178	Ground software shall be provided in vendor format with, at a minimum, documentation that describes the configuration and use of the software.	Requirement	TK. 10.2 FPS	
SLFPS-179	***3.3.1.12 E13 Launch Services***	Heading		
SLFPS-180	The interface of the ground segment to launch services shall be in accordance with the requirements of the launch service provider.	Requirement	TK. 10.2 FPS	
SLFPS-181	***3.3.2 Interface to GFE***	Heading		
SLFPS-182	Not applicable.	Advice	TK. 10.2 FPS	
SLFPS-183	**3.4 System Internal Interface Requirements**	Heading		
SLFPS-184	The internal interface requirements are TBD.	Requirement	TK. 10.2 FPS	
SLFPS-185	**3.5 System Internal Data Requirements**	Heading		
SLFPS-186	The internal data requirements will be determined during the system design phase and specified in the requirements specifications for system components.	Advice	TK. 10.2 FPS	Prepare system internal interface drawing during design
SLFPS-187	**3.6 Adaptation Requirements**	Heading		
SLFPS-188	Not applicable.	Advice	TK. 10.2 FPS	
SLFPS-189	**3.7 Safety Requirements**	Heading		
SLFPS-190	***3.7.1 General***	Heading		
SLFPS-191	All of the personnel access ways shall conform to AS 4024.1702.	Requirement	TK. 10.2 FPS	
SLFPS-192	The Garada facilities shall comply with AS 1657.	Requirement	TK. 10.2 FPS	
SLFPS-193	The noise levels within the occupied areas of Garada facilities shall not exceed the levels specified in NOHSC:2009 (2004).	Requirement	TK. 10.2 FPS	
SLFPS-194	Garada program Computer workstations shall comply with the requirements of AS/NZS 4443. Requirement	Requirement	TK. 10.2 FPS	
SLFPS-195	The Light levels within the inhabited areas of the Garada program shall conform to those recommended in AS/NZS 1680.	Requirement	TK. 10.2 FPS	
SLFPS-196	***3.7.2 Electrical Safety***	Heading		
SLFPS-197	The installation and earthing for all electrical equipment including racks, cabinets and associated equipment shall conform to the requirements of AS 3000.	Requirement	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-198	All Garada equipment that is capable of being connected to the 230/400V AC mains supply shall comply with the requirements of AS3100.	Requirement	TK. 10.2 FPS	
SLFPS-199	All Garada equipment that is capable of being connected to the 230/400V AC mains supply shall comply with the requirements of AS60950.1.	Requirement	TK. 10.2 FPS	
SLFPS-200	The Garada facilities shall protect personnel, equipment and facilities against direct and conducted effects of lightning in accordance with AS/NZS 1768.	Requirement	TK. 10.2 FPS	
SLFPS-201	Fibre systems used in the Garada system shall meet the requirements of AS/NZS 2211.2.	Requirement	TK. 10.2 FPS	
SLFPS-202	***3.7.3 Mechanical Safety Requirements***	Heading		
SLFPS-203	Deleted			
SLFPS-204	Deleted			
SLFPS-205	Deleted			
SLFPS-206	Deleted			
SLFPS-207	Deleted			
SLFPS-208	Deleted			
SLFPS-209	Where guarding is used as a control measure in the Garada system it shall be designed and installed in accordance with AS 4024.1601.	Requirement	TK. 10.2 FPS	
SLFPS-210	Safety related human-machine interfaces that are part of the Garada system shall conform to the applicable requirements of AS 4024.1904.	Requirement	TK. 10.2 FPS	
SLFPS-211	Deleted			
SLFPS-212	***3.7.4 Hazardous Materials***	Heading		
SLFPS-213	Substances that are listed in Schedule 1 of the Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 shall not be used in the Garada system.	Requirement	TK. 10.2 FPS	
SLFPS-214	For all Hazardous Substances incorporated into the Garada system, full details shall be provided to the Commonwealth in the format of a Material Safety Data Sheet in accordance with NOHSC: 2011 (1994).	Requirement	TK. 10.2 FPS	
SLFPS-215	Garada equipment containing dangerous materials shall be labeled in accordance with AS 1216.	Requirement	TK. 10.2 FPS	
SLFPS-216	***3.7.5 Signage***	Heading		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-217	The Garada system shall include danger, caution and warning signs fixed to equipment to advice of specific hazards such as high voltage, high temperature and radiation in accordance with AS 1319 – 1994.	Requirement	TK. 10.2 FPS	
SLFPS-218	***3.7.6 Radiation Hazard***	Heading		
SLFPS-219	Deleted			
SLFPS-220	***3.7.7 Power Protection***	Heading		
SLFPS-221	The Garada system shall be protected against damage caused by excessive current.	Requirement	TK. 10.2 FPS	
SLFPS-222	The Garada system shall be protected against damage caused by short circuit at all antenna ports, audio connections and control connections.	Requirement	TK. 10.2 FPS	
SLFPS-223	**3.8 Security and Privacy Requirements**	Heading		
SLFPS-224	All Garada workstations shall have access requiring user login and password.	Requirement	TK. 10.2 FPS	
SLFPS-225	Users shall be granted permissions to access Garada applications and capabilities based on their role.	Requirement	TK. 10.2 FPS	
SLFPS-226	The Garada system shall have a capability for an operator to manage user access and permissions.	Requirement	TK. 10.2 FPS	
SLFPS-227	The Garada system shall detect and prevent unauthorised access on the external data interfaces.	Requirement	TK. 10.2 FPS	
SLFPS-228	**3.9 System Environment Requirements**	Heading		
SLFPS-229	***3.9.1 Mainland Australia and Tasmania Location***	Heading		
SLFPS-230	The Garada system shall operate within specification, without any degradation in performance when exposed to the maximum operational wind velocity of 20 m/s for a ten minute mean at ten metre height.	Requirement	TK. 10.2 FPS	
SLFPS-231	The Garada system shall survive without damage or permanent deformation when exposed to a three second gust of wind with a velocity of up to 69 m/s.	Requirement	TK. 10.2 FPS	
SLFPS-232	The Garada system shall operate within specification, excluding G/T, when exposed to an ambient temperature range of 5 degrees to +50 degrees Celsius in direct sunlight with solar radiation of 1.02 kW/m2.	Requirement	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-233	The Garada system shall operate within specification, excluding G/T, when exposed to an ambient temperature range of 5 degrees to +50 degrees Celsius with a relative humidity of 95% (non-condensing).	Requirement	TK. 10.2 FPS	
SLFPS-234	The Garada system shall survive without damage or permanent deformation when exposed to an ambient temperature range of 0 to +55 degrees with a relative humidity of 95%.	Requirement	TK. 10.2 FPS	
SLFPS-235	The Garada system shall operate within specification, excluding G/T, when exposed to driving rain of up to and including 50 mm/hr at a wind velocity of 20 m/s for a ten minute mean at ten metre height.	Requirement	TK. 10.2 FPS	
SLFPS-236	The Garada system outdoor equipment shall remain free from water ingress during driving rain of up to and including 200 mm/hr under wind conditions up to a three second gust of wind with a velocity of up to 69 m/s.	Requirement	TK. 10.2 FPS	
SLFPS-237	***3.9.2 Locations outside of Mainland Australia and Tasmania***	Heading		
SLFPS-238	For locations outside of mainland Australia and Tasmania the climatic conditions described in DEF(AUST)5168 shall be used as guidelines for determining the environmental requirements for operation and survival.	Requirement	TK. 10.2 FPS	
SLFPS-239	**3.10 Computer Resource Requirements**	Heading		
SLFPS-240	Each computer processor installed in the Garada system shall use a maximum of 50% processor capacity.	Requirement	TK. 10.2 FPS	
SLFPS-241	Each computer processor installed in the Garada system shall use a maximum of 50% of processor memory capacity.	Requirement	TK. 10.2 FPS	
SLFPS-242	Each computer processor installed in the Garada system shall use a maximum of 50% of input/output capacity.	Requirement	TK. 10.2 FPS	
SLFPS-243	**3.11 System Quality Factors**	Heading		
SLFPS-244	***3.11.1 Availability***	Heading		
SLFPS-245	The combined availability of the Garada system shall be better than 99%.	Requirement	TK. 10.2 FPS	
SLFPS-246	Deleted			
SLFPS-247	***3.11.2 Maintainability***	Heading		
SLFPS-248	All components of the Garada system designated as Line Replaceable Units (LRUs) shall be removable and restorable without the need to remove other LRUs.	Requirement	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-249	All cable terminations to the Garada system modules designated as LRUs shall be capable of disconnection and reconnection without the need to disturb third party cables.	Requirement	TK. 10.2 FPS	
SLFPS-250	All cable terminations to Garada system modules designated as LRUs shall be capable of disconnection and reconnection without the need to cut cable securing straps.	Requirement	TK. 10.2 FPS	
SLFPS-251	**3.12 Design and Construction Constraints**	Heading		
SLFPS-252	The Ground Segment shall use COTS hardware.	Requirement	TK. 10.2 FPS	
SLFPS-253	Ground Segment payload data processing shall be based on COTS software.	Requirement	TK. 10.2 FPS	
SLFPS-254	To minimise Garada system development and operating costs, existing infrastructure shall be used where possible.	Constraint	TK. 10.2 FPS	
SLFPS-255	Where data formats are not specified here, standard industry data formats shall be used where possible.	Constraint	TK. 10.2 FPS	
SLFPS-256	To accommodate possible future applications the Garada system shall be designed to allow for the separation of data and data processing into classified and unclassified classes.	Requirement	TK. 10.2 FPS	
SLFPS-257	In the Garada system, it shall be possible to test new ground-based algorithms in parallel with the operation of existing algorithms.	Constraint	TK. 10.2 FPS	
SLFPS-258	Garada system data processing chains shall be modular to allow modification of processing algorithms and upgrade of the hardware.	Constraint	TK. 10.2 FPS	
SLFPS-259	**3.13 Personnel-related Requirements**	Heading		
SLFPS-260	Software and hardware user manuals shall be electronically accessible from the computer workstations.	Requirement	TK. 10.2 FPS	
SLFPS-261	Software applications shall have context sensitive help available to the operator.	Requirement	TK. 10.2 FPS	
SLFPS-262	**3.14 Training-related Requirements**	Heading		
SLFPS-263	The requirements for a simulator to support operational training are TBD.	Advice	TK. 10.2 FPS	Develop requirements for operator simulator training during design
SLFPS-264	**3.15 Logistics-related Requirements**	Heading		
SLFPS-265	TBD	Advice	TK. 10.2 FPS	Develop during design phase
SLFPS-266	**3.16 Other Requirements**	Heading		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-267	Not applicable.	Advice	TK. 10.2 FPS	Develop during design phase
SLFPS-268	**3.17 Packaging Requirements**	Heading		
SLFPS-269	TBD	Advice	TK. 10.2 FPS	Develop during design phase
SLFPS-270	**3.18 Precedence and Criticality of Requirements**	Heading		
SLFPS-271	Order of precedence: In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.	Requirement	TK. 10.2 FPS	
SLFPS-272	**4 Qualification Provisions**	Heading		
SLFPS-273	**5 Requirements Traceability**	Heading		
SLFPS-274	Traceability to parent specifications is not mandatory for system level requirements. Where applicable, traceability to other project documents is indicated with the requirement.	Advice	TK. 10.2 FPS	
SLFPS-275	**6 Notes**	Heading		
SLFPS-276	**6.1 Abbreviations and Acronyms**	Heading		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-277	ADACS Attitude Determination and Control Subsystem ASRP Australian Space Research Program BIT Built In Test CADH Command And Data Handling CCRS Canadian Centre of Remote Sensing CCSDS Consultative Committee for Space Data Systems CEOS Committee on Earth Observation Satellites COTS Commercial Off The Shelf CS Communication Subsystem EGSE Electrical Ground Support Equipment EOSAT Earth Observation Satellite picture data format EPS Electrical Power Subsystem FDIR Fault Detection, Identification and Reporting subsystem FPS Functional Performance Specification FTP File Transfer Protocol GFE Government Furnished Equipment GNSS Global Navigation Satellite System GNSS-R GNSS Reflectometry payload GS Ground Segment GSE Ground Support Equipment GSS Ground Station Subsystem HAR Harness HBDL High Bandwidth Down Link subsystem HDF Hierarchical Data Format LEOP Launch and Early Orbit Phase LHCP Left Hand Circular Polarised LRU Line Replaceable Unit	Information	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SLFPS-277 (cont'd.)	MCS Mission Control Subsystem MGSE Mechanical Ground Support Equipment MMDPS Mission Management and Data Processing Subsystem NOHSC National Occupational Health and Safety OFCS Optical Fibre Communication Systems OOD Onboard Orbit Determination Subsystem OSRB Objective System Requirements Baseline PAWS Public Accessible Web Site PROP Propulsion subsystem RHCP Right Hand Circular Polarised SAR Synthetic Aperture Radar SDS Signal Distribution Subsystem SFF Support for Formation Flying subsystem SRS Spacecraft Requirement Specification SS Support Subsystem SSS System/Subsystem Specification TBC To Be Calculated TBD To Be Determined THM Thermal Management subsystem TTAC Tracking, Telemetry And Control subsystem TLE Two Line Element V&V Verification and Validation	Information		

SPACE SEGMENT FUNCTIONAL PERFORMANCE SPECIFICATION

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-96	**1 Scope**	Heading		
SSFPS-97	***1.1 Identification***	Heading		
SSFPS-98	This is the Space Segment Functional Performance Specification (FPS) for the Garada Synthetic Aperture Radar (SAR) Formation Flying system. This document will be included in the Garada final report to be delivered to Australia Space Research Program (ARSP). This document is derived from Garada Objective System Requirements Baseline (OSRB), Astrium Preliminary Spacecraft Requirements Specification (SRS) and TK 10.2 Functional Performance Specification.	Information		
SSFPS-99	***1.2 System Overview***	Heading		
SSFPS-100	Garada, funded under the Australian Space Research Program (ASRP), is a collaborative space engineering research project at the Australian Centre for Space Engineering Research. Garada is investigating the design of a low cost L-Band Formation Flying SAR satellite system for monitoring regional deforestation and forest degradation, soil moisture mapping, flood and disaster monitoring. Consortium members include the University of New South Wales, EADS Astrium, Curtin University of Technology, TU Delft, BAE Systems and General Dynamics Corporation.	Information		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-101	The Garada System is comprised of a Ground Segment and a Space Segment. The Ground Segment consists of: 1. Ground Station System (GSS) 2. Mission Control System (MCS) 3. Mission Management and Data Processing System (MMDPS) 4. Communications System (CS) 5. Support System (SS) This FPS specifies the requirements for the Space Segment. The Space Segment is comprised of three systems: A. Spacecraft which consist of fourteen subsystems i. Spacecraft Bus and Structure ii. SAR Sensor iii. Power iv. Harness v. Fault Identification vi. Onboard Orbit Determination vii. Reflectometer viii. Tracking, Telemetry and Control ix. Attitude Determination and Control x. Command and Data Handling xi. Propulsion xii. Thermal Management xiii. High Bandwidth Downlink xiv. Formation Flying B. Launch Services including launch vehicle and relevant requirements C. Ground Support Equipment including mechanical and electrical support equipment.	Information		
SSFPS-102	The Garada Space Segment is composed of one spacecraft or two separate but identical spacecraft, consisting of the Garada Spacecraft and the Garada Spacecraft flying in tandem in the same orbital plane and housing the identical SAR imaging instrument.	Information		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-103	The L-band radars are downward looking Synthetic Aperture Radar Instruments.	Information		
SSFPS-104	When assigned, the Garada Spacecraft contractor will be responsible for In-Orbit Delivery (IOD) of the Garada Spacecraft against the Garada Spacecraft requirements. Implicit in this is the responsibility of the Garada Spacecraft contractor to source an appropriate Launch Service.	Information		
SSFPS-105	When assigned, the Garada System Prime Contractor is responsible for the verification (against the Garada Operational and Performance Requirements or System Specification) and delivery (IOD of the whole Garada System to the Customer). When assigned, the Garada Spacecraft Prime Contractor would be responsible for the verification (against the Garada Spacecraft Requirements Spec) and delivery (again IOD, but to the Garada System prime).	Information		
SSFPS-106	***1.3 Document Overview***	Heading		
SSFPS-107	This document specifies the space segment requirements for the Garada Space Segment. The overall requirements structure is shown in OSRB Section 5.1 Requirements Structure.	Information		
SSFPS-108	**2 Applicable Documents**	Heading		
SSFPS-109	**2.1 Normative References**	Heading		
SSFPS-110	Garada Spacecraft - Ground Segment Interface Control Document (ICD)	Information	Astrium SRS 2.1	Develop during design
SSFPS-111	Garada Spacecraft - Launch Vehicle Interface Requirements Specification	Information	Astrium SRS 2.1	Develop during design
SSFPS-170	Garada Spacecraft Statement of Work	Information	Astrium SRS 2.1	Develop during design
SSFPS-171	Garada Spacecraft Environment and Test Specification	Information	Astrium SRS 2.1	Develop during design

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-172	Garada Spacecraft Product Assurance (PA) Requirements Specification	Information	Astrium SRS 2.1	Develop during design
SSFPS-173	Garada Spacecraft Management Requirements	Information	Astrium SRS 2.1	Develop during design
SSFPS-112	**2.2 Informative References**	Heading		
SSFPS-113	Garada System Design and Interface Document	Information	Astrium SRS 2.2	Develop during design
SSFPS-114	Prime Launch Vehicle User Manual (Falcon 9)	Information	Astrium SRS 2.2	
SSFPS-115	Backup Launch Vehicle User Manual (Delta IV)	Information	Astrium SRS 2.2	
SSFPS-116	International Telecommunications Union (ITU) RR-98 Radio Regulations, Article S5, Section IV	Information	Astrium SRS 2.2	
SSFPS-117	International Space Debris Safety Requirements, W.Flurry	Information	Astrium SRS 2.2	
SSFPS-174	System Design Development & Assembly, Integration and Verification Plan	Information	Astrium SRS 2.2	Develop during design
SSFPS-175	Spacecraft Statement of Compliance to TOPR	Information	Astrium SRS 2.2	Develop during design
SSFPS-176	L-band Instrument Performance Compliance against TOPR 3/C	Information	Astrium SRS 2.2	Develop during design
SSFPS-177	'Handbook of Radar Scattering Statistics for Terrain', Ulaby and Dobson, Artech House, 1989	Information	Astrium SRS 2.2	
SSFPS-178	'Microwave Remote Sensing', Ulaby, Volume I	Information	Astrium SRS 2.2	
SSFPS-179	'Prediction of Attenuation by Rain', R. Crane, IEEE Trans. On Comm., Vol. COM-29, No.9 Sep.1980	Information	Astrium SRS 2.2	
SSFPS-180	'Radar Principles, Technology and Applications', Byron Edde, PTR Prentice Hall, 1993	Information	Astrium SRS 2.2	
SSFPS-181	Garada Spacecraft Product Tree	Information	Astrium SRS 2.2	Develop during design
SSFPS-182	Garada Spacecraft Interface Control Document (ICD)	Information	Astrium SRS 2.2	Develop during design
SSFPS-118	**2.3 Standards**	Heading		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-119	European Co-operation for Space Standardisation (ECSS) Space Engineering - System Engineering	Requirement	Astrium SRS 2.3	
SSFPS-120	Metallic Materials and Elements for Aerospace Vehicle Structures	Requirement	Astrium SRS 2.3	
SSFPS-121	ECSS Space Engineering - Thermal Control	Requirement	Astrium SRS 2.3	
SSFPS-523	**2.4 Garada Documents**	Heading		
SSFPS-524	Garada Mission Baseline	Information		
SSFPS-525	Garada Requirements Summary	Information		
SSFPS-526	TK 1.2 Garada SAR Formation Flying Business Case for Implementation	Information		
SSFPS-527	TK 10.1 Operational Concept Document	Information		
SSFPS-528	Australian Government Information Security Manual	Information		
SSFPS-529	TK 3.3 SAR System Specification Final Issue	Information		
SSFPS-530	TK 2.2 SAR Hardware and Methods Description and Specification	Information		
SSFPS-531	TK 10.2 Ground Segment Functional Performance Specification	Information		
SSFPS-501	**2.5 Australian Standards**	Heading		
SSFPS-502	AS 1319:1994 - Safety Signs for the Occupational Environment	Requirement		
SSFPS-503	AS 1657:1992 - Fixed platforms, walkways, stairways and ladders - Design, construction and installation	Requirement		
SSFPS-504	AS/NZS 1680:2006 - Interior and workplace lighting	Requirement		
SSFPS-505	AS/NZS 1768:2007 - Lightning protection	Requirement		
SSFPS-506	AS/NZS 2211.2:2006 - Safety of laser products - Safety of optical fibre communication systems (OFCS)	Requirement		
SSFPS-507	AS 4024.1604:2006 - Safety of machinery Part 1604: Design of controls, interlocks and guarding - Emergency stop - Principles for design	Requirement		
SSFPS-508	AS 4024.1702:2006 - Safety of machinery Part 1702: Human body measurements – Principles for determining the dimensions required for openings for whole body access into machinery.	Requirement		
SSFPS-509	AS 4024.1904:2006 - Safety of machinery Part 1904: Displays, controls, actuators and signals - Indication, marking and actuation - Requirements for visual, auditory and tactile signals	Requirement		
SSFPS-510	AS/NZS 3000:2007 - Wiring Rules	Requirement		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-511	AS/NZS 3100:2009 - Approval and test specification - General requirements for electrical equipment	Requirement		
SSFPS-512	AS/NZS 4443:1997 Office Panel Systems— Workstations	Requirement		
SSFPS-513	AS/NZS 5070.1:2008 - Siting and operation of radio communications facilities - General guidelines for fixed, mobile and broadcasting facilities including fixed location satellite earth stations independent of the operating frequency	Requirement		
SSFPS-514	AS/NZS 60950.1:2011 - Information technology equipment - Safety - General requirements Requirement	Requirement		
SSFPS-515	AS/CA S003.1:2010 Requirements for Customer Access Equipment for connection to a Telecommunications Network	Requirement		
SSFPS-516	**2.6 Other Documents**	Heading		
SSFPS-517	Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Requirement		
SSFPS-518	DEF(AUST)5168 The climactic and environmental conditions affecting the design of military materiel.	Requirement		
SSFPS-519	DI-IPSC-81431A Data Item Description: System/Subsystem Specification (SSS) (10 JAN 2000)	Requirement		
SSFPS-520	ISO/IEC 15445:2000 Information technology -- Document description and processing languages -- HyperText Markup Language (HTML)	Requirement		
SSFPS-521	NOHSC:2011 (1994) - Preparation of Material Safety Data Sheets	Requirement		
SSFPS-522	OH&S (Safety Standards) Regulations 1994.	Requirement		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-1	**3 Requirements**	Heading		
SSFPS-2	***3.2.1 Segment Requirement (SEGR)***	Heading		
SSFPS-701	The environment within the space segment spacecraft bus envelopes shall support the continuous operation of all subsystems.	Requirement	Thomas Cooney Garada Module Requirements	
SSFPS-684	The Garada space segment shall provide the capability of controlled deorbit at end of mission.	Requirement	OSRB v02_00 3.1.11	
SSFPS-682	The Garada space segment shall provide for data collection at 6 AM [due to the thermal equilibirum between soil/air/vegetation, the capillary moisture raise in the top soil layer, and the minimum of Faraday rotation in the ionosphere].	Requirement	OSRB v02_00 3.1.9	
SSFPS-681	The Garada orbits shall provide for the same azimuth angle of data collection (a pass made in ascending node must be revisited by an ascending node pass, a descending node pass must be revisited by a descending node pass) with elevation angle differences of no more than 5°.	Requirement	OSRB v02_00 3.1.8	
SSFPS-677	The Garada space segment shall be capable of collecting data in areas other than Australia as long as electrical power and data capacity do not preclude it.	Requirement	OSRB v02_00 3.1.4	
SSFPS-675	Orbit maintenance of the Garada space segment shall support the mission design lifetime.	Requirement	OSRB v02_00 3.1.2	
SSFPS-674	The Garada space segment shall support orbit maintenance with a LTAN variation of no more than TBD and an altitude variation of no more than TBD km.	Requirement	OSRB v02_00 3.1.1	
SSFPS-948	The requirements for a simulator to support SS operational training are TBD.	Requirement	TK10.2 (Derived)	
SSFPS-946	To the extent possible, data processing chains shall be modular to allow modification of processing algorithms.	Requirement	TK10.2 (Derived)	
SSFPS-945	The total availability of the Space Segment shall be greater than TBD %.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-944	Each computer processor used in the Space Segment shall use a maximum of TBD % of input/output capacity.	Requirement	TK10.2 (Derived)	
SSFPS-943	Each computer processor used in the Space Segment shall use a maximum of TBD % of processor memory capacity.	Requirement	TK10.2 (Derived)	
SSFPS-942	Each computer processor used in the Space Segment shall use a maximum of TBD % processor capacity.	Requirement	TK10.2 (Derived)	
SSFPS-941	The Garada space segment shall operate within temperature range of TBD.	Requirement	TK10.2 (Derived)	
SSFPS-939	The Space Segment shall detect and prevent unauthorised access of external data interfaces.	Requirement	TK10.2 (Derived)	
SSFPS-938	The interface of the space segment to launch services shall be in accordance with the requirements of the launch service provider.	Requirement	TK10.2 (Derived)	
SSFPS-937	The Garada space segment shall receive software maintenance and enhancement for all space segment flight software uploaded from the Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-936	After space segment launch, the Garada space segment shall interact with the Ground Segment for configuration management of all space segment software.	Requirement	TK10.2 (Derived)	
SSFPS-935	The Garada space segment shall be capable of implementing flight software updates.	Requirement	TK10.2 (Derived)	
SSFPS-934	The Garada space segment shall be capable of operation without connectivity with the ground for a period of at least TBD days.	Requirement	TK10.2 (Derived)	
SSFPS-928	The Garada space segment shall transmit in the frequency range from TBD GHz to TBD GHz to the GSS.	Requirement	TK10.2 (Derived)	
SSFPS-922	The Garada space segment shall support high bandwidth downlink to ground station(s) supporting the Garada program.	Requirement	TK10.2 (Derived)	
SSFPS-920	The Garada space segment shall provide orbit parameters computed onboard to the Ground Segment.	Requirement	TK10.2 (Derived)	
SSFPS-917	The Garada space segment shall implement interface “E14 Beacon” with the ground segment.	Requirement	TK10.2 (Derived)	
SSFPS-915	The Garada space segment shall implement interface “E15 Telecommands” with the ground segment.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-913	The Garada space segment shall implement interface “E17 Telemetry” with the ground segment.	Requirement	TK10.2 (Derived)	
SSFPS-909	The Garada space segment shall implement interface with GSS for E16 Payload Data.	Requirement	TK10.2 (Derived)	
SSFPS-906	The Garada space segment shall implement interface “E16 Payload Data” with the ground segment.	Requirement	TK10.2 (Derived)	
SSFPS-899	The Garada space segment shall support automatic tracking by, and link establishment with, the Ground Segment.	Requirement	TK10.2 (Derived)	
SSFPS-896	The Garada space segment shall support the upgrades of selected flight software over the life time of space segment.	Requirement	TK10.2 (Derived)	
SSFPS-893	The Garada space segment shall support GNSS performance monitoring, calibration and verification.	Requirement	TK10.2 (Derived)	
SSFPS-890	The Garada space segment shall support GNSS reflectometry measurements.	Requirement	OSRB	
SSFPS-886	The Garada space segment shall support monitoring of SAR performance from the ground.	Requirement	TK10.2 (Derived)	
SSFPS-881	The Garada space segment shall support SAR calibration manoeuvres.	Requirement	TK10.2 (Derived)	
SSFPS-877	The Garada space segment shall support internal and external SAR calibration.	Requirement	TK10.2 (Derived)	
SSFPS-876	The Garada space segment shall be capable of collecting data such as time, orbit details, calibration data and deliver it to Ground Station via TTAC.	Requirement	TK10.2 (Derived)	
SSFPS-871	The Garada space segment shall support initiation of downlink immediately upon completion of a SAR data collection period.	Requirement	TK10.2 (Derived)	
SSFPS-854	The Garada space segment shall support transmission of raw SAR data to the Ground Segment.	Requirement	TK10.2 (Derived)	
SSFPS-848	The Garada space segment shall provide all data to the Ground Segment necessary for SAR operations planning.	Requirement	TK10.2 (Derived)	
SSFPS-846	The Garada space segment shall provide the health information of communication system and status to Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-843	The Garada space segment shall allow the operator to configure and manage its communication system from Ground Station.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-839	The Garada space segment shall support the orbiting of two space segment in close formation.	Requirement	TK10.2 (Derived)	
SSFPS-838	The space segment shall operate in accordance to command received from Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-837	The Garada space segment shall have the capability to receive all telecommands via scheduled uplinks.	Requirement	TK10.2 (Derived)	
SSFPS-831	The Garada space segment shall implement the telecommand set as defined in TBD.	Requirement	TK10.2 (Derived)	
SSFPS-827	The Garada space segment shall operate SAR sensor as commanded.	Requirement	TK10.2 (Derived)	
SSFPS-826	The Garada space segment shall provide SAR data to Ground Station via High bandwidth downlink for post-processing.	Requirement	TK10.2 (Derived)	
SSFPS-823	The Garada space segment shall be capable of having onboard software updated via uplink.	Requirement	TK10.2 (Derived)	
SSFPS-822	The Garada space segment shall contain an interface for software update with Ground Station	Requirement	TK10.2 (Derived)	
SSFPS-821	The Garada space segment shall provide all status information and system data to Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-818	The Garada space segment shall maintain communication with Ground Station and sequencing power back on to the various subsystems to resume the mission during recovery from safe mode.	Requirement	TK10.2 (Derived)	
SSFPS-815	The Garada space segment shall provide diagnostic data to Ground Station for recovery analysis.	Requirement	TK10.2 (Derived)	
SSFPS-811	The Garada space segment onboard data system shall respond to ground commands.	Requirement	TK10.2 (Derived)	
SSFPS-806	The Garada space segment power system shall respond to ground commands.	Requirement	TK10.2 (Derived)	
SSFPS-798	The Garada space segment communication systems shall respond to ground commands.	Requirement	TK10.2 (Derived)	
SSFPS-795	The Garada space segment shall maintain UTC reference for time and allow the synchronisation of UTC reference time distributed by Ground segment via uplink.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-794	The Garada space segment shall posses satellite time reference which can be obtained using free running counter from a given epoch.	Requirement	TK10.2 (Derived)	
SSFPS-793	The Garada space segment shall maintain a satellite time reference which can be downlinked by requesting time reports from the satellite.	Requirement	TK10.2 (Derived)	
SSFPS-778	The Garada space segment segment shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-775	The Garada space segment shall provide health and status information to the ground.	Requirement	TK10.2 (Derived)	
SSFPS-768	The Garada space segment shall respond to attitude correction commands from the ground.	Requirement	TK10.2 (Derived)	
SSFPS-765	The Garada space segment shall transmit instantaneous space segment attitude to the ground.	Requirement	TK10.2 (Derived)	
SSFPS-757	The Garada space segment shall respond to orbit correction commands from Ground station.	Requirement	TK10.2 (Derived)	
SSFPS-756	The Garada space segment shall have the capability to compare the actual orbit and desired orbit to determine if orbital correction manoeuvre is required but shall not perform autonomous manoeuvres.	Requirement	TK10.2 (Derived)	
SSFPS-752	The Garada space segment shall support tracking and ranging from the ground.	Requirement	TK10.2 (Derived)	
SSFPS-748	The Garada space segment shall generate orbital elements determined at space segment.	Requirement	TK10.2 (Derived)	
SSFPS-747	The Garada Space Segment shall support the interface of the Ground Segment with launch services.	Requirement	TK10.2 (Derived)	
SSFPS-744	The Space segment interfaces shall be implemented as described in this para and in accordance with Paras 3.3 and 3.4.	Requirement	TK10.2 (Derived)	
SSFPS-740	The Space segment shall consist of no more than two space segment.	Requirement	TK10.2 (Derived)	
SSFPS-738	The Garada space segment shall support the continuous operation of MCS, GSS and CS.	Requirement	TK10.2 (Derived)	
SSFPS-333	The Garada space segment shall contain an onboard GPS used for orbit localisation and clock reference.	Requirement	Astrium SRS 6.2.6	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-248	The Garada shall be capable of producing: a) a single Basic Product at any position along track; b) a single Basic Product at discrete positions across track. Spacing of these positions shall be not larger than three quarters (TBD) the swath width applicable to that incidence angle.	Requirement	Astrium SRS 5.4.1	
SSFPS-348	The Garada Spacecaft Platform shall provide: • electrical power; • thermal control of the whole space segment; • operational access (command, control and monitoring); • attitude and orbit control; • S-band RF up-and downlink; • structural support.	Requirement	Astrium SRS 6.2.9	
SSFPS-125	The Garada space segment shall be designed to be compatible with Falcon 9 as a prime launch vehicle.	Requirement	Astrium SRS 5.1.1.1	
SSFPS-127	The Garada space segment shall be designed to be compatible with Delta IV as a backup launch vehicle.	Requirement	Astrium SRS 5.1.1.1	
SSFPS-129	The Garada space segment shall be designed to be compatible with the constraints of the respective launch service providers for both the prime and the backup launch vehicle.	Requirement	Astrium SRS 5.1.1.1	
SSFPS-132	The Garada space segment shall have an in-orbit lifetime after IOD of TBD years.	Requirement	Astrium SRS 5.1.2	
SSFPS-141	The Garada space segment shall be compliant with the System Design Development & Assembly, Integration and Verification (DD&AIV) Plan when developed.	Requirement	Astrium SRS 5.1.3.4	
SSFPS-184	Fixed high-level command structures established as Macro-Commands expanded on-board shall be used for commanding of the Garada space segment.	Requirement	Astrium SRS 5.3.1	"Macro-Commands" must be defined in design phase
SSFPS-214	The Garada space segment shall perform a check-out of essential functions during switch-on.	Requirement	Astrium SRS 5.3.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-218	The Garada space segment shall automatically monitor all switch on/off cycles for all items with limited switch on/off capabilities.	Requirement	Astrium SRS 5.3.2	
SSFPS-219	The Garada space segment shall provide the capability for status monitoring from the ground.	Requirement	Astrium SRS 5.3.3	
SSFPS-223	The Garada space segment shall support monitoring of spacecraft subsystems and resources at the ground segment.	Requirement	Astrium SRS 5.3.3	
SSFPS-224	It shall be possible to dump all Garada space segment software to the Ground Segment.	Requirement	Astrium SRS 5.3.3	
SSFPS-228	It shall be possible to provide monitoring data in real-time during ground contact of the Garada space segment.	Requirement	Astrium SRS 5.3.3	
SSFPS-243	The Garada space segment design shall accommodate a data acquisition schedule update once per day (TBD).	Requirement	Astrium SRS 5.4.1	
SSFPS-244	The minimum required along track gaps when switching to different product types or incidence angles shall not exceed 30 km.	Requirement	Astrium SRS 5.4.1	
SSFPS-245	The average number of Garada data acquisitions to be acquired per orbit (one day averages) are TBD.	Requirement	Astrium SRS 5.4.1	
SSFPS-246	The worst case number of Garada data acquisitions to be acquired per orbit (expected as a worst case to occur within three consecutive orbits per day), within the daily envelope are TBD.	Requirement	Astrium SRS 5.4.1	
SSFPS-269	space segment-level requirements on calibration are TBD.	Requirement	Astrium SRS 5.4.1	
SSFPS-274	A Garada space segment design shall assume a single Data Reception Ground Station located in Australia.	Requirement	Astrium SRS 5.4.2	
SSFPS-275	The Garada space segment design shall enable accommodation of additional ground receiving stations.	Requirement	Astrium SRS 5.4.2	
SSFPS-276	The Garada space segment design shall preclude unauthorized direct access to the space segment.	Requirement	Astrium SRS 5.4.2	
SSFPS-311	Redundancies shall be implemented as required to achieve the required reliability.	Requirement	Astrium SRS 6.2.2	
SSFPS-315	The Garada space segment shall be designed such that its consumables will last for mission life + 1.5 years after IOD.	Requirement	Astrium SRS 6.2.3	
SSFPS-338	The reference time for Garada space segment operation shall be GPS time.	Requirement	Astrium SRS 6.2.6	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-388	All elements of Garada space segment design, function, performance and operation shall be formally and systematically verified for compliance with the requirements. The verification effort shall be documented.	Requirement	Astrium SRS 8.1	
SSFPS-404	The Garada space segment and the Ground Support Equipment (GSE) design shall also allow operations in hazardous environments. The design shall therefore consider launch site safety regulations.	Requirement	Astrium SRS 8.3.2	
SSFPS-441	Antenna pattern verification shall be measured on different antenna integration levels to the maximum extent practicable. Complementary tests shall be undertaken to supplement performance predictions which can only be performed by analysis.	Requirement	Astrium SRS 8.3.4	
SSFPS-539	The PFM, actually the flight model, shall be used to complete the qualification and acceptance programme.	Requirement	Astrium SRS 8.4.3	
SSFPS-540	The PFM shall support as a minimum the following tests: • Electrical Integration • Functional and performance tests • Alignment, leakage and mass properties tests • Shock, acoustic and thermal tests • Ground Segment compatibility tests • EMC and EMI tests • Deployment test	Requirement	Astrium SRS 8.4.3	
SSFPS-473	The total Garada space segment dry mass shall comply with the margins defined as follows: up to PDR 15% after PDR to CDR 7.5% after CDR to QR 4% after QR to FAR 1%	Requirement	Astrium SRS 9.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-474	The total Garada space segment power consumption shall comply with the margins defined as follows: up to PDR: 30% after PDR to CDR: 15% after CDR to QR: 10% after QR to FAR: 4%	Requirement	Astrium SRS 9.2	
SSFPS-477	For any on-board processor, the peak maximum processor usage shall comply with the margins defined below. up to PDR: 50% after PDR to CDR: 50% after CDR to QR: 75% after QR to FAR: 75%	Requirement	Astrium SRS 9.2	
SSFPS-478	For any on-board processor, the free RAM margin shall comply with the margins defined below. up to PDR: 40% after PDR to CDR: 40% after CDR to QR: 25% after QR to FAR: 25%	Requirement	Astrium SRS 9.2	
SSFPS-479	The Garada space segment overall dimensions inclusive launch adapter and dispenser shall comply with the fairing clearance requirements of the prime and back-up launcher candidates.	Requirement	Astrium SRS 9.3	
SSFPS-481	The Garada space segment mass properties shall comply with the requirements imposed by the prime and back-up launcher candidates.	Requirement	Astrium SRS 9.4	
SSFPS-483	The safety factors defined below shall be used for mechanical design. Item: Yield / Ultimate / Buckling Metallic materials: 1.25 / 1.5 / 2 Unconventional materials (non-metallic): 1.5 / 2 / 2 Inserts and joints: 1.5 / 2 / -	Requirement	Astrium SRS 9.5.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-484	For the purpose of safe preliminary dimensioning and in the absence of test and flight information based on coupled analysis with the launcher, the following design loads have to be used. The loads shall cover the expected design loads of Falcon 9, Delta IV. The overall structure loads are to be applied to the equipped Garada space segment, acting at the centre of gravity of the individual units and items. The masses are to be multiplied by the factors of Section 9.2 (System Margins). The Garada space segment is considered to be rigid supported at the interface to the launcher.	Requirement	Astrium SRS 9.5.3	
SSFPS-485	Worst case combination of the axial and lateral loads of each load case a and b shall be considered. X is the distance in x direction from the separation plane measured in meter. The design loads for the antenna, the tank and the equipment panels are to applied for these items and at the interface to the overall structure. The loads are not to be combined with the overall structure loads. **DESIGN LOADS** — **Axial [g]** — **Lateral [g]** Overall Structure — load case a — ± 9.4 — ± (0.7 + 0.28* X) load case b — ± 5.5 — ± (1.9 + 0.76 * X) SAR Antenna — load case a — ± 12.0 — ± (1.0 + 0.4 * X) load case b — ± 8.0 — ± (3.0 + 1.2 * X) Tank Interface — load case a — 12.0 — 3.0 load case b — 8.0 — 6.0 Equipment Panel — load case a — 16.0 — 8.0 load case b — 8.0 — 16.0	Requirement	Astrium SRS 9.5.3	These are generic and should be compared to requirements of the launch vehicle user handbook.

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-487	**In-Orbit Loads** **Axial(Flight) [g]** **Lateral[g]** Configuration type snapdragon 0.01 0.01	Requirement	Astrium SRS 9.5.3	
SSFPS-489	Hoisting of the entire Garada space segment and the L SAR front-end must be possible. Specific hoisting points are to be foreseen. The maximum specified masses are to used. Loads are to be superimposed. Direction Static acceleration [g] Vertical -1.0 ± 2.0 Horizontal ± 0.5	Requirement	Astrium SRS 9.5.3	
SSFPS-493	**In-orbit Frequency** SAR Antenna >2 Hz (TBD) Solar Array 1.0 Hz Other items 2.0 Hz	Requirement	Astrium SRS 9.5.5	
SSFPS-495	Where possible the ESA ECSS Standards for hardware, software , GSE, tools, processes and procedures shall be applied in the Garada space segment system design, development and qualification.	Requirement	Astrium SRS 9.7	
SSFPS-496	The design of the Garada space segment shall have a configuration modularity, flexibility and adaptability in order to enable the Customer to integrate new partners, which would supply or operate parts of the Garada space segment.	Requirement	Astrium SRS 9.8	
SSFPS-497	The Garada space segment hardware and software shall be developed, integrated and tested using the ECSS standards.	Requirement	Astrium SRS 10.1	
SSFPS-498	The Garada space segment and related GSE shall comply to the relevant launch authority safety requirements.	Requirement	Astrium SRS 10.2	
SSFPS-59	***3.2.1.1 Data Products***	Heading		
SSFPS-60	The space segment design shall include a description of all data types, formats, modes, operational requirements and restrictions to obtain each type, and implications on space segment lifetime and other effects of each data collection process.	Requirement		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-226	The Garada space segment monitoring data shall be composed by fixed high-level formats.	Requirement	Astrium SRS 5.3.3	
SSFPS-247	The Garada shall be capable of producing, consistent with elevation angle limits, duty cycle, … swath width : a) a single Basic Product at any position along track; b) a single Basic Product at discrete positions across track. Spacing of these positions shall be not larger than three quarters (TBD) the swath width applicable to that incidence angle.	Requirement	Astrium SRS 5.4.1	
SSFPS-256	The Data Quality Check Product shall be available within TBD days to allow compensation/rescheduling of subsequent observations in case of unsatisfactory expected basic product quality.	Requirement	Astrium SRS 5.4.1	
SSFPS-299	The degradation in basic product Noise Equivalent Sigma Zero during the space segment lifetime shall be less than 1 dB (TBD).	Requirement	Astrium SRS 6.1.5	
SSFPS-300	The degradation in basic product Relative Radiometric Accuracy Error during the Garada space segment lifetime shall be less than 0.5 dB (TBD).	Requirement	Astrium SRS 6.1.5	
SSFPS-301	The degradation in basic product Radiometric Stability Error during the Garada space segment lifetime shall be TBD.	Requirement	Astrium SRS 6.1.5	
SSFPS-302	The degradation in basic product DTAR during the Garada space segment lifetime shall be less than 3 dB (TBD).	Requirement	Astrium SRS 6.1.5	
SSFPS-350	The Garada Spacecaft Platform be capable of producing a Basic Product at any point on the Earth's surface within TBD km of the radii point, consistent with power and thermal limitations.	Requirement		
SSFPS-61	***3.2.1.2 Space Segment Operation***	Heading		
SSFPS-62	Each space segment will be designed for an operational lifetime of YY years.	Requirement		
SSFPS-63	The SB, EPS, ADACS, C&DH, TT&C, TPS, and PROP subsystems will operate continuously when the space segment are on orbit, subject to safe mode considerations.	Requirement		
SSFPS-64	The SAR, AODS, GNSS-R, and HCDL shall operate intermittently as required for data collection, transmission to the ground segment, and power management.	Requirement		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-160	The Garada space segment shall be able to operate autonomously in any transfer orbit, for up to 7 days.	Requirement	Astrium SRS 5.3.1	
SSFPS-187	It shall be possible to execute a pre-programmed command schedule for Garada space segment space segment operation.	Requirement	Astrium SRS 5.3.1	
SSFPS-239	The mean (average over one day) measurement time per orbit shall be at least: - Multi-Band Strip Map Mode (L-quad) TBD s - Strip Map Mode (L-quad) TBD s	Requirement	Astrium SRS 5.4	
SSFPS-240	The peak load case in terms of accumulated measurement time per orbit shall be at least: - Multi-Band Strip Map Mode (L-quad) TBD s - Strip Map Mode (L-quad) TBD s	Requirement	Astrium SRS 5.4	
SSFPS-241	The reference load shall be a sustained peak load over three consecutive orbits within one day whilst maintaining average load case data volume when averaging over the entire day.	Definition	Astrium SRS 5.4	
SSFPS-242	The space segment shall be capable of measuring, storing and transmitting the reference data load.	Requirement		
SSFPS-308	The design availability of acquisition time of the Garada space segment shall be > 99% (TBD). This shall exclude time needed for satellite maintenance like orbit corrections, Garada calibration etc. Only those scheduled observation time-outs shall count, which are not caused by erroneous operation or operation of the satellite system beyond the specified performance range.	Requirement	Astrium SRS 6.2.1	
SSFPS-313	The Garada space segment shall be designed for a nominal lifetime of TBD years after IOD.	Requirement	Astrium SRS 6.2.3	
SSFPS-65	***3.2.1.3 Mission Phases***	Heading		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-133	The Garada space segment shall be compatible with the following mission phases: – Development and Integration Phase – Launch and Early Orbit Phase – Commissioning Phase – Operational Phase – Disposal Phase taking into account of the constraints induced by the launcher and the number as well as visibility of ground stations.	Requirement	Astrium SRS 5.1.3.1	
SSFPS-135	The development and integration phase shall cover the following subphases: • the development, integration, testing and verification of Space Segment and Ground Segment; • the system engineering and operational validation; • the launch campaign.	Requirement	Astrium SRS 5.1.3.2	
SSFPS-136	The Garada space segment be compatible with a Launch and Early Orbit Phase (LEOP) that includes the following events: • Pre-Launch. • Launch, from the launch itself until the separation of the Garada space segment from launcher. • Station Acquisition. • Mechanical, electrical configuration of Garada space segment consistent with start of commissioning.	Requirement	Astrium SRS 5.1.3.3	
SSFPS-142	The Operational Phase for the Garada space segment shall commence on System Handover to the Customer, and conclude with the start of the Disposal Phase of the Garada space segment.	Definition	Astrium SRS 5.1.3.5	
SSFPS-146	The Disposal Phase shall occur at the end of the Garada space segment operational lifetime.	Definition	Astrium SRS 5.1.3.6	
SSFPS-148	During the Disposal Phase the Garada space segment shall be made safe by disposing of all remaining on-board fuel.	Requirement	Astrium SRS 5.1.3.6	
SSFPS-150	During the Disposal Phase the Garada space segment shall comply with international space debris safety requirements.	Requirement	Astrium SRS 5.1.3.6	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-151	System imaging performance requirements shall not be applicable during the Disposal Phase.	Requirement	Astrium SRS 5.1.3.6	
SSFPS-66	***3.2.1.4 Number of space segment***	Heading		
SSFPS-67	The space segment shall consist of one or two spacecraft in a 6 AM-6 PM sun synchronous orbit of 630 km altitude.	Requirement		
SSFPS-68	***3.2.1.5 States and Modes***	Heading	Astrium SRS	Required states and modes must be defined in design phase
SSFPS-137	The Commissioning Phase shall bring the Garada spacecraft into a fully operational state for which the performances and measurement quality are known and controlled. The following specific activities shall be included (TBD): • Verification of the space segment (operational modes including Safe mode, and verification of the redundancy), verification of space segment status for operability and integrity of Platform Subsystems. • Calibration of SAR Instrument. • Verification of SAR Instrument performance characterisation and measurements, including Basic Products and optimisation of Ground Processor. • Demonstration of lifetime by verification of availability of resources (e.g. power, propellant) at Beginning-of-Life (BOL).	Requirement	Astrium SRS 5.1.3.4	
SSFPS-200	The control of Garada space segment mode transitions shall be consistent with the requirement on minimum along track gaps between basic products defined in Section 5.4.1 (Measurement Data Acquisition).	Requirement	Astrium SRS 5.3.1	
SSFPS-217	After switch-off the Garada space segment shall be in a state which enables a normal switch-on.	Requirement	Astrium SRS 5.3.2	
SSFPS-283	The Garada space segment shall be capable of acquiring SAR raw data in Stripmap Mode.	Requirement	Astrium SRS 6.1.2	
SSFPS-284	In Stripmap Mode the Garada space segment shall be capable of operating in quad or dual polarisation, selectable in-orbit.	Requirement	Astrium SRS 6.1.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-285	All Garada Stripmap Mode Basic Products shall be optionally available as part of combined Garada/Garada products.	Requirement	Astrium SRS 6.1.2	
SSFPS-287	In Stripmap Mode the Garada space segment and Garada Ground Processor shall support the generation of Basic Products with reduced range resolution by: • switching of the chirp-bandwidth (instrument) • reduction of processing bandwidth (ground processor) Reduced range resolution shall be selectable in at least 3 steps.	Requirement	Astrium SRS 6.1.2	
SSFPS-347	In order to simplify Garada space segment operation from ground, the space segment mode structure defined in Table 6.2 1 shall be implemented: Nominal Mode Characteristics Off-Mode (OFF) all equipment off Launch Mode (LAU) PCDU on and battery charging enabled Initialisation Mode (INIT) boot and initialisation of OBDH Safe Mode (SAF) essential function with minimum power dissipation on, instrument switched off, AOCS shall be in Coarse Attitude Mode (CAM) Stand-by Mode (SBY) mainly thermal control is active, instrument is partly switched on (STY), AOCS shall be in Coarse Attitude Mode (CAM) Transfer Mode (TRF) active for orbit transfer and orbit maintenance, instrument is in its STANDBY mode, AOCS shall be in Orbit Correction Mode (OCM) Nominal Mode (NRM) full performance operation of the space segment and instrument, AOCS shall be in Fine Attitude Mode (FAM) Table 6.2 1 space segment Modes (TBC)	Requirement	Astrium SRS 6.2.8	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-353	The following mode structure shall be implemented for the Garada: **Nominal Modes** **Characteristics** OFF All units are off STANDBY Activated are - ICU (for acquisition of commands) and - IPDU (for acquisition of control signals from ICU) The instrument will be in this mode only at the beginning of the mission and under non-nominal operating conditions PAUSE Activated are units which - need to achieve and maintain defined operational temperatures (with extended time required for this goal) - need to be loaded with initial software / data A downlink of data may be commanded (X-band Downlink Unit to be activated). The instrument will remain in this mode during the majority of the mission. READY All units are activated. Parameters for imaging are loaded and any operational mode can start immediately. Previously acquired image data is stored. Downlink of selected image data (scenes) may be commanded. All operational modes will be entered and returned to via this mode. Imaging Modes - STRIPMAP Acquisition of SAR data from a single swath, either dual pol or quad pol	Requirement	Astrium SRS 6.2.10	
SSFPS-69	***3.2.1.6 External Interfaces***	Heading		
SSFPS-70	The space segment shall interface with the launch vehicle from launch vehicle integration through on-orbit delivery.	Requirement	Launch Vehicle User Manual	
SSFPS-71	The space segment shall interface with the ground segment from on-orbit delivery through disposal.	Requirement	GSFPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-72	The space segment shall support a formation flying phase.	Requirement		
SSFPS-357	For nominal operation the following ground station characteristics shall be assumed for telemetry and commanding (TTAC) and for the acquisition of high rate measurement data: **Communications** **TTAC** **High Rata Data Acquisition** Station TBD TBD **Downlink** Frequency Range 2200 – 2400 MHz 7500-8400 MHz OR TBD Polarisation RHCP and LHCP RHCP or LHCP Axial Ratio TBD [dB] TBD [dB] G/T @ 5 deg elevation 22.6 [dB/K] ≥ 34.5 [dB/K] (7.5-8.0 GHz) ≥ 35.0 [dB/K] (8.0-8.4 GHz) Minimum elevation, at which reception is possible 5° 5° (TBC) **Uplink** Frequency Range 2025 – 2120 MHz - Polarisation RHCP or LHCP - Axial Ratio TBD [dB] - EIRP 64 [dBW] @ 2025 MHz -	Requirement	Astrium SRS 7.2	
SSFPS-369	Garada measurement data, orbit and ephemeris data and auxiliary/auxiliary data shall be transmitted to ground with a high data rate communications system using the following frequency range and bandwidth: X-band 8.025 – 8.400 GHz OR ..... Bandwidth ≥ 300 MHz **Table 7.4 1 Data Downlink Frequencies**	Requirement	Astrium SRS 7.4	
SSFPS-381	Deleted			
SSFPS-382	Deleted			
SSFPS-383	Deleted			

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-385	Deleted			
SSFPS-387	The space segment shall not produce detectable emissions in the Radio Astronomy bands as follows: Frequency Band [MHz] — Allocated Service 1400 - 1427 — Earth exploration by space segment (passive) 1660 - 1660.5 — Radio Astronomy 2655 - 2670 — Radio Astronomy 2670 - 2690 — Radio Astronomy 4800 - 4990 — Radio Astronomy 4990 - 5000 — Radio Astronomy 10.60 - 10.68 — Radio Astronomy 10.68 - 10.70 — Radio Astronomy 15.35 - 15.40 — Space Research (passive) 18.60 - 18.80 — Space Research (passive) 21.20 - 21.40 — Space Research (passive) 22.41 - 21.50 — Space Research (passive) 23.60 - 24.00 — Space Research (passive) 31.30 - 31.50 — Space Research (passive) 36.00 - 37.00 — Space Research (passive)	Requirement	Astrium SRS 7.7	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-3	***3.2.2 Spacecraft Bus and Structure (SBAS)***	Heading		
SSFPS-940	The Garada spacecraft shall have structural analysis to determine the structural requirements, especially vibration during launch.	Requirement	TK10.2 (Derived)	
SSFPS-779	The Garada spacecraft bus and structure shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-486	Worst case combination of the axial and lateral loads of each load case a and b shall be considered. X is the distance in x direction from the separation plane measured in meter. The design loads for the antenna, the tank and the equipment panels are to applied for these items and at the interface to the overall structure. The loads are not to be combined with the overall structure loads. **DESIGN LOADS** — **Axial [g]** — **Lateral [g]** Overall Structure — load case a — ± 9.4 — ± (0.7 + 0.28* X) load case b — ± 5.5 — ± (1.9 + 0.76 * X) SAR Antenna — load case a — ± 12.0 — ± (1.0 + 0.4 * X) load case b — ± 8.0 — ± (3.0 + 1.2 * X) Tank Interface — load case a — 12.0 — 3.0 load case b — 8.0 — 6.0 Equipment Panel — load case a — 16.0 — 8.0 load case b — 8.0 — 16.0	Requirement	Astrium SRS 9.5.3	These are generic loads, compare to launch vehicle user manual during design phase.
SSFPS-488	**In-Orbit Loads** — **Axial(Flight) [g]** — **Lateral[g]** Configuration type snapdragon — 0.01 — 0.01	Requirement	Astrium SRS 9.5.3	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-490	Hoisting of the entire Garada spacecraft and the L SAR front-end must be possible. Specific hoisting points are to be foreseen. The maximum specified masses are to used. Loads are to be superimposed. **Direction** **Static acceleration [g]** Vertical -1.0 ± 2.0 Horizontal ± 0.5	Requirement	Astrium SRS 9.5.3	
SSFPS-491	The following stiffness requirements shall be applied to hard mounted condition in launch configuration. **STIFFNESS REQUIREMENT** **Axial** **Lateral** S/C ≥ 35 Hz (TBD) ≥ 10 Hz (TBD) SAR Antenna (stowed) ≥ 45 Hz (TBD) ≥ 25 Hz (TBD) Tile ≥ 100Hz ≥ 85 Hz Tanks ≥ 60 Hz (TBD) ≥ 60 Hz (TBD) Equipment Panels ≥ 40 Hz (TBD) ≥ 40 Hz (TBD) Secondary Items ≥ 80 Hz (TBD) ≥ 80 Hz (TBD)	Requirement	Astrium SRS 9.5.5	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-4	***3.2.3 SAR Sensor (SAR)***	Heading		
SSFPS-703	Integrated circuits used in the SAR sensor shall be commercial off-the-shelf.	Requirement	Thomas Cooney Garada Module Requirements	
SSFPS-699	The Garada radar design thermal baseline shall be anti-Sun-looking 6 AM passes, but shall include Sun-looking passes when necessary to avoid imaging when the nadir is over water.	Requirement	OSRB v02_00 5.1.7	
SSFPS-698	The Garada radar design shall be capable of segmented operation (left-right, or other segmentation approaches) to support investigations of its use in other applications.	Requirement	OSRB v02_00 5.1.6	
SSFPS-697	The Garada radar shall provide a radiometric resolution capable of distinguishing a TBD% difference in reflectivity between two parcels of multilooked pixels.	Requirement	OSRB v02_00 5.1.5	
SSFPS-696	The radar shall provide a scanSAR mode with ability to resolve 1000m parcels after multilooking.	Requirement	OSRB v02_00 5.1.4	
SSFPS-695	The radar shall provide a stripmap mode with ability to resolve 250m parcels after multilooking.	Requirement	OSRB v02_00 5.1.3	
SSFPS-694	The radar design shall be based on coherent quad polarization operation to allow for correction of Faraday rotation in the ionosphere, in support of soil moisture measurement from space.	Requirement	OSRB v02_00 5.1.2	
SSFPS-693	The radar shall operate in the L band [to minimize the contributions of surface roughness and overlying vegetation to the radar echo, and yet take advantage of the larger bandwidth allocation in L band compared to P band].	Requirement	OSRB v02_00 5.1.1	
SSFPS-692	The Garada space segment shall support the periodic adjustment of orbits for the performance of interferometric imaging .	Requirement	OSRB v02_00 3.1.21	
SSFPS-683	The radar duty cycle of the Garada spacecraft shall be no less than that required to cover the longest linear dimension of the entire Murray-Darling basin.	Requirement	OSRB v02_00 3.1.10	
SSFPS-680	The Garada space segment shall support obtaining radar returns from the Earth's surface at high spatial resolution.	Requirement	OSRB v02_00 3.1.7	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-679	The Garada orbits shall support imaging the entire MDB at 1 km (multilooked) resolution every 2 weeks in Quad Pol and every 3 days in Dual Pol.	Requirement	OSRB v02_00 3.1.6	
SSFPS-678	The Garada space segment shall support the launch, operation, calibration, and commanding of a SAR sensor that is optimized for soil moisture measurements.	Requirement	OSRB v02_00 3.1.5	
SSFPS-907	SAR shall provide radar data to Onboard Data handling CADH.	Requirement	TK10.2 (Derived)	
SSFPS-887	The Garada spacecraft shall provide parameters to CADH and FDIR for performance assessment.	Requirement	TK10.2 (Derived)	
SSFPS-878	SAR shall enable periodic recording of the transmit waveform.	Requirement	TK10.2 (Derived)	
SSFPS-875	The Garada spacecraft shall be capable of providing data in sub-kilometre parcels, comprised of 25*25 multilooks.	Requirement	TK10.2 (Derived)	
SSFPS-870	SAR shall produce data of sufficient accuracy to identify: a) Outlines of water bodies, b) Outlines of forests, c) Outlines of clear cut forests, d) Soil moisture contours.	Requirement	TK10.2 (Derived)	
SSFPS-869	SAR shall be capable of providing Raw Data sufficient to create these products: a) Single Look Complex, b) Path Image, c) Map Image, d) Multi Look.	Requirement	TK10.2 (Derived)	
SSFPS-863	The Garada spacecraft shall be able to obtain squinted data up to a squint angle of DD degrees.	Requirement	TK10.2 (Derived)	
SSFPS-861	SAR shall obtain data in SAR scanSAR mode.	Requirement	TK10.2 (Derived)	
SSFPS-859	SAR shall obtain data in SAR stripmap mode.	Requirement	TK10.2 (Derived)	
SSFPS-850	The Garada spacecraft shall have modes for internal and external calibration.	Requirement	TK10.2 (Derived)	
SSFPS-849	The Garada SAR shall carry the equipment necessary to conduct SAR calibration upon command.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-828	The Garada spacecraft SAR sensor shall operate in accordance with commands from Ground Station when in operational mode	Requirement	TK10.2 (Derived)	
SSFPS-780	The Garada SAR sensor shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-731	The following test programme on a flight representative SAR Instrument Demonstrator (elegant breadboard) is defined below: Test / Measurement Electrical I/F test (internal and external I/F) Comprehensive functional test Comprehensive performance test (CPT) Complementary EMC test Column level pattern verification **Table 8.3 2 Instrument Level Demonstrator Tests**	Requirement	Astrium SRS 8.3.4	
SSFPS-732	The integrated instrument shall be verified for correct operation in all modes and with the defined individual functions in the specified manner.	Requirement	Astrium SRS 8.3.4	
SSFPS-733	The integrated instrument shall be verified for correct operation in all modes and with the defined individual functions in the specified manner with selected combinations of nominal and redundant units.	Requirement	Astrium SRS 8.3.4	
SSFPS-734	Planarity and orientation of the SAR antenna support structure shall be measured after final mechanical assembly. Deviations shall be compensated by shimming. After mounting of all antenna panels, a check of the final alignment of the radiating elements shall be performed.	Requirement	Astrium SRS 8.3.4	
SSFPS-735	The integrated SAR instrument shall be verified for correct performance of the specified parameters. Data for the characterisation of the instrument performance will be recorded in the frame of a characterisation test performed within selected operationally and thermally stabilised operating states.	Requirement	Astrium SRS 8.3.4	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-736	The integrated instrument shall be verified (in specific modes) for selected emission levels and for correct operation under Electro-Magnetic Compactibility (EMC) conditions which cannot be verified on unit level.	Requirement	Astrium SRS 8.3.4	
SSFPS-434	The integrated instrument shall be verified for correct operation in all modes and with the defined individual functions in the specified manner.	Requirement	Astrium SRS 8.3.4	
SSFPS-436	The integrated instrument shall be verified for correct operation in all modes and with the defined individual functions in the specified manner with selected combinations of nominal and redundant units.	Requirement	Astrium SRS 8.3.4	
SSFPS-123	The centre co-ordinate of the imaged area shall be selectable at time of order placement.	Requirement	Astrium Def 3.1-12	
SSFPS-124	The maximum deviation of any desired centre co-ordinate to a realisable centre co-ordinate of a basic product shall not exceed a fraction of the across-track product size.	Requirement	Astrium Def 3.1-12	
SSFPS-138	Calibration of SAR Instrument and verification of SAR Instrument performance characterisation and measurements, including Basic Products and optimisation of Ground Processor shall be conducted during the commissioning phase of Garada spacecraft.	Requirement		
SSFPS-144	During the Operational Phase the SAR instrument shall operate with nominal performance, except during attitude adjustment and major orbit manoeuvres.	Requirement	Astrium SRS 5.1.3.5	
SSFPS-145	During the Operational Phase periodic calibration / validation of data and basic products shall be undertaken.	Requirement	Astrium SRS 5.1.3.5	
SSFPS-152	System imaging shall not be operational during the Disposal Phase.	Requirement		
SSFPS-268	The system shall provide for periodic calibration / validation of data (TBD) during the Operational Phase.	Requirement	Astrium SRS 5.4.1	Detailed procedures for calibration and data validation must be defined during design phase.

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-278	The Garada spacecraft and its respective Garada Ground Processor shall support the generation of the following Basic Products: 1. Basic Products based on SAR images and quality data obtained by processing of Garada Stripmap and ScanSAR Mode 2. Basic Products based on SAR images and quality data obtained by processing of Garada Low Resolution Mode 3. Multi-band based on SAR images and quality data obtained by processing of Garada Stripmap Mode	Requirement	Astrium SRS 6.1.1	
SSFPS-281	The average number of Garada raw data acquisitions per orbit (one day average) shall be TBD.	Requirement	Astrium SRS 6.1.1	Define during design phase
SSFPS-282	The worst case number of Garada raw data acquisitions per orbit within the daily envelope shall be TBD.	Requirement	Astrium SRS 6.1.1	Define during design phase
SSFPS-286	For Garada Stripmap Quad Polarisation Basic Products, assuming the nominal back-scattering model in the imaged swath and at the nadir region, the width of the area where nadir ambiguity artefacts exceed the power of the nominal image shall not exceed (TBD).	Requirement	Astrium SRS 6.1.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-290	The Garada shall be capable of generating and providing L-band Quad-polar Stripmap (L_Q/SM) Basic Products as specified below: Product type identifier **L_Q/SM** **Product Characteristics** Radar band L Polarisation Quad polarisation (or circular, TBD) Product coverage along track: free selectable across track: ≥ 40 km **Product Quality Characteristics** Data collection incidence angle range 10 deg to 40 deg Minimum swath overlap(in across track 25 % min.) 10 km Full performance incidence angle range 20 deg to 32 deg Geometric resolution along track ≤5 m Geometric resolution ground range @ 20° const. BW ≤ 9.0 m Ambiguity ratio DTAR (Beginning of life) ≤ -17 dB DTAR (End Of Life) ≤ -14 dB Sidelobe ratio ISLR ≤ -13 dB NE SZ @ 9 m across track res., BOL ≤ -30 dB NE SZ @ 9 m across track res., EOL ≤ -29 dB Radiometric stability BOL ≤ 0.5 dB EOL ≤ TBD dB Pixel localisation accuracy RMS ≤ 4.5m Relative radiometric accuracy BOL ≤ 0.5 dB EOL ≤ 1 dB Absolute radiometric accuracy ≤ 1.5 dB Inter-channel phase accuracy ≤ 10 degrees	Requirement	Astrium SRS 6.1.2	These are generic requirements that should be adjusted in coordination with soil moisture algorithm developers.

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-291	The Garada shall be capable of generating and providing L-band Dual-polar Stripmap (L_D/SM) Basic Products as specified herein: Product type identifier **L_D/SM** **Product Characteristics** Radar band L Polarisation Dual polarisation Product coverage along track: free selectable across track: ≥ 60 km **Product Quality Characteristics** Data collection incidence angle range 15 deg to 60 deg Minimum swath overlap(in across track 25 % min.) 15 km Full performance incidence angle range 20 deg to 45 deg Geometric resolution along track ≤ 5 m Geometric resolution ground range @ 20° const. BW ≤ 9.0 m Ambiguity ratio DTAR (BOL) ≤ -17 dB DTAR (EOL) ≤ -14 dB Sidelobe ratio ISLR ≤ -13 dB NE SZ @ 9 m across track res.), BOL ≤ -30 dB NE SZ @ 9 m across track res.), EOL ≤ -29 dB Radiometric stability BOL ≤ 0.5 dB EOL ≤ TBD dB Pixel localisation accuracy RMS ≤ 4.5m Relative radiometric accuracy BOL ≤ 0.5 dB EOL ≤ 1 dB Absolute radiometric accuracy ≤ 1.5 dB Dynamic Range (point targets) ≥ 60 dB	Requirement	Astrium SRS 6.1.2	These are generic requirements that should be adjusted in coordination with soil moisture algorithm developers.
SSFPS-292	The Multi-Band Strip Map Product shall utilise Garada Stripmap image components in combination with data components from other sources.	Requirement	Astrium SRS 6.1.3	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-293	Generation of Multi-Band Strip Map Products shall be feasible from components employing any polarisation mode or resolution specified for the respective band as long as located within the full performance incidence angle range of both components.	Requirement	Astrium SRS 6.1.3	
SSFPS-294	The Garada shall be capable of generating and providing Multi-Band Strip Map Basic Products as specified herein: Product Components L_Q/SM L_D/SM Temporal separation < 15 minutes Incident angle difference < 0.5° Product coverage 40 Km Co-registration accuracy L_D/S along <2.5 m across <4.5 m Co-registration accuracy L_Q/SM along <2.5 m across <4.5 m	Requirement	Astrium SRS 6.1.3	These are generic requirements that should be adjusted after consultation with soil moisture algorithm developers.
SSFPS-295	Low-resolution products in Garada and its combination shall be derived from Instrument data when operating in Scan-SAR Mode.	Requirement	Astrium SRS 6.1.4	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-296	The Garada shall be capable of generating and providing L-band Dual (L_D)/ScanSAR (SC) Basic Products as specified herein: Product type identifier **L_D/SC_200** **Product Characteristics** Radar band L Polarisation Dual polarisation Product coverage along track: free selectable across track: ≥ 200 km **Product Quality Characteristics** Data collection incidence angle range 20 deg to 60 deg Full performance incidence angle range 23 deg to 45 deg Geometric resolution along track 30 m Along looks ≥ 2 Geometric resolution ground range 30 m Across looks ≥ 4 Ambiguity ratio DTAR (BOL) ≤ -17 dB DTAR (EOL) ≤ -14dB Sidelobe ratio ISLR ≤ -13 dB NE SZ @ 45, BOL ≤-28 dB NE SZ @ 45°, EOL ≤ -27 dB Relative radiometric accuracy ≤ 1.3 dB Dynamic Range (point targets) ≥ 54 dB	Requirement	Astrium SRS 6.1.4	These are generic requirements that should be adjusted after consultation with soil moisture algorithm developers.

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-297	The Garada shall be capable of generating and providing L-band Dual (L_D)/ScanSAR (SC) Basic Products as specified herein: Product type identifier **L_D/SC_100** **Product Characteristics** Radar band L Polarisation Dual polarisation Product coverage along track: free selectable across track: ≥ 100 km **Product Quality Characteristics** Data collection incidence angle range 20 deg to 60 deg Full performance incidence angle range 20 deg to 45 deg Geometric resolution along track 30m Along looks ≥ 2 Geometric resolution ground range 30m Across looks ≥ 4 Ambiguity ratio DTAR (BOL) ≤ -17 dB DTAR (EOL) ≤ -14 dB Sidelobe ratio ISLR ≤ -13 dB NE SZ @ 45°, BOL ≤ -28dB NE SZ @ 45°, EOL ≤ -27dB Relative radiometric accuracy BOL ≤ 1.3 dB EOL ≤ 1.8 dB Dynamic Range (point targets) ≤ 54 dB	Requirement	Astrium SRS 6.1.4	These are generic requirements that should be adjusted after consultation with soil moisture algorithm developers.
SSFPS-303	The Garada spacecraft shall be capable of operating in a repeat-pass INSAR mode at L-band.	Requirement	Astrium SRS 6.1.6	
SSFPS-305	Phase stability of the instrument and the SAR processor shall be such as to maintain instrument and processor-induced phase errors to less than 10 degrees (TBD) across an individual scene. Note that the phase error excludes any absolute or relative phase errors caused by propagation or ground motion effects.	Requirement	Astrium SRS 6.1.6	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-306	Stereo pairs shall be acquired with a minimum of 10 degrees difference in incidence angle, within a range of 20 to 45 degrees incidence angle, from the same viewing direction (i.e. both ascending or both descending swaths).	Requirement	Astrium SRS 6.1.6	
SSFPS-328	It shall be possible to disable the SAR data compression function.	Requirement	Astrium SRS 6.2.5	
SSFPS-329	SAR data compression shall have the minimum possible loss consistent with productivity and downlink requirements.	Requirement	Astrium SRS 6.2.5	
SSFPS-340	The Garada spacecraft shall provide the following timing information for processing of SAR raw data: • Onboard Time (OBT), synchronised to GPS time (HK data stream) • Garada instrument time in the datation of SAR packets (synchronised to GPS time, SAR Data stream) • Event report regarding the synchronisation event OBT – GPS also including the values of OBT and GPS time (HK data stream) • Event reports regarding the synchronisation event Garada instrument time – GPS also including the values of instrument and GPS time (HK data stream)	Requirement	Astrium SRS 6.2.6	
SSFPS-351	The Garada spacecraft instrument complement shall include an L-band SAR and a GNSS reflectometry instrument.	Requirement	Astrium SRS 6.2.10	
SSFPS-354	The Garada instrument shall operate in the frequency between 1.215 to 1.300 GHz with a chirp bandwidth of 55 MHz.	Requirement	Astrium SRS 6.2.10	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-355	The Garada Instrument shall be able to operate in the following polarisation: • Dual polarisation, i.e. either HH+HV or VV+VH • Quad polarisation, i.e. HH+HV , VV+VH	Requirement	Astrium SRS 6.2.10	In the design phase, specify **Instrument Performance Requirements:** ability to detect inteference, frequency stability, relative phase error between radiating element, power limit, beam pointing error, failed element tolerance (achieve required performance with XX% failed), surface figure tolerance (maybe), received signal detectability, element noise figure.
SSFPS-356	The Garada shall operate in the frequency range between 1.215 to 1.300 GHz, (with a centre frequency of 1.2575 GHz), with a chirp bandwidth of 55 MHz.	Requirement	Astrium SRS 7.1	
SSFPS-442	Antenna pattern verification shall be measured on different antenna integration levels to the maximum extent practicable. Complementary tests shall be undertaken to supplement performance predictions which can only be performed by analysis.	Requirement	Astrium SRS 8.3.4	
SSFPS-494	**In-orbit Mechanical Frequency** SAR Antenna >2 Hz (TBD) Solar Array 1.0 Hz Other items 2.0 Hz	Requirement	Astrium SRS 9.5.5	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-5	***3.2.4 Electrical Power Subsystem (EPS)***	Heading		
SSFPS-949	The Garada spacecraft electrical subsystem shall be capable of supporting data collection in areas other than Australia.	Requirement		
SSFPS-816	The Garada EPS shall provide sufficient power to account for attitude changes for SAR operation and thermal management.	Requirement	TK10.2 (Derived)	
SSFPS-808	The Garada EPS shall provide real time information of power generated from solar arrays and power consumption to TTAC.	Requirement	TK10.2 (Derived)	
SSFPS-807	The Garada spacecraft shall respond to ground commanded mode changes.	Requirement	TK10.2 (Derived)	
SSFPS-781	The Garada electrical power subsystem shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-213	The Garada spacecraft shall perform an automatic switch-on after connection to electrical power.	Requirement	Astrium SRS 5.3.2	
SSFPS-475	The total Garada spacecraft power consumption shall comply with the margins defined as follows: up to PDR 30% after PDR to CDR 15% after CDR to QR 10% after QR to FAR 4%	Requirement	Astrium SRS 9.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-6	***3.2.5 Attitude Determination and Control System (ADACS)***	Heading		
SSFPS-923	The Garada spacecraft shall support antenna pointing with an accuracy no worse than 1 degree.	Requirement	TK10.2 (Derived)	
SSFPS-908	The Garada ADACS shall provide attitude information to CADH for implementing interface “E16 Payload Data.”	Requirement	TK10.2 (Derived)	
SSFPS-900	The Garada ADACS shall provide attitude information to CADH to support autonomous tracking during ground station passes.	Requirement	TK10.2 (Derived)	
SSFPS-882	The Garada ADACS shall support SAR calibration manoeuvres.	Requirement	TK10.2 (Derived)	
SSFPS-872	In conjunction with HBDL, the Garada spacecraft shall be capable of pointing to Ground Segment so as to initiate downlink immediately upon completion of SAR operation.	Requirement	TK10.2 (Derived)	
SSFPS-867	The Garada ADACS shall determine attitude with sufficient accuracy to support SAR georegistration with an accuracy of one pixel.	Requirement	TK10.2 (Derived)	
SSFPS-865	The Garada ADACS shall determine attitude with sufficient accuracy for interferometric processing of SAR images.	Requirement	TK10.2 (Derived)	
SSFPS-817	The Garada ADACS shall remain active during safe mode and to enable maintaining communication with Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-782	The Garada ADACS shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-770	The ADACS subsystem shall execute commands received for attitude correction.	Requirement	TK10.2 (Derived)	
SSFPS-769	The Garada spacecraft shall respond to attitude correction commands from the ground.	Requirement	TK10.2 (Derived)	
SSFPS-766	The Garada spacecraft shall determine instantaneous spacecraft attitude and provide it to TTAC.	Requirement	TK10.2 (Derived)	
SSFPS-758	The Garada spacecraft shall respond to orbit correction commands from Ground station.	Requirement	TK10.2 (Derived)	
SSFPS-745	The Garada spacecraft shall have the capability to perform manoeuvre once the collision risk is accessed via Conjunction Assessment Service.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-743	The Garada spacecraft shall have an operational mode where all equipment is operational.	Requirement	TK10.2 (Derived)	
SSFPS-742	The Garada spacecraft shall have a self-test mode for pre-launch testing where the equipment undertakes self-test.	Requirement	TK10.2 (Derived)	
SSFPS-345	For nominal operation the Garada spacecraft shall be right looking as defined in Section 3.1.2 (Reference Frames).	Requirement	Astrium SRS 6.2.7	
SSFPS-346	The Garada spacecraft shall support yaw steering in order to compensate the Doppler shift of ground targets resulting from the rotation of the Earth.	Requirement	Astrium SRS 6.2.7	During design, requirements should be added for attitude determination accuracy, attitude control accuracy, and jitter.
SSFPS-391	The verification of the in-orbit spacecraft Centre of Mass (CoM) position shall be based on a CoM analysis. In addition, the Moments of Inertia (MoI), shall be analysed. The accuracy of the analysis shall be 5% (TBD).	Requirement	Astrium SRS 8.3.1	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-393	In order to predict the pointing, pointing stability, and pointing knowledge in-orbit performance, an alignment analysis shall be performed, considering the following effects: • Alignment measurement error • Build-up of assembly tolerances • Personnel error • 0g/1g variation • In-orbit thermo-elastic distortion The alignment analysis shall be conducted at least for the following equipment: • alignment between SAR antenna reference frame and the star tracker boresight(s) • alignment between the star trackers and the spacecraft build reference system • alignment between thrusters and the spacecraft build reference system • alignment between the RF downlink antenna and the spacecraft build reference system	Requirement	Astrium SRS 8.3.1	
SSFPS-395	The geo-location knowledge accuracy shall be supported by OOD performance analysis. This analysis shall include GPS position errors, star sensor errors, alignment errors between star sensor and SAR Antenna, SAR Antenna pointing errors and timing errors (TBD).	Requirement	Astrium SRS 8.3.1	
SSFPS-426	The CoM-requirement shall be verified by a balance test campaign consisting of combined static/dynamic measurement and trimming (TBC). The spacecraft shall be: • fully flight representative (except final balance masses) • the mass of the hydrazine in the tank shall suitably be simulated. The influence of variable configuration items shall be tested. After installation of the final balance masses, the result of final balancing (position of the CoM and the orientation of the S/C principal axes) shall be verified by a second test run (TBC).	Requirement	Astrium SRS 8.3.3	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-7	***3.2.6 Command and Data Handing (CADH)***	Heading		
SSFPS-686	The Garada space segment shall provide for encryption of its downlink.	Requirement	OSRB v02_00 3.1.13	
SSFPS-947	To the extent possible, data processing chains shall be modular to allow modification of processing algorithms.	Requirement	TK10.2 (Derived)	
SSFPS-931	The Garada CADH shall be capable of implementing telecommands received from TTAC.	Requirement	TK10.2 (Derived)	
SSFPS-910	The Garada CADH shall control HBDL for implementing interface “E16 Payload Data.”	Requirement	TK10.2 (Derived)	
SSFPS-902	The Garada spacecraftC&DH shall support HBDL antenna pointing for link establishment.	Requirement	TK10.2 (Derived)	
SSFPS-901	The Garada CADH shall process attitude signals to support automatic link establishment with the Ground Segment.	Requirement	TK10.2 (Derived)	
SSFPS-898	The Garada spacecraft shall support upgrades of selected hosted applications.	Requirement	TK10.2 (Derived)	
SSFPS-897	The Garada spacecraft shall validate the new software before updating the systems.	Requirement	TK10.2 (Derived)	
SSFPS-888	The Garada CADH shall store SAR performance data and deliver SAR performance parameters to TTAC.	Requirement	TK10.2 (Derived)	
SSFPS-883	The Garada CADH shall execute SAR calibration manoeuvre commands.	Requirement	TK10.2 (Derived)	
SSFPS-873	The Garada spacecraft shall be capable of storing data from multiple SAR operations periods such that no data is lost from a single period of GS unavailability.	Requirement	TK10.2 (Derived)	
SSFPS-864	The Garada spacecraft shall record and downlink data in SAR squinted mode.	Requirement	TK10.2 (Derived)	
SSFPS-862	The Garada spacecraft shall support collection of SAR data in scanSAR mode.	Requirement	TK10.2 (Derived)	
SSFPS-860	The Garada spacecraft shall support collection of SAR data in stripmap mode.	Requirement	TK10.2 (Derived)	
SSFPS-856	The Garada spacecraft shall retain raw SAR data in memory until receipt of signal indicating error-free reception of data on the ground.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-855	The Garada spacecraft shall store raw SAR data from time of collection to time of downlink.	Requirement	TK10.2 (Derived)	
SSFPS-851	The Garada spacecraft shall perform calculations required for internal and external calibration.	Requirement	TK10.2 (Derived)	
SSFPS-836	The Garada CADH shall verify commands received and only implement validated commands.	Requirement	TK10.2 (Derived)	
SSFPS-833	The Garada spacecraft shall generate acknowledgements of received telecommands.	Requirement	TK10.2 (Derived)	
SSFPS-832	The Garada spacecraft shall implement the telecommand set as defined in TBD.	Requirement	TK10.2 (Derived)	
SSFPS-829	The Garada CADH shall send detailed control signals to SAR in response to commands.	Requirement	TK10.2 (Derived)	
SSFPS-824	The Garada CADH shall implement uplinked software changes.	Requirement	TK10.2 (Derived)	
SSFPS-813	The Garada CADH shall store all data received onboard and deliver it to Ground Station for post-processing.	Requirement	TK10.2 (Derived)	
SSFPS-812	The Garada CADH shall respond to ground commanded mode changes by generating corresponding commands to other subsystems.	Requirement	TK10.2 (Derived)	
SSFPS-801	The Garada CADH shall respond to the commands given by Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-799	The Garada CADH shall generate signal to acknowledge command received from Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-796	3.2.6: The Garada CADH shall collate and archive the status of the satellite time service and then downlink the information to Ground Segment.	Requirement	TK10.2 (Derived)	
SSFPS-783	The Garada spacecraft Command and Data Handing shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-774	The Garada spacecraft shall have the capability to reject attitude correction telecommands that are not validated.	Requirement	TK10.2 (Derived)	
SSFPS-771	The Garada spacecraft shall interpret attitude correction commands received from the ground, and send proper control signals to ADACS to execute them.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-763	The Garada spacecraft shall have the capability to reject orbit correction telecommands that are not validated.	Requirement	TK10.2 (Derived)	
SSFPS-759	The Garada spacecraft shall interpret orbit correction commands received from the ground, and send proper control signals to ADACS and PROP to execute them.	Requirement	TK10.2 (Derived)	
SSFPS-161	In the absence of commands and predicted orbit positions, the Garada spacecraft shall be able to operate autonomously for 7 days without the need for ground intervention (applicable after Low Earth Orbit Phase).	Requirement	Astrium SRS 5.3.1	
SSFPS-162	The Garada spacecraft shall provide the capability to be commanded from the ground.	Requirement	Astrium SRS 5.3.1	
SSFPS-165	The Garada spacecraft shall perform a verification of all commands with respect to the correctness of the command layout and parameters.	Requirement	Astrium SRS 5.3.1	
SSFPS-166	Commands which fail command verification by the Garada spacecraft shall not be executed.	Requirement	Astrium SRS 5.3.1	
SSFPS-167	The Garada spacecraft shall not execute commands that jeopardise its health or safety except well-identified critical commands.	Requirement	Astrium SRS 5.3.1	During design phase, select specific commands with spacecraft operational safety implications for addition of safeguards.
SSFPS-168	The Garada spacecraft shall provide a capability for manual command override.	Requirement	Astrium SRS 5.3.1	
SSFPS-169	The execution of critical commands by the Garada spacecraft shall be secured by specific safety mechanisms.	Requirement	Astrium SRS 5.3.1	Define critical commands during design phase
SSFPS-183	Fixed high-level command structures established as Macro-Commands expanded on-board shall be used for commanding of the Garada Spacecraft.	Requirement	Astrium SRS 5.3.1	Define macro-commands during design phase
SSFPS-185	All Garada spacecraft commands shall automatically be distributed to the function responsible for execution.	Requirement	Astrium SRS 5.3.1	
SSFPS-186	It shall be possible to execute a pre-programmed command schedule for Garada spacecraft space segment operation.	Requirement	Astrium SRS 5.3.1	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-188	Garada spacecraft functions shall be executed either by: a) verified command; or b) by autonomous operation.	Requirement	Astrium SRS 5.3.1	
SSFPS-190	It shall be possible to enable/disable all Garada spacecraft autonomous functions by dedicated command.	Requirement	Astrium SRS 5.3.1	
SSFPS-191	The spacecraft shall provide a capability to modify Garada spacecraft parameters used in the on-board software by dedicated command.	Requirement	Astrium SRS 5.3.1	
SSFPS-192	The spacecraft shall provide a capability to patch Garada spacecraft on-board software by dedicated command.	Requirement	Astrium SRS 5.3.1	
SSFPS-193	Conflicting commandings to the Garada spacecraft shall not be executed.	Requirement	Astrium SRS 5.3.1	During design phase, identify potential command conflicts and implement deconfliction methodology.
SSFPS-196	The Garada spacecraft measurement data streams shall be encrypted.	Requirement	Astrium SRS 5.3.1	
SSFPS-197	It shall be possible to modify the encryption keys (TBD) used for the Garada spacecraft measurement data streams.	Requirement	Astrium SRS 5.3.1	
SSFPS-198	The encryption level on the Garada spacecraft measurement data streams shall be (TBD).	Requirement	Astrium SRS 5.3.1	
SSFPS-201	The Garada spacecraft shall be capable to store on-board the volume of acquired instrument data compatible with the reference measurement scenario for two orbits.	Requirement	Astrium SRS 5.3.1	
SSFPS-205	The Garada spacecraft shall have a capability to assign priority to the data received onboard.	Requirement		
SSFPS-212	The Garada spacecraft buffers shall have the capacity to store commands and predicted orbit positions for at least 24 hours.	Requirement	Astrium SRS 5.3.1	
SSFPS-215	The Garada spacecraft shall provide the capability to perform a detailed check-out by commanding.	Requirement	Astrium SRS 5.3.2	
SSFPS-216	The Garada CADH subsystem shall be capable of shifting into and out of safe mode by commanding.	Requirement	Astrium SRS 5.3.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-221	It shall be possible to monitor the completion status of all commands to the Garada spacecraft.	Requirement	Astrium SRS 5.3.3	
SSFPS-225	The spacecraft shall store onboard a history of all Garada spacecraft events (nominal and non-nominal) and transmit on command.	Requirement	Astrium SRS 5.3.3	
SSFPS-227	The monitoring data from the Garada spacecraft shall be acquired and recorded onboard over the complete orbit.	Requirement	Astrium SRS 5.3.3	
SSFPS-235	The Garada spacecraft shall be capable of handling pre-programmed time-scheduled command sequences for a duration of seven days ahead of time.	Requirement	Astrium SRS 5.3.5	
SSFPS-236	The Garada spacecraft shall be capable of executing commands at each position in the orbit for execution at later designated times.	Requirement	Astrium SRS 5.3.5	
SSFPS-237	The Garada spacecraft shall be capable of handling deletion of single commands from a pre-programmed time-tagged sequence.	Requirement	Astrium SRS 5.3.5	
SSFPS-253	Deleted			
SSFPS-277	The on-board mass memory shall be organised such, that stored data can be downlinked with priority.	Requirement	Astrium SRS 5.4.2	
SSFPS-320	Each data acquisition (scene) shall be assigned onboard with a unique identification number (ID). The Garada spacecraft shall attach the ID numbers, which will be up-linked by the Ground Segment, to the measurement data.	Requirement	Astrium SRS 6.2.5	
SSFPS-322	The high rate data stream shall contain all relevant data required for on-ground processing of measurement data, i.e. instrument source packets including measurement data and auxiliary data.	Requirement	Astrium SRS 6.2.5	
SSFPS-323	The measurement data streams shall be encrypted.	Requirement	Astrium SRS 6.2.5	
SSFPS-324	It shall be possible to modify the used encryption keys (TBC).	Requirement	Astrium SRS 6.2.5	
SSFPS-325	The encryption level shall be (TBD).	Requirement	Astrium SRS 6.2.5	
SSFPS-326	The Garada spacecraft shall be designed to have an on-board storage and compression (if needed) capability in compliance with the worst case measurement (load) scenario as defined in Section 3.2 (Assumptions) and the available contact time per pass over the X-band acquisition station as defined in Section 3.2 and the down-link capability as specified in Section 7.4 (X-Band Downlink Interface).	Requirement	Astrium SRS 6.2.5	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-334	The Garada spacecraft shall store GPS raw data every 30s (TBD) and shall include them in the Housekeeping Data stream.	Requirement	Astrium SRS 6.2.6	
SSFPS-336	The Garada spacecraft shall be capable of correcting for each scene the commanded start time of data acquisition (correction of along-track error). The error of the corrected start time shall be in compliance with the required Spacecraft position accuracy. The CADH subsystem shall collate necessary information. The correction of the start time shall be computed from: • the commanded start time and • the predicted orbit position received from the ground and stored onboard the spacecraft and from • actual orbit data obtained by precise in-orbit determination.	Requirement	Astrium SRS 6.2.6	
SSFPS-342	The Garada spacecraft shall provide the following timing information for processing of SAR raw data: • Onboard Time (OBT), synchronised to GPS time (HK data stream) • Garada instrument time in the datation of SAR packets (synchronised to GPS time, SAR Data stream) • Event report regarding the synchronisation event OBT – GPS also including the values of OBT and GPS time (HK data stream) • Event reports regarding the synchronisation event Garada instrument time – GPS also including the values of instrument and GPS time (HK data stream)	Requirement	Astrium SRS 6.2.6	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-8	***3.2.7 Onboard Orbit Determination (OOD)***	Heading		
SSFPS-676	The Garada space segment shall be capable of independent determination of orbital parameters.	Requirement	OSRB v02_00 3.1.3	
SSFPS-921	The Garada OOD shall provide TLE data computed onboard to TTAC via CADH.	Requirement	TK10.2 (Derived)	
SSFPS-894	The Garada OOD shall generate parameters required for GNSS performance monitoring.	Requirement	TK10.2 (Derived)	
SSFPS-891	The Garada OOD shall generate parameters required for GNSS calibration.	Requirement	TK10.2 (Derived)	
SSFPS-868	The Garada OOD shall provide sufficient accuracy to support SAR georegistration with an accuracy of one pixel.	Requirement	TK10.2 (Derived)	
SSFPS-866	The Garada OOD shall provide sufficient accuracy to support interferometric processing of SAR images.	Requirement	TK10.2 (Derived)	
SSFPS-840	The Garada spacecraft onboard orbit determination shall support the flying of two spacecrafts in close formation.	Requirement	TK10.2 (Derived)	
SSFPS-797	The Garada TTAC shall provide satellite time reference to assist onboard determination of time-varying orbital elements.	Requirement	TK10.2 (Derived)	
SSFPS-784	The Garada spacecraft OOD shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-764	The Garada spacecraft shall support the generation of two line element set data describing spacecraft's orbit.	Requirement	TK10.2 (Derived)	
SSFPS-754	The Garada spacecraft shall support onboard computation of orbital elements for tracking purposes.	Requirement	TK10.2 (Derived)	
SSFPS-751	OOD shall provide relevant data to support spacecraft tracking by Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-749	The Garada spacecraft shall provide GNSS data and/or computed orbital elements to the GS via the TTAC interface.	Requirement	TK10.2 (Derived)	
SSFPS-746	The Garada spacecraft shall perform orbit determination to assist Conjunction Assessment Service via the GS.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-344	The Garada instrument on-board time resolution shall be better than 1µs.	Requirement	Astrium SRS 6.2.6	
SSFPS-153	Unless explicitly defined otherwise, the reference orbit of the Garada spacecraft shown below shall be used: Orbital Element — Value — Remark Number of orbits per day — 14 + 5/6 — 6 days repetition cycle, nodal period 5824.72 s Semi-Major Axis [km] — 6991.124 — Altitude at equator 612.987 km Inclination [°] — 97.8436 — Sun-synchronous orbit Eccentricity — < 0.001 — Frozen orbit Argument of Perigee [°] — ± 90 — Frozen orbit Local Time ascending node [h] — 06:00 or 18:00 ± 15 min — Dawn-Dusk Orbit. Separation < 15 mn (Right Asc. Of Asc Node: 88.856 deg)	Requirement	Astrium SRS 5.2	
SSFPS-154	The Garada spacecraft shall maintain its orbit over the whole mission lifetime within the following tolerances: • Accuracy of mean local solar time of ascending node crossing: ± TBD min • Accuracy of ground track distance: ± TBD km	Requirement	Astrium SRS 5.2	
SSFPS-155	The manoeuvre strategy shall take into account the availability, the lifetime, and the orbit accuracy requirements to ensure adequate propellant remains at end of mission.	Requirement	Astrium SRS 5.2	
SSFPS-157	When the Garada spacecrafts are in orbit the following relative orbit tolerances shall be maintained: • Mean local solar time of ascending node crossing: ± TBD s. • Ground track distance: ± TBD km	Requirement	Astrium SRS 5.2	
SSFPS-158	The Garada spacecraft shall be capable to perform TBD times debris avoidance manoeuvres during the in-orbit lifetime, each consisting of manouevres of no more than TBD km.	Requirement	Astrium SRS 5.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-304	The Garada spacecraft shall ensure that the orbit can be maintained to a repeating accuracy of less than 1km horizontal deviation, and that knowledge of the orbit deviation is provided to an accuracy of better than 35 metres (TBD).	Requirement	Astrium SRS 6.1.6	
SSFPS-330	The Garada spacecraft shall be capable of performing in-orbit determination of the spacecraft position. The accuracy of in-orbit determination shall be sufficient to fulfil the localisation requirements for basic products.	Requirement	Astrium SRS 6.2.6	
SSFPS-331	Garada spacecraft position data obtained by in-orbit determination shall be: • used for in-orbit correction of start time of data acquisition, see below • included in the X-band down-link data stream to be used for geo-coding of Basic Products • included in the Housekeeping Data stream	Requirement	Astrium SRS 6.2.6	
SSFPS-332	The Garada spacecraft shall contain an onboard GPS used for orbit localisation and clock reference.	Requirement	Astrium SRS 6.2.6	
SSFPS-337	The Garada spacecraft shall be capable of correcting for each scene the commanded start time of data acquisition (correction of along-track error). The error of the corrected start time shall be in compliance with the required Spacecraft position accuracy. The OOD subsystem shall support these corrections. The correction of the start time shall be computed from: • the commanded start time and • the predicted orbit position received from the ground and stored onboard the spacecraft and from • actual orbit data obtained by precise in-orbit determination from the OOD subsystem.	Requirement	Astrium SRS 6.2.6	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-89	***3.2.8 Harness (HAR)***	Heading		
SSFPS-700	The Spacecraft harness shall provide all connectivity required by the Harness Table.	Requirement	3.2.7 Harness	Harness table to be developed in design phase.
SSFPS-785	The Garada spacecraft Harness shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-536	The harness layout of the bench test and/or electrical model shall be representative of the flight hardware.	Requirement	Astrium SRS 8.4.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-10	***3.2.9 Tracking, Telemetry and Control (TTAC)***	Heading		
SSFPS-685	The Garada space segment shall receive uplinked commands in encrypted form.	Requirement	OSRB v02_00 3.1.12	
SSFPS-932	The Garada TTAC shall receive telecommands from GSS in S band.	Requirement	TK10.2 (Derived)	
SSFPS-930	The Garada spacecraft shall transmit telemetry data to the ground in S band.	Requirement	TK10.2 (Derived)	
SSFPS-929	The Garada TTAC shall be capable of transmitting telemetry data in S band to Ground Station System.	Requirement	TK10.2 (Derived)	
SSFPS-919	The Garada spacecraft shall provide telemetry data to support the tracking of Garada spacecraft.	Requirement	TK10.2 (Derived)	
SSFPS-918	The Garada TTAC shall implement interface “E14 Beacon” with the ground segment.	Requirement	TK10.2 (Derived)	
SSFPS-916	The Garada TTAC shall implement interface “E15 Telecommands” with the ground segment.	Requirement	TK10.2 (Derived)	
SSFPS-914	The Garada TTAC shall implement interface “E17 Telemetry” with the ground segment.	Requirement	TK10.2 (Derived)	
SSFPS-904	The Garada TTAC shall be capable of automatic link establishment with the Ground Segment.	Requirement	TK10.2 (Derived)	
SSFPS-903	The Garada TTAC shall provide a tracking beacon signal.	Requirement	TK10.2 (Derived)	
SSFPS-895	The Garada TTAC shall transmit GNSS parameters required for performance monitoring.	Requirement	TK10.2 (Derived)	
SSFPS-892	The Garada TTAC shall transmit GNSS parameters required for calibration.	Requirement	TK10.2 (Derived)	
SSFPS-889	The Garada TTAC shall transmit SAR performance parameters on command and during each downlink period.	Requirement	TK10.2 (Derived)	
SSFPS-884	The Garada TTAC shall receive commands for SAR calibration manoeuvres.	Requirement	TK10.2 (Derived)	
SSFPS-879	The Garada TTAC shall transmit internal calibration parameters when required.	Requirement	TK10.2 (Derived)	
SSFPS-857	The Garada spacecraft shall receive uplinked commands for downlink of raw SAR data.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-852	The Garada spacecraft shall transmit parameters impacting SAR operations.	Requirement	TK10.2 (Derived)	
SSFPS-847	The Garada TTAC shall provide spacecraft and SAR status data to Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-844	The Garada TTAC shall be configurable via ground command.	Requirement	TK10.2 (Derived)	
SSFPS-835	The Garada spacecraft shall transmit telecommand acknowledgments.	Requirement	TK10.2 (Derived)	
SSFPS-834	The Garada spacecraft shall receive the telecommand set.	Requirement	TK10.2 (Derived)	
SSFPS-830	The Garada TTAC shall receive uplinked SAR commands and pass to CADH.	Requirement	TK10.2 (Derived)	
SSFPS-825	The Garada TTAC shall receive software updates and pass to CADH.	Requirement	TK10.2 (Derived)	
SSFPS-814	The Garada TTAC shall receive ground commanded CADH mode changes.	Requirement	TK10.2 (Derived)	
SSFPS-809	The Garada spacecraft shall receive ground commanded EPS mode changes, and shall transmit real time solar array performance.	Requirement	TK10.2 (Derived)	
SSFPS-803	The Garada spacecraft shall receive ground commanded communication mode changes.	Requirement	TK10.2 (Derived)	
SSFPS-802	The Garada spacecraft shall respond to the ground commanded mode changes.	Requirement	TK10.2 (Derived)	
SSFPS-800	The Garada TTAC shall transmit acknowledgements of ground commands.	Requirement	TK10.2 (Derived)	
SSFPS-786	The Garada spacecraft TTAC shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-776	The TTAC subsystem shall support downlink of real time health and status data to Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-772	The Garada spacecraft shall receive attitude correction commands from the ground.	Requirement	TK10.2 (Derived)	
SSFPS-767	The Garada spacecraft shall transmit instantaneous spacecraft attitude to Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-760	The Garada spacecraft shall receive orbit correction commands from the ground.	Requirement	TK10.2 (Derived)	
SSFPS-755	The Garada spacecraft shall generate tracking data to assist computation of orbital elements.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-753	The Garada spacecraft shall generate signals that support tracking and ranging from the ground.	Requirement	TK10.2 (Derived)	
SSFPS-750	The Garada spacecraft shall transmit onboard-computed orbital elements to the ground.	Requirement	TK10.2 (Derived)	
SSFPS-739	The Garada spacecraft shall communicate with Ground Segment to support the operation of MS, GSS and CS.	Requirement	TK10.2 (Derived)	
SSFPS-220	The Garada spacecraft shall carry equipment to provide the capability for status monitoring from the ground.	Requirement		
SSFPS-229	The Garada spacecraft shall carry equipment to support real-time monitoring during contact with ground station.	Requirement		
SSFPS-363	The TTAC baseband interface shall have the following characteristics: Garada TTAC Baseband Interface Uplink Command Downlink Telemetry Access Control CCSDS Spacecraft ID - Data Format Non-Return-to-Zero-Level (NRZ-L) Non-Return-to-Zero-Level (NRZ-L) Data Rate 4 kbit/s 32 kbit/s for real-time telemetry 1 Mbit/s for playback telemetry Subcarrier Frequency 16 kHz - Subcarrier Modulation BPSK - Data Encoding - Reed Solomon (only if required for link margin)	Requirement	Astrium SRS 7.3	These are representative requirements that should be reviewed during the design phase in conjunction with the Ground Segment designer.
SSFPS-194	The Garada spacecraft TT&C protocols shall be according to the Consultative Committee for Space Data Systems (CCSDS) standards.	Requirement	Astrium SRS 5.3.1	
SSFPS-195	The Garada spacecraft Telecommand link shall provide a function for the authentication of the sender (TBD).	Requirement	Astrium SRS 5.3.1	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-206	The availability of Garada spacecraft tasking via the TTAC to the spacecraft OBDH shall be 99.9%.	Requirement	Astrium SRS 5.3.1	
SSFPS-208	The Garada spacecraft shall be designed such in the Operational Phase the control can be performed via a single TTAC station.	Requirement	Astrium SRS 5.3.1	
SSFPS-210	When a viable link is established, the Garada spacecraft shall be able to receive and process a continuous up-link of telecommand packets at the nominal up-link rate.	Requirement	Astrium SRS 5.3.1	
SSFPS-318	On request the Garada spacecraft shall transmit via S-band real-time telemetry all logged housekeeping data. Telemetry data shall be provided such that complete and unambiguous assessment of the Spacecraft / Garada status and performance is possible.	Requirement	Astrium SRS 6.2.4	
SSFPS-319	The Garada spacecraft shall provide the following data sets in fixed format: • Real-time housekeeping measurement and status information (real time telemetry format) through the TT&C channel during Garada spacecraft visibility • On-board stored real-time housekeeping measurement and status information (real time telemetry format), which comprises all data back to the last ground contact • On-board stored history of significant nominal and non-nominal events within the Garada spacecraft (history report format). The on-board buffer shall be dimensioned to store history information worth 24 hours. • Memory dump data of on-board software code, software coded parameters and data tables, which are not made available through the parameterised housekeeping telemetry (processor dump format).	Requirement	Astrium SRS 6.2.4	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-358	For nominal operation the following ground station characteristics shall be assumed for telemetry and commanding (TTAC) and for the acquisition of high rate measurement data: **Communications** **TTAC** **High Rata Data Acquisition** Station TBD TBD **Downlink** Frequency Range 2200 – 2400 MHz 7500-8400 MHz OR -------- Polarisation RHCP and LHCP RHCP or LHCP Axial Ratio TBD [dB] TBD [dB] G/T @ 5 deg elevation 22.6 [dB/K] $\geq$ 34.5 [dB/K] (7.5-8.0 GHz) $\geq$ 35.0 [dB/K] (8.0-8.4 GHz) Minimum elevation, at which reception is possible 5° 5° (TBC) **Uplink** Frequency Range 2025 – 2120 MHz - Polarisation RHCP or LHCP - Axial Ratio TBD [dB] - EIRP 64 [dBW] @ 2025 MHz - **Table 7.2 1 Ground Station Characteristics**	Requirement	Astrium SRS 7.2	These are representative requirements that should be reviewed during the design phase in conjunction with the Ground Segment designer.
SSFPS-360	For uplink and downlink communications with the dedicated Garada ground stations, the Garada spacecraft shall be equipped with a TTAC system operating in the S-Band range and applying the following frequencies: Uplink 2.025 – 2.110 GHz Downlink 2.200 – 2.290 GHz	Requirement	Astrium SRS 7.3	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-362	The TTAC baseband interface shall have the following characteristics: Garada TTAC Baseband Interface Uplink Command Downlink Telemetry Access Control CCSDS Spacecraft ID - Data Format Non-Return-to-Zero-Level (NRZ-L) Non-Return-to-Zero-Level (NRZ-L) Data Rate 4 kbit/s 32 kbit/s for real-time telemetry 1 Mbit/s for playback telemetry Subcarrier Frequency 16 kHz - Subcarrier Modulation BPSK - Data Encoding - Reed Solomon (only if required for link margin)	Requirement	Astrium SRS 7.3	These are representative requirements that should be reviewed during the design phase in conjunction with the Ground Segment designer.
SSFPS-365	The TTAC subsystem shall be designed to ensure the following link margin and bit error rate for the ground station characteristics and elevation: Up-link margin 3db Maximum up-link bit error rate 10^{-7} Down-link margin 3db Maximum down-link bit error rate 10^{-6}	Requirement	Astrium SRS 7.3	These are representative requirements that should be reviewed during the design phase in conjunction with the Ground Segment designer.

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-11	***3.2.10 GNSS Reflectometry Sensor (GNSS-R)***	Heading		
SSFPS-787	The Garada spacecraft GNSS-R shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-335	The Garada spacecraft shall include two downward looking GNSS antennas capable of receiving right-hand and left-hand circularly polarized GNSS signals.	Requirement	Section 3.2.1 SSFPS-890	
SSFPS-339	The Garada spacecraft shall include a GNSS receiver separate from that used for OOD, which shall be capable of determining the GNSS signal amplitude received by the two downward-looking GNSS antennas.	Requirement	Section 3.2.1 SSFPS-890	
SSFPS-341	The amplitudes measured by the GNSS-R receiver shall be included in the sensor data for transmission to the ground via the HBDL.	Requirement	Section 3.2.1 SSFPS-890	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-12	***3.2.11 Propulsion (PROP)***	Heading		
SSFPS-788	The Garada spacecraft propulsion shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-773	The Garada spacecraft shall have sufficient consumables to support attitude correction for period no lesser than spacecraft mission lifetime.	Requirement	TK10.2 (Derived)	
SSFPS-762	The Garada spacecraft shall have sufficient consumables to support orbital correction for period no lesser than spacecraft mission lifetime.	Requirement	TK10.2 (Derived)	
SSFPS-761	The Garada spacecraft shall respond to orbit correction commands from Ground station.	Requirement	TK10.2 (Derived)	
SSFPS-140	Demonstration of lifetime by verification of availability of propellant at Beginning-of-Life (BOL) shall be conducted during the commissioning phase of Garada spacecraft.	Requirement		
SSFPS-149	The Garada spacecraft shall be capable of disposing of all remaining on-board fuel during the Disposal Phase.	Requirement		
SSFPS-156	The propulsion required to conduct manoeuvring strategy shall take into account of the availability, debris avoidance, orbit accuracy, and the lifetime requirements.	Requirement		
SSFPS-159	The Garada spacecraft shall have sufficient propellant to performance TBD times debris avoidance manoeuvres at the beginning of Operational Phase, with each consisting of manoeuvres of no more than TBD km.	Requirement		
SSFPS-314	The Garada spacecraft shall be designed such that its consumables will last for mission life plus 1.5 years after IOD.	Requirement	Astrium SRS 6.2.3	
SSFPS-476	On all orbit maintenance manoeuvres a margin of 2.0 on the required velocity change shall be applied to propellant calculations.	Requirement	Astrium SRS 9.2	
SSFPS-730	The total propellant budget must include the ability to lower altitude at end of mission such that natural decay will take less than 20 years.	Requirement	OSRB 2P.X	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-13	***3.2.12 High Bandwidth Downlink (HBDL)***	Heading		
SSFPS-933	The Garada HBDL shall transmit its payload data to GSS in X band.	Requirement	TK10.2 (Derived)	
SSFPS-927	The Garada spacecraft shall have a maximum sidelobe level of not greater than TBD dB compared to the main beam.	Requirement	TK10.2 (Derived)	
SSFPS-926	The Garada spacecraft shall have an antenna pointing accuracy of no worse than 1 degree RMS.	Requirement	TK10.2 (Derived)	
SSFPS-925	The Garada spacecraft shall provide a minimum EIRP of TBD dBW.	Requirement	TK10.2 (Derived)	
SSFPS-924	The Garada spacecraft shall provide Left Hand Circular Polarised (LHCP) and Right Hand Circular Polarised (RHCP) signals in the appropriate communication band. .	Requirement	TK10.2 (Derived)	
SSFPS-912	The Garada HBDL shall implement interface “E16 Payload Data” with the ground segment.	Requirement	TK10.2 (Derived)	
SSFPS-911	The Garada HBDL shall downlink payload data to GSS.	Requirement	TK10.2 (Derived)	
SSFPS-905	The Garada HBDL shall be capable of automatic link establishment with the Ground Segment.	Requirement	TK10.2 (Derived)	
SSFPS-885	The Garada spacecraft shall downlink SAR data to Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-880	The Garada HBDL shall transmit recorded transmit waveforms along with SAR data.	Requirement	TK10.2 (Derived)	
SSFPS-874	In conjunction with ADACS, the Garada spacecraft shall be capable of pointing to Ground Segment so as to initiate downlink immediately upon completion of SAR operation.	Requirement	TK10.2 (Derived)	
SSFPS-858	The Garada HBDL shall be capable of downlinking 2,000 km of raw quad polar SAR data to Ground Station in one pass.	Requirement	TK10.2 (Derived)	
SSFPS-845	The Garada HBDL shall be configurable via ground command.	Requirement	TK10.2 (Derived)	
SSFPS-804	The Garada spacecraft shall respond to the ground commanded mode changes.	Requirement	TK10.2 (Derived)	
SSFPS-789	The Garada HBDL shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-374	The HBDL subsystem shall be designed to ensure the following link margin and bit error rate for the ground station characteristics and elevation as assumed in Section 7.2 (Ground Station Interface). Down-link margin 3db Maximum downlink bit error rate 10^{-6}	Requirement	Astrium SRS 7.4	These are typical requirements which should be reviewed during the design phase in conjuction with the Ground Segment designer.
SSFPS-371	The high rate data baseband interface shall have the following characteristics: **High Rate Data Baseband** **Down-link Telemetry** Data Format NRZ-L Modulation QPSK Maximum Data Rate 2 * 150 MBPS Encoding Reed Solomon (233,32) Block Code **Table 7.4 2 High Data Rate Baseband Interface** Note: Forward Error Correction (FEC) shall be implemented to ensure the required bit error rate.	Requirement	Astrium SRS 7.4	These are typical requirements which should be reviewed during the design phase in conjuction with the Ground Segment designer.
SSFPS-199	The Garada spacecraft shall provide a capability to downlink measurement data in a prioritised order.	Requirement	Astrium SRS 5.3.1	
SSFPS-202	The average time from measurement to download from the Garada spacecraft shall be less than two orbit periods.	Requirement	Astrium SRS 5.3.1	
SSFPS-203	The on-board stored data volume compatible with the reference measurement scenario shall be transferred from the Garada spacecraft to the Ground Segment within 24 hours after the measurement.	Requirement	Astrium SRS 5.3.1	
SSFPS-204	The download sequences shall download highest priority data from the Garada spacecraft first.	Requirement	Astrium SRS 5.3.1	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-207	The availability to down-link successfully all Garada spacecraft telemetry data from the spacecraft mass memory to the spacecraft control entry point shall be TBD.	Requirement	Astrium SRS 5.3.1	
SSFPS-209	The availability of high-bandwidth downlink when a ground station is accessible shall be at least TBD%	Requirement		
SSFPS-252	The Garada Spacecraft Ground Processor shall provide a Data Quality Check Product for each raw data set, which shall contain at least: a) Raw data statistics (including downlink quality). b) Doppler centroid, ambiguity number. c) Auxiliary data (i.e. instrument mode, antenna pattern). d) Geographic localisation, incidence angle range, incidence angle and sensor look angle at centre of raw data set. e) Chirp replica power. The HBDL shall support transmission of this data.	Requirement	Astrium SRS 5.4.1	
SSFPS-270	For the calculation of the amount of high rate data received per orbit and for the dimensioning of the onboard mass memory onboard the spacecraft, the contact times assumed shall be 6 minutes for Australian ground stations.	Requirement	Astrium SRS 5.4.1	
SSFPS-271	The data downlink volume shall be $\geq$ 98% (TBD) of the maximum required data downlink time.	Requirement	Astrium SRS 5.4.2	
SSFPS-272	The system design shall avoid simultaneous acquisition and downlinking of measurement data.	Requirement	Astrium SRS 5.4.2	
SSFPS-309	The downlink time of the Garada spacecraft shall not exceed 0.995 (TBD) of the scheduled downlink time.	Requirement	Astrium SRS 6.2.1	
SSFPS-327	The Garada spacecraft shall be designed to have an on-board storage and compression (if needed) capability in compliance with the worst case measurement (load) scenario as defined in Section 3.2 (Assumptions) and the available contact time per pass over the X-band acquisition station as defined in Section 3.2 and the down-link capability as specified in Section 7.4 (X-Band Downlink Interface).	Requirement	Astrium SRS 6.2.5	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-368	Garada measurement data, orbit and ephemeris data and auxiliary/auxiliary data shall be transmitted to ground with a high data rate communications system using the following frequency range and bandwidth: X-band 8.025 – 8.400 GHz OR ..... Bandwidth ≥ 300 MHz	Requirement	Astrium SRS 7.4	These are typical requirements which should be reviewed during the design phase in conjuction with the Ground Segment designer.
SSFPS-372	The high rate data baseband interface shall have the following characteristics: **High Rate Data Baseband** **Down-link Telemetry** Data Format NRZ-L Modulation QPSK Maximum Data Rate 2 * 150 MBPS Encoding Reed Solomon (233,32) Block Code Note: Forward Error Correction (FEC) shall be implemented to ensure the required bit error rate.	Requirement	Astrium SRS 7.4	These are typical requirements which should be reviewed during the design phase in conjuction with the Ground Segment designer.
SSFPS-375	The X-band communication system shall be designed to ensure the following link margin and bit error rate for the ground station characteristics and elevation as assumed in Section 7.2 (Ground Station Interface). Down-link margin 3db Maximum downlink bit error rate 10^{-6}	Requirement	Astrium SRS 7.4	These are typical requirements which should be reviewed during the design phase in conjuction with the Ground Segment designer.
SSFPS-386	Deleted			

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-14	***3.2.13 Launch Services (LS)***	Heading		
SSFPS-690	The Garada space segment design shall consider proposed secondary payloads to the extent that they will not jeopardize the primary mission.	Requirement	OSRB v02_00 3.1.19	
SSFPS-689	The Garada space segment shall be capable of delivering all spacecraft required to meet data collections requirements in 1 or 2 launches.	Requirement	OSRB v02_00 3.1.18	
SSFPS-688	The Garada space segment shall be compatible with the Delta IV Medium launch vehicle of the Boeing Corporation.	Requirement	OSRB v02_00 3.1.17	
SSFPS-687	The Garada space segment shall be compatible with the Falcon 9 launch vehicle of Space Exploration Corporation.	Requirement	OSRB v02_00 3.1.16	
SSFPS-126	The Falcon 9 shall be the prime launch vehicle.	Requirement		
SSFPS-128	The Delta IV shall be the backup launch vehicle	Requirement		
SSFPS-130	The Garada spacecraft shall be designed to be compatible with the constraints of the respective launch service providers for both the prime and the backup launch vehicle.	Requirement		
SSFPS-131	The Garada spacecraft shall be launched in a window which is TBD.	Requirement	Astrium SRS 5.1.1.2	
SSFPS-134	Deleted			
SSFPS-378	The spacecraft shall be designed in terms of mass and volume for compatibility with at least 2 alternative launcher types available in the time frame anticipated for launch vehicle integration.	Requirement	Astrium SRS 7.5	
SSFPS-380	The Garada spacecraft shall be the only primary payload of the selected launch vehicle.	Requirement	Astrium SRS 7.5	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-390	The objectives of the Garada spacecraft performance verification process are subdivided in two areas ' Pre-Launch and Post-Launch (TBC) Verification ' and they shall be: Pre-Launch Verification – to demonstrate the qualification of design and performance, as meeting all specified requirements at all levels (from lower to system level); – to ensure that the flight hardware and software are free from workmanship defects and accepted for flight; – to predict flight variations and provide data for calibration, in-flight performance verification and ground processor initialisation; – to verify tools, procedures and personnel necessary to support the system ground and flight operations; – to confirm system integrity and quality of performance after certain stages in the project life cycle. Post–Launch Verification (i.e. Spacecraft In Orbit Delivery acceptance), TBC – to demonstrate Spacecraft performance (e.g. AOCS, pointing, power, timing, thermal, data handling, etc.) meets its in-orbit specification (including in-orbit accuracy); – calibration of SAR Instrument; – to demonstrate that the SAR Instrument measurement and characterisation performance are within specification; – to verify the system design driven basic products and the related performance of GS SAR processing as well as the in-flight calibration.	Requirement	Astrium SRS 8.1	
SSFPS-449				
SSFPS-451				
SSFPS-480	The Garada spacecraft overall dimensions inclusive launch adapter and dispenser shall comply with the fairing of the prime and back-up launcher candidates.	Requirement	Astrium SRS 9.3	
SSFPS-482	The Garada spacecraft mass properties shall comply with the requirements imposed by the prime and back-up launcher candidates.	Requirement	Astrium SRS 9.4	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-492	The stiffness requirements are valid in hard mounted condition in launch configuration. The masses are to be multiplied by a safety factor of TBD. **STIFFNESS REQUIREMENT** **Axial** **Lateral** S/C ≥ 35 Hz (TBD) ≥ 10 Hz (TBD) SAR Antenna (stowed) ≥ 45 Hz (TBD) ≥ 25 Hz (TBD) Tile ≥ 100Hz ≥ 85 Hz Tanks ≥ 60 Hz (TBD) ≥ 60 Hz (TBD) Equipment Panels ≥ 40 Hz (TBD) ≥ 40 Hz (TBD) Secondary Items ≥ 80 Hz (TBD) ≥ 80 Hz (TBD)	Requirement	Astrium SRS 9.5.5	Launch Configuration Stiffness Requirements to be reverified by checking launch vehicle user manuals

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-73	***3.2.14 Mechanical and Electrical Ground Support Equipment (MGSE/EGSE)***	Heading		
SSFPS-790	The Garada spacecraft MGSE/EGSE shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-163	The Garada spacecraft shall have support equipment necessary for assembly, test, and launch operations phases.	Requirement		
SSFPS-238	The Garada spacecraft shall be capable of being monitored on-ground for the status of the on-board scheduler for pre-programmed command sequences.	Requirement	Astrium SRS 5.3.5	
SSFPS-249	Deleted			
SSFPS-251	The Garada Spacecraft Ground Processor shall provide a Data Quality Check Product for each raw data set, which shall contain at least: a) Raw data statistics (including downlink quality). b) Doppler centroid, ambiguity number. c) Auxiliary data (i.e. instrument mode, antenna pattern). d) Geographic localisation, incidence angle range, incidence angle and sensor look angle at centre of raw data set. e) Chirp replica power. The Ground Support Equipment shall support testing this capability.	Requirement	Astrium SRS 5.4.1	
SSFPS-259	Deleted			

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-279	The Garada spacecraft and its respective Garada Ground Processor shall have mechanical and electrical equipment to support the generation of the following Basic Products: 1. Basic Products based on SAR images and quality data obtained by processing of Garada Stripmap and ScanSAR Mode 2. Basic Products based on SAR images and quality data obtained by processing of Garada Low Resolution Mode 3. Multi-band based on SAR images and quality data obtained by processing of Garada Stripmap Mode. The Ground Support Equipment shall support pre-launch testing of this capability.	Requirement		
SSFPS-288	Deleted			
SSFPS-405	The Garada Spacecraft and the Ground Support Equipment (GSE) design shall also allow operations in hazardous environments. The design shall therefore consider launch site safety regulations.	Requirement	Astrium SRS 8.3.2	
SSFPS-460	The Ground Support Equipment (GSE) items shall be capable of supporting System Validation Tests via external communications channels to the Ground Segment without prevention of local monitoring of operations.	Requirement	Astrium SRS 8.5	
SSFPS-462	The design lifetime of the GSE items shall be at least 10 years (TBD).	Requirement	Astrium SRS 8.5	
SSFPS-465	The GSE design shall take into account the requirements of the facilities as appropriate.	Requirement	Astrium SRS 8.6	
SSFPS-499	The Garada spacecraft and related GSE shall comply to the relevant launch authority safety requirements.	Requirement	Astrium SRS 10.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-74	***3.2.15 Support for Formation Flying (SFF)***	Heading		
SSFPS-691	The Garada space segment shall support an operational mode of two spacecraft operating in formation (close proximity) to evaluate bistatic radar operation .	Requirement	OSRB v02_00 3.1.20	
SSFPS-842	SFF shall establish a data link between two spacecraft to support the orbiting of two spacecraft in close formation.	Requirement	TK10.2 (Derived)	
SSFPS-841	SFF shall establish data link between two spacecrafts to achieve precise relative navigation.	Requirement	TK10.2 (Derived)	This requirement may be lifted if the performance of individual OOD subsystems is predicted to provide the required relative precision.
SSFPS-791	The Garada Support for Formation Flying shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-741	Deleted			

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-75	***3.2.16 Thermal Management (TM)***	Heading		
SSFPS-702	The thermal control subsystem shall maintain the environment within the spacecraft bus within the range -40°C to 85°C.	Requirement	Garada T/R Module design project	Reverify temperature range after selection of components
SSFPS-819	The Garada Thermal Management shall provide thermal information to CADH for recovery analysis.	Requirement	TK10.2 (Derived)	
SSFPS-810	The Garada Thermal Management shall provide real time temperature reading of all subsystems to Ground Station.	Requirement	TK10.2 (Derived)	
SSFPS-792	The Garada spacecraft Thermanl Management shall provide measurements of subsystem physical parameters to FDIR as required for health, status, and fault detection.	Requirement	TK10.2 (Derived)	
SSFPS-392	The thermal analysis shall be based on a thermal mathematical model (TMM) with a minimum of 200 nodes, which shall allow for the prediction of the temperature at each equipment temperature reference point (TRP). The TMM shall be verified and correlated using equipment and system level test results. The thermal analyses shall cover the whole variety of environmental and operational conditions during spacecraft life from launch to end of life.	Requirement	Astrium SRS 8.3.1	
SSFPS-950	The thermal management subsystem shall maintain all electronic components containing integrated circuits between -15C and +60C (TBD).	Requirement	Garada T/R Module design project	Reverify temperature range after selection of components

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-90	***3.2.17 Fault Detection, Isolation and Recovery (FDIR)***	Heading		
SSFPS-853	The Garada spacecraft shall measure all spacecraft and payload parameters that could impact SAR operations planning.	Requirement	TK10.2 (Derived)	
SSFPS-820	The Garada FDIR shall provide all subsystem health information to CADH.	Requirement	TK10.2 (Derived)	
SSFPS-805	The Garada spacecraft shall provide all subsystem health information to TTAC for relay to Ground Station	Requirement	TK10.2 (Derived)	
SSFPS-777	The Garada spacecraft shall generate health and status information.	Requirement	TK10.2 (Derived)	
SSFPS-211	The Garada spacecraft shall incorporate a capability to: • detect malfunctions; • perform pre-programmed corrective actions; • provide reports of malfunctions and corrective actions.	Requirement	Astrium SRS 5.3.1	
SSFPS-222	The Garada spacecraft shall provide sufficient monitoring data to analyse the health status and to detect, isolate and recover failures.	Requirement	Astrium SRS 5.3.3	
SSFPS-231	The Garada spacecraft shall be capable to detect, identify and recover single selected failures which violate the Garada spacecraft availability w.r.t. the mission scenario defined in Section 6.2.1 (Spacecraft Functional and Performance Requirements - Availability) autonomously. All other failures shall be handled by operator intervention.	Requirement	Astrium SRS 5.3.4	
SSFPS-232	All autonomous Garada spacecraft failure detection, identification and recovery strategies shall be pre-programmed.	Requirement	Astrium SRS 5.3.4	
SSFPS-233	The identification of Garada spacecraft failures shall be possible down to a level compatible with reconfiguration at the lowest switchable redundancy level.	Requirement	Astrium SRS 5.3.4	
SSFPS-234	All autonomous Garada spacecraft failure detection, isolation and recovery activities shall be reported in an event history.	Requirement	Astrium SRS 5.3.4	
SSFPS-312	Reconfiguration after any failure of the Spacecraft to full performance of the space segment shall be possible within TBD hours.	Requirement	Astrium SRS 6.2.2	
SSFPS-384	FDIR data shall be encrypted to prevent cyber intrusion.	Requirement	Astrium SRS 7.6	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-418	The Mission Sequence Test (MST) shall demonstrate that the complete system is working properly during a simulation of a typical mission operation phase. The satellite shall be operated in all modes and the related sub-modes and it shall be possible to execute all mode transitions, either initiated by command or triggered by the on-board FDIR. Operation of the instrument is only required on a functional level.	Requirement	Astrium SRS 8.3.3	
SSFPS-470	Single point failures, defined as a single part or unit failure which could cause permanent loss of the mission, shall be precluded. All unavoidable single point failures, such as deployable structures, and RF feeds shall be identified as a critical item.	Requirement	Astrium SRS 9.1	
SSFPS-471	Redundancies shall be implemented to eliminate critical modes, avoidable single point failures and achieve the required reliability.	Requirement	Astrium SRS 9.1	
SSFPS-472	Redundancies shall be physically separated to prevent failure propagation from the nominal to the redundant path.	Requirement	Astrium SRS 9.1	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-541	**3.3 Segment External Interface Requirements**	Heading		
SSFPS-542	***3.3.1 Interface Identification and Diagrams***	Heading		
SSFPS-543	***3.3.1.1 Interface Diagram***	Heading		
SSFPS-544	The Space Segment external interfaces are shown in Figure TBD.	Requirement	TK. 10.2 FPS	Interface diagram must be developed in design phase.
SSFPS-545	***3.3.1.2 Spacecraft Interfaces***	Heading		
SSFPS-546	***3.3.1.2.1 E14 Beacon***	Heading		
SSFPS-547	***3.3.1.2.2 E15 Telecommands***	Heading		
SSFPS-548	***3.3.1.2.3 E16 Payload Data***	Heading		
SSFPS-549	***3.3.1.2.4 E17 Telemetry Data***	Heading		
SSFPS-550	***3.3.1.3 Customer Interfaces***	Heading		
SSFPS-551	***3.3.1.3.1 E07 Requests for Data***	Heading		
SSFPS-552	Requests from the customer shall be received electronically and shall be in a format specified by the Ground Segment contractor.	Requirement	TK. 10.2 FPS	
SSFPS-553	Requests shall contain at a minimum, the area to be scanned, data type, data format, SAR mode, interpretation, date and time of scan.	Requirement	TK. 10.2 FPS	
SSFPS-554	***3.3.1.3.2 E09 Data Products***	Heading		
SSFPS-555	Data products shall be provided electronically.	Requirement	TK. 10.2 FPS	
SSFPS-556	***3.3.1.3.3 E08 Invoicing and Payment***	Heading		
SSFPS-557	Invoicing and payment shall be in vendor format.	Requirement	TK. 10.2 FPS	
SSFPS-558	***3.3.1.4 E01 Mains Power***	Heading		
SSFPS-559	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-560	***3.3.1.5 E05 Voice Comms***	Heading		
SSFPS-561	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-562	***3.3.1.6 E04 Email and Web Access***	Heading		
SSFPS-563	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-564	***3.3.1.7 E06 Public Web Access***	Heading		
SSFPS-565	Access to the Ground Segment public web site shall be in accordance with ISO/IEC 15445:2000.	Requirement	TK. 10.2 FPS	
SSFPS-566	***3.3.1.8 E10 Earth Observation Data***	Heading		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-567	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-568	***3.3.1.9 Conjunction Assessment Service***	Heading		
SSFPS-569	Interface E02 Orbital data shall be provided as NORAD two line element sets.	Requirement	TK. 10.2 FPS	
SSFPS-570	Interface E03 Conjunction assessment data shall be in vendor format.	Requirement	TK. 10.2 FPS	
SSFPS-571	***3.3.1.10 E11 Flight Software Vendors***	Heading		
SSFPS-572	Flight software shall be provided in vendor format with, at a minimum, documentation that describes the configuration and use of the software.	Requirement	TK. 10.2 FPS	
SSFPS-573	***3.3.1.11 E12 Ground Software Vendors***	Heading		
SSFPS-574	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-575	***3.3.1.12 E13 Launch Services***	Heading		
SSFPS-576	The interface of the space segment to launch services shall be in accordance with the requirements of the launch service provider.	Requirement	TK. 10.2 FPS	
SSFPS-577	***3.3.2 Interface to GFE***	Heading		
SSFPS-578	Not applicable.	Advice	TK. 10.2 FPS	
SSFPS-579	**3.4 System Internal Interface Requirements**	Heading		
SSFPS-580	The internal interface requirements shall be determined during the system design phase and specified in the requirements specifications for system components. This shall include the preparation of a space segment internal interface diagram.	Requirement	TK. 10.2 FPS	
SSFPS-581	**3.5 System Internal Data Requirements**	Heading		
SSFPS-582	The internal data requirements shall be determined during the system design phase and specified in the requirements specifications for system components.	Advice	TK. 10.2 FPS	
SSFPS-583	**3.6 Adaptation Requirements**	Heading		
SSFPS-584	Not applicable.	Advice	TK. 10.2 FPS	
SSFPS-585	**3.7 Safety Requirements**	Heading		
SSFPS-586	***3.7.1 General***	Heading		
SSFPS-587	All of the space segment assembly, integration and test personnel access ways shall conform to AS 4024.1702.	Requirement	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-588	The space segment assembly, integration and test facility shall comply with AS 1657.	Requirement	TK. 10.2 FPS	
SSFPS-589	The noise levels within the occupied areas of the space segment assembly, integration and test facility shall not exceed the levels specified in NOHSC:2009 (2004).	Requirement	TK. 10.2 FPS	
SSFPS-590	The space segment design, assembly, integration and test facility Computer workstations shall comply with the requirements of AS/NZS 4443. Requirement	Requirement	TK. 10.2 FPS	
SSFPS-591	The Light levels within the inhabited areas of the space segment design, assembly, integration and test facilities shall conform to those recommended in AS/NZS 1680.	Requirement	TK. 10.2 FPS	
SSFPS-592	***3.7.2 Electrical Safety***	Heading		
SSFPS-593	The installation and earthing for all electrical equipment including racks, cabinets and associated equipment shall conform to the requirements of AS 3000.	Requirement	TK. 10.2 FPS	
SSFPS-594	All equipment in the space segment design, assembly, integration and test facilities that is capable of being connected to the 230/400V AC mains supply shall comply with the requirements of AS3100.	Requirement	TK. 10.2 FPS	
SSFPS-595	All equipment in the space segment design, assembly, integration and test facilities that is capable of being connected to the 230/400V AC mains supply shall comply with the requirements of AS60950.1.	Requirement	TK. 10.2 FPS	
SSFPS-596	The space segment design, assembly, integration and test facilities shall protect personnel, equipment and facilities against direct and conducted effects of lightning in accordance with AS/NZS 1768.	Requirement	TK. 10.2 FPS	
SSFPS-597	Fibre systems used in the space segment design, assembly, integration and test facilities shall meet the requirements of AS/NZS 2211.2.	Requirement	TK. 10.2 FPS	
SSFPS-598	***3.7.3 Space Segment Facility Mechanical Safety Requirements***	Heading		
SSFPS-599	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-600	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-601	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-602	Not applicable.	Requirement	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-603	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-604	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-605	Where guarding is used as a control measure in the space segment design, assembly, integration and test facilities it shall be designed and installed in accordance with AS 4024.1601.	Requirement	TK. 10.2 FPS	
SSFPS-606	Safety related human-machine interfaces that are part of the space segment design, assembly, integration and test facilities shall conform to the applicable requirements of AS 4024.1904.	Requirement	TK. 10.2 FPS	
SSFPS-607	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-608	***3.7.4 Hazardous Materials***	Heading		
SSFPS-609	Substances that are listed in Schedule 1 of the Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 shall not be used in the space segment design, assembly, integration and test facilities.	Requirement	TK. 10.2 FPS	
SSFPS-610	For all Hazardous Substances incorporated into the space segment design, assembly, integration and test facilities, full details shall be provided to the Commonwealth in the format of a Material Safety Data Sheet in accordance with NOHSC: 2011 (1994).	Requirement	TK. 10.2 FPS	
SSFPS-611	The space segment design, assembly, integration and test facilities equipment containing dangerous materials shall be labeled in accordance with AS 1216.	Requirement	TK. 10.2 FPS	
SSFPS-612	***3.7.5 Signage***	Heading		
SSFPS-613	The space segment design, assembly, integration and test facilities shall include danger, caution and warning signs fixed to equipment to advice of specific hazards such as high voltage, high temperature and radiation in accordance with AS 1319 – 1994.	Requirement	TK. 10.2 FPS	
SSFPS-614	***3.7.6 Radiation Hazard***	Heading		
SSFPS-615	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-616	***3.7.7 Power Protection***	Heading		
SSFPS-617	The space segment design, assembly, integration and test facilities shall be protected against damage caused by excessive current.	Requirement	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-618	During assembly, integration and test, the space segment shall be protected against damage caused by short circuit at all antenna ports, audio connections and control connections.	Requirement	TK. 10.2 FPS	
SSFPS-619	**3.8 Security and Privacy Requirements**	Heading		
SSFPS-620	All space segment design, assembly, integration and test facility workstations shall have access requiring user login and password.	Requirement	TK. 10.2 FPS	
SSFPS-621	Users shall be granted permissions to access space segment capabilities based on their role.	Requirement	TK. 10.2 FPS	
SSFPS-622	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-623	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-624	**3.9 System Environment Requirements**	Heading		
SSFPS-463	Appropriate facilities shall be selected to support the Assembly, Integration and Verification (AIV) programme at all levels.	Requirement	Astrium SRS 8.6	
SSFPS-464	Special facility requirements, if needed, shall be identified early in the programme.	Requirement	Astrium SRS 8.6	
SSFPS-468	Suitable storage facilities shall be provided for the Garada spacecraft at all stages throughout the verification programme.	Requirement	Astrium SRS 8.6	
SSFPS-469	The conditions required during storage of the Garada spacecraft are TBD.	Requirement	Astrium SRS 8.6	
SSFPS-625	***3.9.1 Mainland Australia and Tasmania Location***	Heading		
SSFPS-626	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-627	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-628	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-629	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-630	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-631	The space segment HBDL shall support operation when the ground station is exposed to driving rain of up to and including 50 mm/hr at a wind velocity of 20 m/s for a ten minute mean at ten metre height.	Requirement	TK. 10.2 FPS	
SSFPS-632	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-633	***3.9.2 Locations outside of Mainland Australia and Tasmania***	Heading		
SSFPS-634	Not applicable.	Requirement	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-635	**3.10 Computer Resource Requirements**	Heading		
SSFPS-636	Each computer processor used in the Space Segment shall use a maximum of 50% processor capacity.	Requirement	TK. 10.2 FPS	
SSFPS-637	Each computer processor used in the Space Segment shall use a maximum of 50% of processor memory capacity.	Requirement	TK. 10.2 FPS	
SSFPS-638	Each computer processor used in the Space Segment shall use a maximum of 50% of input/output capacity.	Requirement	TK. 10.2 FPS	
SSFPS-639	**3.11 System Quality Factors**	Heading		
SSFPS-310	From the time the Garada spacecraft has been handed over to the primary customer of Garada (IOD), the probability of survival due to random failure causes (non-environmental) for the Garada Spacecraft shall not be less then 0.8 (TBD) after 5 years.	Requirement	Astrium SRS 6.2.2	
SSFPS-317	The Garada spacecraft shall be designed to allow for an on-ground storage in a controlled environment of 2 years after the Flight Acceptance Review without the need for maintenance.	Requirement	Astrium SRS 6.2.3	
SSFPS-459	The requirements for spares at the spacecraft-level are TBD.	Requirement	Astrium SRS 8.4.4	
SSFPS-737	System quality factors shall support a spacecraft operational lifetime of TBD years.	Requirement		
SSFPS-394	In order to verify compatibility with the selected launchers and to support structural verification by testing, the following structural analyses shall be performed: I. Satellite - Launcher Coupled Dynamic Analysis (LCDA) to verify that • the natural frequency requirement of the satellite is met • the dynamic coupling of the launcher, the satellite and units on the satellite is acceptable II. Satellite Dynamic Analysis to verify that • the natural frequency requirements are met • the structure is capable to withstand the launch loads. III. Stress analysis for all load carrying elements IV. Vibration Test Prediction V. Impact Assessment of Launch Adapter interface loads and stresses	Requirement	Astrium SRS 8.3.1	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-411	For verification of the integration workmanship, a sine sweep test shall be performed in the given order: (1) Alignment Check (2) Low Level Resonance Search (3) Acceptance Level Sine Sweep Test (4) Low Level Resonance Search (5) Abbreviated Functional Test (6) Alignment Check (7) Visual Inspection The satellite configuration shall be fully flight-representative (launch configuration). The satellite shall be tested together with the flight representative launcher adapter, if existing. The satellite shall be attached to the launcher adapter via its regular interface. For each Spacecraft axis the test shall start with a low level run as basis for the definition of potential notches (shaker input reduction in certain frequency range(s)) such that satellite or unit limit loads are not exceeded and for the definition of pilot and abort accelerometer channels and their response limits. For the acceptance run, the test loads and duration shall be as agreed with the launcher authority. Units powered during launch shall also be powered during vibration testing and monitored for failures or intermittent operation. After the acceptance run the low level run shall be repeated. The comparison of both low	Requirement	Astrium SRS 8.3.3	
SSFPS-413	After successful performance of the vibration test sequence, all launcher adapter and spacecraft pyros (if existing) shall be fired with flight representative charge/timing. Units which are powered on during Spacecraft separation shall be shock tested in the powered on state. After the shock tests a visual inspection of the complete spacecraft shall be performed to identify any structural, thermal or other hardware failure/degradation.	Requirement	Astrium SRS 8.3.3	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-415	An Acoustic Noise Test shall be performed on satellite level to certify system workmanship and verify system integrity (visual inspection) and functional performance in launch configuration. Test levels and durations shall be agreed with the launcher authority. After the acoustic tests a visual inspection of the complete spacecraft shall be performed to identify any structural, thermal or other hardware failure/degradation.	Requirement	Astrium SRS 8.3.3	
SSFPS-640	***3.11.1 Availability***	Heading		
SSFPS-641	The combined availability of the space segment shall be better than 99.85% over areas to be scanned.	Requirement	TK. 10.2 FPS	
SSFPS-642	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-643	***3.11.2 Maintainability***	Heading		
SSFPS-644	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-645	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-646	Not applicable.	Requirement	TK. 10.2 FPS	
SSFPS-647	**3.12 Design and Construction Constraints**	Heading		
SSFPS-648	The Space Segment design shall consider the use COTS hardware for the SAR system and other subsystems where the impact on reliability can be tolerated.	Constraint	TK. 10.2 FPS	
SSFPS-649	Not applicable.	Constraint	TK. 10.2 FPS	
SSFPS-650	To minimise Ground Segment development and operating costs, the Space Segment design shall be compatible with existing ground infrastructure where possible.	Constraint	TK. 10.2 FPS	
SSFPS-651	Where data formats are not specified here, standard industry data formats shall be used where possible.	Constraint	TK. 10.2 FPS	
SSFPS-652	To accommodate possible future applications the Space Segment shall be designed to allow for the separation of data and data processing into classified and unclassified classes.	Requirement	TK. 10.2 FPS	
SSFPS-653	In the MCS and MMDPS, it shall be possible to test new algorithms in parallel with the operation of existing algorithms.	Constraint	TK. 10.2 FPS	
SSFPS-654	Not applicable.	Constraint	TK. 10.2 FPS	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-655	**3.13 Personnel-related Requirements**	Heading		
SSFPS-656	Software and hardware user manuals shall be electronically accessible from the computer workstations.	Requirement	TK. 10.2 FPS	
SSFPS-657	Software applications shall have context sensitive help available to the operator.	Requirement	TK. 10.2 FPS	
SSFPS-658	**3.14 Training-related Requirements**	Heading		
SSFPS-659	The Space Segment development shall support development of a simulator to support GS operational training.	Advice	TK. 10.2 FPS	
SSFPS-660	**3.15 Logistics-related Requirements**	Heading		
SSFPS-661	To be developed in the design phase.	Advice	TK. 10.2 FPS	
SSFPS-662	**3.16 Other Requirements**	Heading		
SSFPS-663	Not applicable.	Advice	TK. 10.2 FPS	
SSFPS-664	**3.17 Packaging Requirements**	Heading		
SSFPS-665	To be developed in the design phase.	Advice	TK. 10.2 FPS	
SSFPS-666	**3.18 Precedence and Criticality of Requirements**	Heading		
SSFPS-667	Order of precedence: In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.	Requirement	TK. 10.2 FPS	
SSFPS-668	**4 Qualification Provisions**	Heading		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-389	The objectives of the Garada spacecraft performance verification process are subdivided in two areas ' Pre-Launch and Post-Launch (TBC) Verification ' and they shall be: Pre-Launch Verification – to demonstrate the qualification of design and performance, as meeting all specified requirements at all levels (from lower to system level); – to ensure that the flight hardware and software are free from workmanship defects and accepted for flight; – to predict flight variations and provide data for calibration, in-flight performance verification and ground processor initialisation; – to verify tools, procedures and personnel necessary to support the system ground and flight operations; – to confirm system integrity and quality of performance after certain stages in the project life cycle. Post–Launch Verification (i.e. Spacecraft In Orbit Delivery acceptance), TBC – to demonstrate Spacecraft performance (e.g. AOCS, pointing, power, timing, thermal, data handling, etc.) meets its in-orbit specification (including in-orbit accuracy); – calibration of SAR Instrument; – to demonstrate that the SAR Instrument measurement and characterisation performance are within specification; – to verify the system design driven basic products and the related performance of GS SAR processing as well as the in-flight calibration.	Requirement	Astrium SRS 8.1	
SSFPS-399	The Garada spacecraft shall be tested on-ground in accordance with the test requirements specification.	Requirement	Astrium SRS 8.3.2	
SSFPS-400	The structure and modularity of Garada spacecraft tests shall allow the transfer of test results from lower to higher level for tests of the same nature.	Requirement	Astrium SRS 8.3.2	
SSFPS-401	The Garada spacecraft shall be designed to include sufficient test points to allow all the Garada spacecraft functional and performance tests.	Requirement	Astrium SRS 8.3.2	
SSFPS-402	The use of special tools and equipment for testing and measurement shall be avoided as far as possible.	Requirement	Astrium SRS 8.3.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-403	The time for the Garada spacecraft unit integration, hardware replacement or test shall be minimised by adequate means.	Requirement	Astrium SRS 8.3.2	
SSFPS-406	Critical Garada Spacecraft alignments shall be identified at an early stage in the verification programme.	Requirement	Astrium SRS 8.3.2	
SSFPS-407	The Garada spacecraft-level test programme shall comprise the functional and environmental tests as defined below: Test / Measurement (1) Electrical I/F Test (2) Comprehensive Performance Test (CPT) (3) Sine Sweep Test (4) Separation Shock Test (5) Acoustic Noise Test (6) Integrated System Test (IST) (7) Mission Simulation Test (MST) (8) Abbreviated Function Test (AFT) (multiple) (9) RF Compatibility Test X- and S- band (suitcase only) (10) EMC/EMI Test (11) TB/TV Test (12) Mass property measurement and balance (13) Alignment measurement (14) Leakage Test (15) Bonding Measurement (16) Deployment Test (17) System Validation Test	Requirement	Astrium SRS 8.3.3	
SSFPS-409	The electrical interface testing shall be performed during electrical integration of units at system level. The wiring attachment, electrical connection, shielding grounding in/output circuit characteristics and in/output functional checks shall be performed according to the unit specific requirement. The bonding requirements shall be verified.	Requirement	Astrium SRS 8.3.3	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-410	For verification of the integration workmanship, a sine sweep test shall be performed in the given order: (1) Alignment Check (2) Low Level Resonance Search (3) Acceptance Level Sine Sweep Test (4) Low Level Resonance Search (5) Abbreviated Functional Test (6) Alignment Check (7) Visual Inspection The satellite configuration shall be fully flight-representative (launch configuration). The satellite shall be tested together with the flight representative launcher adapter, if existing. The satellite shall be attached to the launcher adapter via its regular interface. For each Spacecraft axis the test shall start with a low level run as basis for the definition of potential notches (shaker input reduction in certain frequency range(s)) such that satellite or unit limit loads are not exceeded and for the definition of pilot and abort accelerometer channels and their response limits. For the acceptance run, the test loads and duration shall be as agreed with the launcher authority. Units powered during launch shall also be powered during vibration testing and monitored for failures or intermittent operation. After the acceptance run the low level run shall be repeated. The comparison of both low	Requirement	Astrium SRS 8.3.3	
SSFPS-412	After successful performance of the vibration test sequence, all launcher adapter and spacecraft pyros (if existing) shall be fired with flight representative charge/timing. Units which are powered on during Spacecraft separation shall be shock tested in the powered on state. After the shock tests a visual inspection of the complete spacecraft shall be performed to identify any structural, thermal or other hardware failure/degradation.	Requirement	Astrium SRS 8.3.3	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-414	An Acoustic Noise Test shall be performed on satellite level to certify system workmanship and verify system integrity (visual inspection) and functional performance in launch configuration. Test levels and durations shall be agreed with the launcher authority. After the acoustic tests a visual inspection of the complete spacecraft shall be performed to identify any structural, thermal or other hardware failure/degradation.	Requirement	Astrium SRS 8.3.3	
SSFPS-416	The Integrated System Test (IST) shall verify the correct performance of the satellite in all operational modes and with all individual functions in the specified manner. All instrument modes will be executed with Tx amplitudes set to zero (i.e. antenna not radiating). The antenna Tx and Rx characteristics can be tested using the calibration mode. The IST shall be repeated during TV/TB test.	Requirement	Astrium SRS 8.3.3	
SSFPS-417	The Mission Sequence Test (MST) shall demonstrate that the complete system is working properly during a simulation of a typical mission operation phase. The satellite shall be operated in all modes and the related sub-modes and it shall be possible to execute all mode transitions, either initiated by command or triggered by the on-board FDIR. Operation of the instrument is only required on a functional level.	Requirement	Astrium SRS 8.3.3	
SSFPS-419	The Abbreviated Functional Test (AFT) shall contain a concise subset of the IST. It shall serve as a go/no go check of the satellite and its components after each transport, during the environmental test program and after integration on the launcher. The test shall be performed at nominal system conditions only, alternating between main and redundant chains.	Requirement	Astrium SRS 8.3.3	
SSFPS-420	The RF Compatibility Test shall verify that the uplink (S-Band only) and down-link characteristics of the satellite and the ground stations used during LEOP and in the operational phase of the mission are compatible. For these tests, an S-Band RF Compatibility Tester (RFCT) and a X-Band RFCT, respectively, shall be used.	Requirement	Astrium SRS 8.3.3	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-422	Conducted Emission/Conducted Susceptibility shall be verified prior to final closure of the spacecraft interior with panels / thermal H/W in electrically flight configuration. Radiated Emission / Radiated Susceptibility shall be verified with a completely integrated satellite in a dedicated EMC chamber. It shall be verified that pyro squibs (if applicable) will not unintentionally be ignited.	Requirement	Astrium SRS 8.3.3	
SSFPS-423	A thermal balance and vacuum test (TB/TV test) shall be performed including a TB part to verify the thermal design and a TV part with a hot and cold IST and MST, to verify satellite function and performance under thermal vacuum conditions. Since RF radiation is not possible within the TV chamber, the Garada instrument shall be operated in its calibration mode. For the TV cold and hot phases, the S/C temperature level shall be adjusted such that at least one of S/C internal units is at its acceptance temperature limit, when performing the IST and MST.	Requirement	Astrium SRS 8.3.3	
SSFPS-425	The CoM-requirement shall be verified by a balance test campaign consisting of combined static/dynamic measurement and trimming (TBC). The spacecraft shall be: • fully flight representative (except final balance masses) • the mass of the hydrazine in the tank shall suitably be simulated. The influence of variable configuration items shall be tested. After installation of the final balance masses, the result of final balancing (position of the CoM and the orientation of the S/C principal axes) shall be verified by a second test run (TBC).	Requirement	Astrium SRS 8.3.3	
SSFPS-427	A System Validation Test shall be performed, which repeats the Mission Sequence Test, but with the satellite operated via the Mission Operation Centre instead of the Central Check-Out Equipment. This System Validation Test (SVT) is under responsibility of the customer.	Requirement	Astrium SRS 8.3.3	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-428	The following test programme on a flight representative SAR Instrument Demonstrator (elegant breadboard) is defined below: Test / Measurement Electrical I/F test (internal and external I/F) Comprehensive functional test Comprehensive performance test (CPT) Complementary EMC test Column level pattern verification	Requirement	Astrium SRS 8.3.4	
SSFPS-429	The instrument level FM test programme shall comprise the tests defined below: Test / Measurement Electrical I/F test (internal and external I/F) Comprehensive functional test Test of redundant functions Antenna planarity and alignment Comprehensive performance test (CPT) and instrument characterisation Complementary tests of performance parameters (supported by analysis)	Requirement	Astrium SRS 8.3.4	
SSFPS-430	The testing of internal and external electrical interfaces shall be performed during electrical integration of units at the instrument level. The wiring attachment, electrical connection, shielding grounding in/output circuit characteristics and in/output functional checks shall be performed according to the instrument interface requirement. The bonding requirements shall be verified.	Requirement	Astrium SRS 8.3.4	
SSFPS-433	The integrated instrument shall be verified for correct operation in all modes and with the defined individual functions in the specified manner.	Requirement	Astrium SRS 8.3.4	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-435	The integrated instrument shall be verified for correct operation in all modes and with the defined individual functions in the specified manner with selected combinations of nominal and redundant units.	Requirement	Astrium SRS 8.3.4	
SSFPS-437	Planarity and orientation of the SAR antenna support structure shall be measured after final mechanical assembly. Deviations shall be compensated by shimming. After mounting of all antenna panels, a check of the final alignment of the radiating elements shall be performed.	Requirement	Astrium SRS 8.3.4	
SSFPS-439	The integrated SAR instrument shall be verified for correct performance of the specified parameters. Data for the characterisation of the instrument performance will be recorded in the frame of a characterisation test performed within selected operationally and thermally stabilised operating states.	Requirement	Astrium SRS 8.3.4	
SSFPS-443	The integrated instrument shall be verified (in specific modes) for selected emission levels and for correct operation under Electro-Magnetic Compactibility (EMC) conditions which cannot be verified on unit level.	Requirement	Astrium SRS 8.3.4	
SSFPS-445	The functional performance test on unit/system level shall include verification of the unit function and specified performance parameters.	Requirement	Astrium SRS 8.3.5	
SSFPS-446	The electrical I/F test shall include measurement/application of voltages, impedance, frequencies, pulses and wave forms at the electrical interfaces of the unit as far as appropriate. The data output shall be compared with the specified requirements.	Requirement	Astrium SRS 8.3.5	
SSFPS-448	Sine and random vibration tests shall be conducted on all units to verify their acceptability for the Garada spacecraft verification programme. The test loads and duration shall be derived from an Garada spacecraft structural analysis enveloping all potential launcher candidates and shall include sufficient margin. Units powered during launch shall also be powered during vibration testing and monitored for failures or intermittent operation. The sine test is not required for units with already proven design according to the Garada spacecraft test loads. A full functional test shall precede and follow the vibration tests.	Requirement	Astrium SRS 8.3.5	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-450	Shock test requirements are TBD. Nevertheless, each unit supplier shall agree to the applicability of an envelope over all launcher/satellite separation shock spectra.	Requirement	Astrium SRS 8.3.5	
SSFPS-452	Unit thermal acceptance tests may be performed in vacuum or ambient pressure, depending on the unit vacuum sensitivity.	Requirement	Astrium SRS 8.3.5	
SSFPS-454	In general, for qualification of electronics and structural parts, temperature cycling tests under vacuum are required.	Requirement	Astrium SRS 8.3.5	
SSFPS-454	In general, for qualification of electronics and structural parts, temperature cycling tests under vacuum are required.	Requirement	Astrium SRS 8.3.5	
SSFPS-457	Each electrical equipment shall be subjected to a conductive EMC test according to MIL-STD 462 D. Prior to performance of the conducted emission and susceptibility test, DC isolation and bonding shall be measured.	Requirement	Astrium SRS 8.3.5	
SSFPS-532	For system design qualification and flight acceptance, the following models shall be prepared: • Structure Model (StM) • Electrical Model or Test Bench (TbH) • Protoflight Model (PFM)	Requirement	Astrium SRS 8.4	
SSFPS-533	The StM shall support qualification tests of the satellite structure.	Requirement	Astrium SRS 8.4.1	
SSFPS-534	The StM shall support as a minimum the following major tests: • Static Test (Structure only) • Fit check • Mass Properties and alignment • Leakage (if applicable) • Modal survey • Sine Vibration • Acoustic Vibration	Requirement	Astrium SRS 8.4.1	
SSFPS-537	The Electrical Model shall be used to qualify by test the electrical design of the satellite, its operational and functional interfaces and the system checkout including software and data base.	Requirement	Astrium SRS 8.4.2	

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-538	The Electrical Model shall support as a minimum the following tests: • Electrical integration • Functional tests • Ground Segment preliminary compatibility tests	Requirement	Astrium SRS 8.4.2	
SSFPS-466	The use of a particular facility must in no way result in unacceptable degradation of the test article or invalidation of the verification results.	Requirement	Astrium SRS 8.6	
SSFPS-467	Facilities shall be selected, accounting for the physical size of the Garada spacecraft and Instrument in a deployed configuration.	Requirement	Astrium SRS 8.6	
SSFPS-500	All parts (mechanical and electrical), materials and processes shall be selected to fulfil the performance, lifetime and reliability requirements in the orbit environment of the Garada spacecraft.	Requirement	Astrium SRS 10.3	
SSFPS-669	**5 Requirements Traceability**	Heading		
SSFPS-670	Traceability to parent specifications is not applicable to system level requirements. Where applicable, traceability to other project documents is indicated with the requirement.	Advice	TK. 10.2 FPS	
SSFPS-671	**6 Notes**	Heading		
SSFPS-672	**6.1 Abbreviations and Acronyms**	Heading		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-673	ADACS Attitude Determination and Control Subsystem ASRP Australian Space Research Program BIT Built In Test CADH Command And Data Handling CCRS Canadian Centre of Remote Sensing CEOS Committee on Earth Observation Satellites COTS Commercial Off The Shelf CS Communication Subsystem EGSE Electrical Ground Support Equipment EOSAT Earth Observation Satellite picture data format EPS Electrical Power Subsystem FDIR Fault Detection, Identification and Reporting subsystem FPS Functional Performance Specification FTP File Transfer Protocol GFE Government Furnished Equipment GNSS Global Navigation Satellite System GNSS-R GNSS Reflectometry payload GS Ground Segment GSE Ground Support Equipment GSS Ground Station Subsystem HAR Harness HBDL High Bandwidth Down Link subsystem HDF Hierarchical Data Format LEOP Launch and Early Orbit Phase LHCP Left Hand Circular Polarised LRU Line Replaceable Unit MCS Mission Control Subsystem	Information		

ID	Function and Performance Specification	Type	Traceability	Issue to Resolve
SSFPS-673 cont'd.	MGSE Mechanical Ground Support Equipment MMDPS Mission Management and Data Processing Subsystem NOHSC National Occupational Health and Safety OFCS Optical Fibre Communication Systems OOD Onboard Orbit Determination Subsystem OSRB Objective System Requirements Baseline PAWS Public Accessible Web Site PROP Propulsion subsystem RHCP Right Hand Circular Polarised SAR Synthetic Aperture Radar SDS Signal Distribution Subsystem SFF Support for Formation Flying subsystem SRS Spacecraft Requirement Specification SS Support Subsystem SSS System/Subsystem Specification TBC To Be Calculated TBD To Be Determined THM Thermal Management subsystem TTAC Tracking, Telemetry And Control subsystem TLE Two Line Element V&V Verification and Validation	Information		

ID	Function and Performance Specification	Type	Traceability
GSFPS-39	**1 Scope**	Heading	
GSFPS-40	***1.1 Identification***	Heading	
GSFPS-525	This is the Ground Segment Functional Performance Specification (FPS) for the Garada Formation Flying Synthetic Aperture Radar (SAR) system. The document is a deliverable under Garada Work Package 10-Ground Segment Study, deliverable TK 10.2 Functional Performance Specification. The document has been prepared in accordance with DI-IPSC-81431A. It has been prepared using the DOORS 9.3 requirements management tool.	Information	
GSFPS-41	***1.2 System Overview***	Heading	
GSFPS-526	Garada, funded under the Australian Space Research Program (ASRP), is a collaborative space engineering research project at the Australian Centre for Space Engineering Research. Garada is investigating the design of a low cost L-Band Formation Flying SAR satellite system for monitoring regional deforestation and forest degradation, soil moisture mapping, flood and disaster monitoring. Consortium members include the University of New South Wales, EADS Astrium, Curtin University of Technology, TU Delft, BAE Systems and General Dynamics Corporation.	Information	

ID	Function and Performance Specification	Type	Traceability
GSFPS-647	The Garada System is comprised of a Ground Segment and a Space Segment. The Space Segment consists of: i) Two spacecraft with each comprising of a satellite platform with Synthetic Aperture Radar (SAR) and Global Navigation Satellite System (GNSS) payloads. ii) Electrical Ground Support Equipment. iii) Mechanical Ground Support Equipment iv) Launch Services This FPS specifies the requirements for the Ground Segment. The Ground Segment is comprised of five systems: a) A Ground Station System (GSS) that undertakes the reception of payload and telemetry data and the transmission of command data to the Garada Spacecraft. b) A Mission Control System (MCS) that undertakes the monitoring and control of the spacecraft and payloads, operations planning and scheduling, and GSS monitoring and control. c) A Mission Management and Data Processing System (MMDPS) that undertakes the calibration and processing of the SAR and GNSS payloads, interpretation of imagery, receiving of customer requests and distribution of processed products to customers. d) A Communications System (CS) that handles all voice and data communications between the systems and with the outside world. e) A Support System (SS) that provides hardware and software maintenance and upgrades to the Ground Segment. The Ground Segment context is shown in Figure 1.	Information	
GSFPS-42	***1.3 Document Overview***	Heading	
GSFPS-524	This document specifies the system level requirements for the Garada Ground Segment. Figures are located at the end of the document.	Information	
GSFPS-43	**2 Applicable Documents**	Heading	

ID	Function and Performance Specification	Type	Traceability
GSFPS-551	***2.1 Australian Standards***	Heading	
GSFPS-560	AS 1319:1994 - Safety Signs for the Occupational Environment	Requirement	
GSFPS-561	AS 1657:1992 - Fixed platforms, walkways, stairways and ladders - Design, construction and installation	Requirement	
GSFPS-559	AS/NZS 1680:2006 - Interior and workplace lighting	Requirement	
GSFPS-554	AS/NZS 1768:2007 - Lightning protection	Requirement	
GSFPS-563	AS/NZS 2211.2:2006 - Safety of laser products - Safety of optical fibre communication systems (OFCS)	Requirement	
GSFPS-556	AS 4024.1604:2006 - Safety of machinery Part 1604: Design of controls, interlocks and guarding - Emergency stop - Principles for design	Requirement	
GSFPS-568	AS 4024.1702:2006 - Safety of machinery Part 1702: Human body measurements – Principles for determining the dimensions required for openings for whole body access into machinery.	Requirement	
GSFPS-567	AS 4024.1904:2006 - Safety of machinery Part 1904: Displays, controls, actuators and signals - Indication, marking and actuation - Requirements for visual, auditory and tactile signals	Requirement	
GSFPS-555	AS/NZS 3000:2007 - Wiring Rules	Requirement	
GSFPS-570	AS/NZS 3100:2009 - Approval and test specification - General requirements for electrical equipment	Requirement	
GSFPS-557	AS/NZS 4443:1997 Office Panel Systems— Workstations	Requirement	
GSFPS-571	AS/NZS 5070.1:2008 - Siting and operation of radio communications facilities - General guidelines for fixed, mobile and broadcasting facilities including fixed location satellite earth stations independent of the operating frequency	Requirement	
GSFPS-562	AS/NZS 60950.1:2011 - Information technology equipment - Safety - General requirements	Requirement	
GSFPS-573	AS/CA S003.1:2010 Requirements for Customer Access Equipment for connection to a Telecommunications Network	Requirement	
GSFPS-553	***2.2 Other Documents***	Heading	
GSFPS-564	Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Requirement	
GSFPS-566	DEF(AUST)5168 The climactic and environmental conditions affecting the design of military materiel.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-565	DI-IPSC-81431A Data Item Description: System/Subsystem Specification (SSS) (10 JAN 2000)	Requirement	
GSFPS-574	ISO/IEC 15445:2000 Information technology -- Document description and processing languages -- HyperText Markup Language (HTML)	Requirement	
GSFPS-558	NOHSC:2011 (1994) - Preparation of Material Safety Data Sheets	Requirement	
GSFPS-714	OH&S (Safety Standards) Regulations 1994.	Requirement	
GSFPS-44	**3 Requirements**	Heading	
GSFPS-45	***3.1 Required States and Modes***	Heading	
GSFPS-69	The required states and modes are listed separately under each system.	Information	
GSFPS-46	***3.2 System Capability Requirements***	Heading	
GSFPS-70	3.2.1 Segment Requirements	Heading	
GSFPS-71	**3.2.1.1 Data Request Policy**	Heading	
GSFPS-75	The Ground Segment shall establish a Data Request Policy that defines the terms for a valid customer request.	Requirement	
GSFPS-72	The Data Request Policy shall define criteria including who can request data, what data can be requested, compliance with Australian and International rules and regulations, data to be available to the public and priorities for customer requests.	Requirement	
GSFPS-76	The Ground Segment shall receive and evaluate requests from external agencies for changes to the Data Request Policy.	Requirement	
GSFPS-77	The Ground Segment shall review and maintain the Data Request Policy throughout the life of the project.	Requirement	
GSFPS-79	**3.2.1.2 Segment Operation**	Heading	
GSFPS-80	The MCS, GSS and CS shall operate continuously.	Requirement	
GSFPS-631	The SS hardware maintenance shall support the continuous operation of the MCS, GSS and CS.	Requirement	
GSFPS-81	The MMDPS shall operate 10 hours a day, seven days a week.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-82	**3.2.1.3 Mission Phases**	Heading	
GSFPS-83	The GS shall support the following mission phases: a) Pre Launch b) Commissioning c) Nominal operation d) End of life.	Requirement	
GSFPS-84	**3.2.1.4 Number of Spacecraft**	Heading	
GSFPS-85	The Ground Segment shall support two Garada spacecraft in a 630km sun synchronous polar orbit.	Requirement	Garada TK1.2, Garada Business Case for Implementation, V 01_01, Para 4. SAR Payload Specification, Issue 1, table 2-2.
GSFPS-86	3.2.2 Mission Control System (MCS)	Heading	
GSFPS-87	**3.2.2.1 States and Modes**	Heading	
GSFPS-94	The MCS shall have an off state where all equipment is powered off.	Requirement	
GSFPS-93	The MCS shall have an on state where all equipment is powered on.	Requirement	
GSFPS-92	The MCS shall have a self-test mode where the equipment undertakes self-test.	Requirement	
GSFPS-91	The MCS shall have an operational mode where all equipment is operational.	Requirement	
GSFPS-90	The MCS shall automatically transition into self-test mode at power on of the equipment.	Requirement	
GSFPS-89	The MCS shall automatically transition from self-test mode to operational mode on the successful conclusion of self-test.	Requirement	
GSFPS-88	The MCS transitions from on to off state and off to on state shall be by manual intervention from an operator.	Requirement	
GSFPS-95	**3.2.2.2 MCS Interfaces**	Heading	

ID	Function and Performance Specification	Type	Traceability
GSFPS-615	The MCS interfaces shall be implemented as described in this para and in accordance with Paras 3.3 and 3.4.	Requirement	
GSFPS-96	3.2.2.2.1 External	Heading	
GSFPS-650	The MCS shall interface with the Conjunction Assessment Service via the CS.	Requirement	
GSFPS-666	The MCS shall interface with the Launch Services via the CS.	Requirement	
GSFPS-101	3.2.2.2.2 Internal	Heading	
GSFPS-110	The MCS shall interface to the GSS via the CS.	Requirement	
GSFPS-104	The MCS shall interface to the MMDPS via the CS.	Requirement	
GSFPS-718	The MCS shall interface to the SS.	Requirement	
GSFPS-719	The MCS shall interface to the CS.	Requirement	
GSFPS-111	**3.2.2.3 Spacecraft Orbit Monitoring and Control**	Heading	
GSFPS-112	The MCS shall support spacecraft tracking by Doppler measurements from the ground as well as GNSS data.	Requirement	
GSFPS-108	The MCS shall receive tracking and ranging data from the GSS via the CS.	Requirement	
GSFPS-123	The MCS shall analyse the spacecraft positional and tracking data and determine the orbital elements describing the spacecraft's orbit.	Requirement	
GSFPS-122	The MCS shall analyse the spacecraft orbit and determine any orbit correction maneuvers required.	Requirement	
GSFPS-121	The MCS shall prepare orbit correction telecommands.	Requirement	
GSFPS-612	The orbit correction telecommands shall be validated by an operator prior to sending to the GSS to be uploaded during subsequent spacecraft passes.	Requirement	
GSFPS-120	The MCS shall generate two line element set data describing each spacecraft's orbit.	Requirement	
GSFPS-119	The MCS shall transmit the two line element set data to the GSS.	Requirement	
GSFPS-118	The MCS shall generate pass prediction ephemeris data.	Requirement	
GSFPS-668	The MCS shall provide the two line element set data to the conjunction assessment service.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-117	The MCS shall transmit pass prediction data to the GSS for transmission to the spacecraft.	Requirement	
GSFPS-116	The MCS shall determine future orbit predictions.	Requirement	
GSFPS-115	The MCS shall provide future orbit predictions to the conjunction assessment service.	Requirement	
GSFPS-114	The MCS shall receive spacecraft conjunction risk and threat assessments from the conjunction assessment service.	Requirement	
GSFPS-113	The MCS shall analyse spacecraft conjunction risk and threat assessments, and recommend to the operator orbital corrections to minimise the risk of collisions.	Requirement	
GSFPS-124	**3.2.2.4 Spacecraft Attitude Monitoring and Control**	Heading	
GSFPS-128	The MCS shall determine the attitude of the spacecraft.	Requirement	
GSFPS-127	The MCS shall determine any attitude correction that is required for the spacecraft.	Requirement	
GSFPS-126	The MCS shall prepare attitude correction telecommands.	Requirement	
GSFPS-613	The attitude correction telecommands shall be validated by an operator prior to sending to the GSS to be uploaded during subsequent spacecraft passes.	Requirement	
GSFPS-129	**3.2.2.5 Spacecraft Monitoring**	Heading	
GSFPS-139	The MCS shall receive spacecraft telemetry in real time from the GSS.	Requirement	
GSFPS-138	The MCS shall receive from the GSS, spacecraft telemetry that has been stored at the GSS.	Requirement	
GSFPS-137	The MCS shall display the telemetry parameters on monitors in tabular form and as mimic diagrams.	Requirement	
GSFPS-136	The MCS shall use colour to indicate the status of each telemetry parameter as in range or out of range.	Requirement	
GSFPS-135	The MCS shall have alarms for key telemetry parameters.	Requirement	
GSFPS-134	The MCS shall provide programmable thresholds for spacecraft parameter alarms.	Requirement	
GSFPS-133	The MCS shall analyse the telemetry and report abnormal or potentially abnormal conditions.	Requirement	
GSFPS-132	The MCS shall automatically analyse essential satellite data upon receipt from the GSS.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-131	The MCS shall be able to automatically trigger sequences of pre stored commands for routine operations or for contingency recovery after analysis of the telemetry data.	Requirement	
GSFPS-541	**3.2.2.6 Spacecraft Management**	Heading	
GSFPS-130	The MCS shall undertake time management of the spacecraft, the GSS and the MCS.	Requirement	
GSFPS-545	The MCS shall manage the spacecraft communications.	Requirement	
GSFPS-548	The MCS shall manage the spacecraft power.	Requirement	
GSFPS-547	The MCS shall manage the spacecraft thermal control.	Requirement	
GSFPS-549	The MCS shall manage the spacecraft on board data handling.	Requirement	
GSFPS-651	The MCS shall manage the spacecraft recovery from safe mode.	Requirement	
GSFPS-652	*Note: Recovery from safe mode may involve reestablishing communications, downloading diagnostic data, sequencing power and root cause analysis.*	Advice	
GSFPS-716	The MCS shall analyse spacecraft status and determine any changes required to spacecraft software.	Requirement	
GSFPS-98	The MCS shall provide spacecraft flight software update requests to the Support System.	Requirement	
GSFPS-97	The MCS shall receive spacecraft flight software from the Support System.	Requirement	
GSFPS-717	The MCS shall upload to the spacecraft and confirm correct operation of spacecraft software.	Requirement	
GSFPS-542	**3.2.2.7 SAR Management**	Heading	
GSFPS-166	The MCS shall receive requests for SAR data collection from the MMDPS.	Requirement	
GSFPS-165	The MCS shall generate the SAR work program for acquiring the requested data.	Requirement	
GSFPS-103	The MCS shall receive calibration and calibration maneuver requests from the MMDPS via the CS.	Requirement	
GSFPS-715	The MCS shall generate the SAR work program for performing the SAR calibration.	Requirement	
GSFPS-164	From the work program the MCS shall generate the telecommands for the SAR.	Requirement	
GSFPS-614	The SAR telecommands shall be validated by an operator prior to sending to the GSS to be uploaded during subsequent spacecraft passes.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-140	**3.2.2.8 Spacecraft Telecommands**	Heading	
GSFPS-150	*Note: telecommands are sent to the satellite to adjust its attitude or position in its orbit, manage on board equipment or program the payloads.*	Advice	
GSFPS-667	The MCS shall implement the telecommand set as defined in TBD.	Requirement	
GSFPS-148	The MCS shall have a capability for operators to create, edit and validate telecommand procedures.	Requirement	
GSFPS-147	The MCS shall verify the procedures for correct procedural syntax.	Requirement	
GSFPS-146	The MCS shall validate the procedures for correct spacecraft and payload operation.	Requirement	
GSFPS-145	The MCS shall create telecommand sequences from the telecommand procedures.	Requirement	
GSFPS-144	The MCS shall have a capability for an operator to enter and edit telecommand sequences.	Requirement	
GSFPS-143	The MCS shall verify the telecommand sequences.	Requirement	
GSFPS-142	The MCS shall send telecommand sequences to the GSS.	Requirement	
GSFPS-141	The MCS shall schedule the transmission of telecommands from the GSS to the spacecraft.	Requirement	
GSFPS-191	**3.2.2.9 Operations Planning**	Heading	
GSFPS-194	The MCS shall undertake planning and scheduling of spacecraft operations based on mission and payload operation plans provided by the MMDPS and the needs of spacecraft management.	Requirement	
GSFPS-193	The MCS shall report on the timely execution of the operations and any deviations including ground and spacecraft anomalies.	Requirement	
GSFPS-645	The MCS shall provide spacecraft and payload status to the MMDPS to support SAR and mission planning.	Requirement	
GSFPS-192	The MCS shall provide operations planning and scheduling tools integrated with the telemetry analysis and command generation tools.	Requirement	
GSFPS-151	**3.2.2.10 Spacecraft Database**	Heading	
GSFPS-153	The MCS shall have a Spacecraft Database to permanently store spacecraft and MCS data.	Requirement	
GSFPS-161	The MCS shall store all telemetry downloaded from the spacecraft in the Spacecraft Database.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-160	The MCS shall store all telecommands uploaded to the spacecraft in the Spacecraft Database.	Requirement	
GSFPS-640	The MCS shall store all telecommand acknowledgments from the spacecraft.	Requirement	
GSFPS-159	The MCS shall store all GSS status data in the Spacecraft Database.	Requirement	
GSFPS-158	The MCS shall store all GSS control commands and acknowledgments in the Spacecraft Database.	Requirement	
GSFPS-157	The MCS shall have tools for querying the Spacecraft Database and filtering, analysing and reporting the telemetry data.	Requirement	
GSFPS-156	The MCS shall generate reports summarising the behaviour of each item of equipment on the spacecraft.	Requirement	
GSFPS-155	The MCS shall undertake trend analysis on the received spacecraft telemetry.	Requirement	
GSFPS-154	The MCS shall provide trend analysis reports on the spacecraft telemetry.	Requirement	
GSFPS-162	*Note these reports would include parameters such as operating time, predicted operating time, faults, spacecraft orbital characteristics and trends etc.*	Advice	
GSFPS-167	**3.2.2.11 GSS Monitoring and Control**	Heading	
GSFPS-168	The MCS shall receive GSS status data in real time from the GSS.	Requirement	
GSFPS-184	The MCS shall receive from the GSS, GSS status data that has been stored at the GSS.	Requirement	
GSFPS-183	The MCS shall display the GSS status data on monitors in tabular form and as mimic diagrams.	Requirement	
GSFPS-182	The MCS shall use colour to indicate the status of each parameter of GSS status data as in range or out of range.	Requirement	
GSFPS-181	The MCS shall have alarms for key GSS status data parameters.	Requirement	
GSFPS-180	The MCS shall provide programmable thresholds for GSS parameter alarms.	Requirement	
GSFPS-179	The MCS shall have tools for querying the Spacecraft Database and filtering, analysing and reporting the GSS status data.	Requirement	
GSFPS-178	The MCS shall generate reports summarising the behaviour of each item of equipment in the GSS	Requirement	
GSFPS-177	The MCS shall undertake trend analysis on the received GSS data.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-176	The MCS shall provide GSS trend analysis reports.	Requirement	
GSFPS-175	The MCS shall enable the operator to enter control commands for the GSS	Requirement	
GSFPS-173	The MCS shall verify GSS control commands prior to sending.	Requirement	
GSFPS-172	The MCS shall send GSS control commands to the Ground Station.	Requirement	
GSFPS-171	The MCS shall schedule GSS control commands for execution by the GSS.	Requirement	
GSFPS-170	The MCS shall receive GSS control command acknowledgments from the Ground Station.	Requirement	
GSFPS-186	The MCS shall display GSS control command acknowledgments to the operator.	Requirement	
GSFPS-185	The MCS shall have an operator enabled capability to automatically generate control commands in response to out of range conditions.	Requirement	
GSFPS-188	**3.2.2.12 Formation Flying**	Heading	
GSFPS-189	The MCS shall support the orbiting of two spacecraft in close formation.	Requirement	
GSFPS-190	**3.2.2.13 Network Management**	Heading	
GSFPS-198	The MCS shall provide operator controls for configuring and managing the Communication System.	Requirement	
GSFPS-197	The MCS shall display and log the status of the Communication System.	Requirement	
GSFPS-196	The MCS shall display and log the performance of the networks in the Communication System.	Requirement	
GSFPS-195	The MCS shall determine and display the predicted availability of the networks in the Communication System.	Requirement	
GSFPS-199	**3.2.2.14 Spacecraft and Ground Segment Simulator**	Heading	
GSFPS-202	The MCS shall incorporate a simulator that simulates the MCS and the behaviour of the spacecraft.	Requirement	
GSFPS-201	The spacecraft simulator shall enable the following: i) Testing and verification of the ground segment prior to launch of the spacecraft. ii) Generation of flight operating procedures. iii) Training of ground segment personnel in spacecraft operations, spacecraft contingency and recovery procedures, and spacecraft special operations; eg eclipse, LEOP and commissioning.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-200	*Note, the spacecraft simulator may also be designed to perform the flight software V&V capability.*	Advice	
GSFPS-203	3.2.3 Mission Management and Data Processing System (MMDPS)	Heading	
GSFPS-204	**3.2.3.1 States and Modes**	Heading	
GSFPS-212	The MMDPS shall have an off state where all equipment is powered off.	Requirement	
GSFPS-218	The MMDPS shall have an on state where all equipment is powered on.	Requirement	
GSFPS-217	The MMDPS shall have a self test mode where the equipment undertakes self test.	Requirement	
GSFPS-216	The MMDPS shall have an operational mode where all equipment is operational.	Requirement	
GSFPS-215	The MMDPS transition from self test mode to operational mode shall be automatic on the successful conclusion of self test.	Requirement	
GSFPS-214	The MMDPS transition into self test mode shall be automatic after entering on state.	Requirement	
GSFPS-213	The MMDPS transition from on to off state and off to on state shall be by manual intervention from an operator.	Requirement	
GSFPS-219	**3.2.3.2 MMDPS Interfaces**	Heading	
GSFPS-616	The MMDPS interfaces shall be implemented as described in this para and in accordance with Paras 3.3 and 3.4.	Requirement	
GSFPS-617	3.2.3.2.1 External Interfaces	Heading	
GSFPS-220	The MMDPS shall interface with the customer via the CS.	Requirement	
GSFPS-223	The MMDPS shall interface with existing earth observation data providers via the CS.	Requirement	
GSFPS-641	The MMDPS Public Accessible Web Site shall interface to the public via the CS.	Requirement	
GSFPS-618	3.2.3.2.2 Internal Interfaces	Heading	
GSFPS-222	The MMDPS shall interface to the MCS via the CS.	Requirement	
GSFPS-227	The MMDPS shall interface to the GSS via the CS.	Requirement	
GSFPS-643	The MMDPS shall interface to the SS.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-228	**3.2.3.3 Requests for Data**	Heading	
GSFPS-669	The MMDPS shall receive requests for new data and existing data from the customer.	Requirement	
GSFPS-231	The MMDPS shall log all requests for data.	Requirement	OCD iss1, Para 3.4.2.1.
GSFPS-235	The MMDPS shall validate each request for data for conformance with the Customer Request Policy.	Requirement	OCD iss1, Para 3.4.2.1.
GSFPS-234	The MMDPS shall confirm that correct payment has been received for each validated request.	Requirement	OCD iss1, Para 3.4.2.1.
GSFPS-233	The MMDPS shall prioritise each customer request in accordance with the Customer Request Policy.	Requirement	OCD iss1, Para 3.4.2.1.
GSFPS-230	The MMDPS shall prioritise requests for interpreted data separately to the priority for acquiring the related raw data.	Requirement	OCD iss1, Para 3.4.2.3.
GSFPS-236	**3.2.3.4 SAR Operations Planning**	Heading	
GSFPS-642	The MMDPS shall receive spacecraft and SAR Status data from the MCS via the CS.	Requirement	
GSFPS-240	The MMDPS shall undertake SAR operations planning and scheduling based on a) The prioritised and validated customer requests for new data. b) SAR calibration requirements c) Any other SAR operational requirements. d) Spacecraft and SAR status.	Requirement	
GSFPS-239	The MMDPS shall provide the SAR operations schedule to the MCS.	Requirement	
GSFPS-238	*Note: The MMDPS is responsible for the SAR payload; it provides its recommended operations plan and schedule for SAR operation to the MCS. The MCS incorporates this into the satellite operations schedule.*	Advice	
GSFPS-251	**3.2.3.5 Receipt of Raw SAR Data**	Heading	
GSFPS-252	The MMDPS shall provide the operator with a list of data files stored at the GSS.	Requirement	
GSFPS-253	On operator request, the MMDPS shall download raw SAR data from the GSS.	Requirement	
GSFPS-254	The MMDPS shall store all raw SAR data received from the GSS to permanent non-volatile storage.	Requirement	
GSFPS-255	**3.2.3.6 Processing of Data**	Heading	

ID	Function and Performance Specification	Type	Traceability
GSFPS-632	The MMDPS shall process data from the SAR stripmap operational mode.	Requirement	Garada TK 2.3 SAR Processor Performance Requirements V 1.0 31 Mar 12. Para 3.4
GSFPS-633	The MMDPS shall process data from the SAR scansar operational mode.	Requirement	Garada TK 2.3 SAR Processor Performance Requirements V 1.0 31 Mar 12. Para 3.4
GSFPS-637	The MMDPS shall process data from the SAR squinted operational mode.	Requirement	Garada TK 2.3 SAR Processor Performance Requirements V 1.0 31 Mar 12. Para 3.6
GSFPS-636	The MMDPS shall perform temporal interferometry processing of multiple SAR images.	Requirement	Garada TK 2.3 SAR Processor Performance Requirements V 1.0 31 Mar 12. Para 3.5
GSFPS-638	The MMDPS shall register multiple images with each other with an accuracy of one pixel.	Requirement	Garada TK 2.3 SAR Processor Performance Requirements V 1.0 31 Mar 12. Para 3.3
GSFPS-639	The MMDPS shall process multilook SAR data.	Requirement	Garada TK 2.3 SAR Processor Performance Requirements V 1.0 31 Mar 12. Para 3.2
GSFPS-258	The MMDPS shall process the Raw Data to create the following processed products: a) Single Look Complex, b) Path Image, c) Map Image, d) Multi Look.	Requirement	OCD Iss1, Para 3.4.1
GSFPS-257	When requested by the customer, the MMDPS shall overlay SAR imagery on existing map data or earth observation imagery sourced from the customer or external providers as requested by the customer.	Requirement	OCD Iss1, Para 3.4.2.3

ID	Function and Performance Specification	Type	Traceability
GSFPS-256	The MMDPS shall package the processed data in the following file formats as requested by the customer: a) GeoTiff, b) CCRS, c) CEOS, d) EOSAT, e) Fast7a, f) HDF.	Requirement	OCD Iss1, Para 3.4.1
GSFPS-264	The MMDPS shall interpret SAR imagery to produce the following products: a) Outlines of water bodies, b) Outlines of forests, c) Outlines of clear cut forests, d) Ocean oil slick outlines, e) Soil moisture contours.	Requirement	OCD Iss1, Para 3.4.2.3
GSFPS-263	*Note: the interpretation of the imagery may be undertaken automatically or by a subject matter expert.*	Advice	
GSFPS-262	The MMDPS shall meet the processing and interpreting times specified in Table 1: Processing Times and Accuracy.	Requirement	OCD Iss1, Table 5
GSFPS-261	The MMDPS shall meet the accuracy of processed data specified in Table 1: Processing Times and Accuracy.	Requirement	OCD Iss1, Table 5

<table>
<tr><th>ID</th><th>Function and Performance Specification</th><th>Type</th><th>Traceability</th></tr>
<tr><td>GSFPS-259</td><td>Table 1: Processing Times and Accuracy
<table>
<tr><th>Product</th><th>Processing plus interpreting time</th><th>Accuracy of Outline Boundary</th></tr>
<tr><td>Flood outlines to support disaster management</td><td>Less than one hour</td><td>5m</td></tr>
<tr><td>Oil slicks</td><td>Less than three hours</td><td>5m</td></tr>
<tr><td>All other products</td><td>No better than two business days.</td><td>NA</td></tr>
</table></td><td>Requirement</td><td>OCD Iss1, Table 5</td></tr>
<tr><td>GSFPS-265</td><td>The MMDPS shall process the data to create single look complex, path image and map image products before the next data downlink.</td><td>Requirement</td><td></td></tr>
<tr><td>GSFPS-266</td><td>3.2.3.7 User Services</td><td>Heading</td><td></td></tr>
<tr><td>GSFPS-267</td><td>The MMDPS shall provide the following data to users: Raw SAR data, processed SAR data, interpreted SAR data, and ancillary satellite and payload data required to process SAR data; eg time, orbit details, calibration data, etc.</td><td>Requirement</td><td></td></tr>
<tr><td>GSFPS-270</td><td>The MMDPS shall have a secure web site for delivery of data products to the customer.</td><td>Requirement</td><td></td></tr>
<tr><td>GSFPS-271</td><td>Customer access to the MMDPS secure site shall be password protected.</td><td>Requirement</td><td></td></tr>
<tr><td>GSFPS-269</td><td>The MMDPS shall restrict customer access to the secure web site to the products purchased by the customer.</td><td>Requirement</td><td></td></tr>
<tr><td>GSFPS-268</td><td>The MMDPS shall undertake customer account management including ordering, invoicing and payment receipt.</td><td>Requirement</td><td></td></tr>
<tr><td>GSFPS-671</td><td>The MMDPS shall send invoices, receipts and confirmation of orders to the customer.</td><td>Requirement</td><td></td></tr>
<tr><td>GSFPS-672</td><td>The MMDPS shall receive payments from the customer.</td><td>Requirement</td><td></td></tr>
<tr><td>GSFPS-242</td><td>3.2.3.8 Public Accessible Web Site (PAWS)</td><td>Heading</td><td></td></tr>
</table>

ID	Function and Performance Specification	Type	Traceability
GSFPS-243	The MMDPS shall provide a web site accessible by the public.	Requirement	OCD iss1, Para 5.1.2.4.
GSFPS-250	The MMDPS shall place on the PAWS the data that has been assessed to be available to the public in accordance with the Customer Request Policy.	Requirement	
GSFPS-249	The data on the PAWS shall be indexed and searchable on the following: type of product, time and date of acquisition, and location.	Requirement	
GSFPS-248	The PAWS shall have sample sets of imagery available for download.	Requirement	
GSFPS-247	The PAWS shall have an automated system for the purchase of data.	Requirement	
GSFPS-244	The PAWS shall enable purchased data to be directly downloaded to the customer's computer.	Requirement	
GSFPS-246	The PAWS shall enable requests to be made for data that is not publicly available on the PAWS.	Requirement	
GSFPS-245	The PAWS home page shall include general mission information, querying service, browsing service, conditions of use and ordering service.	Requirement	
GSFPS-274	**3.2.3.9 Indexing and Archiving**	Heading	
GSFPS-280	The MMDPS shall archive all raw SAR data and processed data to a permanent archive on site.	Requirement	
GSFPS-275	The MMDPS shall archive all raw SAR data and processed data to a permanent archive off site.	Requirement	
GSFPS-279	The MMDPS shall index all raw SAR data received from the GSS, using, at a minimum, time and date of acquisition, surveyed area, SAR Mode.	Requirement	
GSFPS-278	The MMDPS shall index all processed data using as a minimum, type of product, time and date of acquisition, surveyed area, requesting customer.	Requirement	
GSFPS-277	The MMDPS shall enable an operator to interrogate the indices and retrieve the data.	Requirement	
GSFPS-276	During the mission and up to 10 years after launch, the MMDPS shall be capable of providing users with the archived data and processed products.	Requirement	
GSFPS-282	**3.2.3.10 SAR Calibration**	Heading	
GSFPS-283	The MMDPS shall perform SAR calibration parameter generation and verification.	Requirement	
GSFPS-610	The MMDPS shall determine SAR calibration maneuvers required to undertake SAR calibration.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-611	The MMDPS shall provide SAR calibration maneuver requests to the MCS as part of the mission operations schedule.	Requirement	
GSFPS-284	**3.2.3.11 SAR Monitoring**	Heading	
GSFPS-285	The MMDPS shall monitor SAR performance parameters.	Requirement	
GSFPS-287	*(These could be direct from the telemetry or calculated after processing of the SAR data.)*	Advice	
GSFPS-288	The MMDPS shall evaluate the SAR performance parameters against established quality criteria.	Requirement	
GSFPS-286	The MMDPS shall perform trend analysis on the SAR performance parameters and identify trends that show performance degradation.	Requirement	
GSFPS-289	The MMDPS shall provide the details of the SAR performance and trends to the Support System for further analysis and corrective action.	Requirement	
GSFPS-291	**3.2.3.12 GNSS Calibration and Processing**	Heading	
GSFPS-292	The MMDPS shall perform GNSS calibration parameter generation and verification.	Requirement	
GSFPS-293	**3.2.3.13 GNSS Monitoring.**	Heading	
GSFPS-294	The MMDPS shall monitor GNSS performance parameters.	Requirement	
GSFPS-298	*(These could be direct from the telemetry or calculated after processing of the GNSS data.)*	Advice	
GSFPS-297	The MMDPS shall evaluate the GNSS performance parameters against established quality criteria.	Requirement	
GSFPS-296	The MMDPS shall perform trend analysis on the GNSS performance parameters.	Requirement	
GSFPS-295	The MMDPS shall provide the details of the GNSS performance to the Support System for further analysis and corrective action.	Requirement	
GSFPS-299	**3.2.3.14 Mission Planning & Scheduling**	Heading	
GSFPS-303	The MMDPS shall undertake mission planning and scheduling.	Requirement	
GSFPS-306	The MMDPS shall provide the mission planning schedule to the MCS.	Requirement	
GSFPS-305	*Note: The MMDPS is responsible for the overall mission planning; it provides the mission plan to the MCS. The MCS incorporates this into the overall satellite operations schedule.*	Advice	

ID	Function and Performance Specification	Type	Traceability
GSFPS-720	**3.2.3.15 Enhancements**	Requirement	
GSFPS-721	The MMDPS shall provide enhancement requests for the MMDPS software to the SS.	Requirement	
GSFPS-722	The MMDPS shall receive and validate MMDPS software from the SS.	Requirement	
GSFPS-308	3.2.4 Ground Station System (GSS)	Heading	
GSFPS-313	**3.2.4.1 States and Modes**	Heading	
GSFPS-315	The GSS shall have an off state where all the equipment is powered off.	Requirement	
GSFPS-322	The GSS shall have an on state where all the equipment is powered on.	Requirement	
GSFPS-321	The GSS shall have a standby state where only the equipment required to control the GSS power, send status data to the MCS, and receive commands from the MCS is on.	Requirement	
GSFPS-320	The GSS shall have an automatic mode for operating without local or remote operator intervention.	Requirement	
GSFPS-319	In automatic mode the GSS shall configure, track and establish a communications link to and from the Garada spacecraft.	Requirement	
GSFPS-318	The GSS shall have a local mode providing, at a minimum, control of azimuth and elevation from within the Ground Station.	Requirement	
GSFPS-316	In local mode the GSS shall disable automatic operation of the antenna.	Requirement	
GSFPS-317	The GSS shall have a remote mode for operation from a remote location.	Requirement	
GSFPS-314	The GSS shall have a self test mode where the equipment performs power on BIT.	Requirement	
GSFPS-323	The GSS transition between states and modes shall be as per Figure 2.	Requirement	
GSFPS-324	**3.2.4.2 GSS Interfaces**	Heading	
GSFPS-619	The GSS interfaces shall be implemented as described in this para and in accordance with Paras 3.3 and 3.4.	Requirement	
GSFPS-620	3.2.4.2.1 External Interfaces	Heading	
GSFPS-325	The GSS shall implement interface "E16 Payload Data" with the spacecraft.	Requirement	
GSFPS-334	The GSS shall implement interface "E17 Telemetry" with the spacecraft.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-333	The GSS shall implement interface "E15 Telecommands" with the spacecraft.	Requirement	
GSFPS-723	The GSS shall implement interface "E14 Beacon" with the spacecraft.	Requirement	
GSFPS-327	The GSS shall implement interface "E01 Mains Power" with the national grid.	Requirement	
GSFPS-621	3.2.4.2.2 Internal Interfaces	Heading	
GSFPS-332	The GSS shall interface with the MCS via the CS.	Requirement	
GSFPS-331	The GSS shall interface with the MMDPS via the CS.	Requirement	
GSFPS-309	**3.2.4.3 Location and Operation**	Heading	
GSFPS-311	The GSS shall be remotely located from the other ground systems.	Requirement	
GSFPS-310	In all modes other than local mode, the GSS shall operate unattended.	Requirement	
GSFPS-601	**3.2.4.4 Mechanical Requirements**	Heading	
GSFPS-349	The GSS shall incorporate an Antenna Stow function to park and lock the antenna.	Requirement	
GSFPS-345	The GSS shall be capable of driving the antenna to the stow position in wind speeds of up to 36 m/s.	Requirement	
GSFPS-346	The GSS shall automatically initiate the Antenna Stow function once the external wind speed has exceeded a preconfigured value.	Requirement	
GSFPS-603	The GSS antenna shall be capable of a minimum elevation range of -3° to 93°.	Requirement	
GSFPS-602	The GSS antenna shall be capable of a minimum azimuth range of ±390°.	Requirement	
GSFPS-343	*Note: This implies that the GSS antenna shall be capable of being pointed to any position in the upper hemisphere.*	Advice	
GSFPS-604	Hand cranking for both antenna azimuth and elevation shall be provided.	Requirement	
GSFPS-335	**3.2.4.5 Tracking**	Heading	
GSFPS-336	The GSS shall be capable of tracking passes that pass over its zenith	Requirement	
GSFPS-350	The GSS shall be capable of tracking passes at elevation angles at least as low as 5 degrees.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-342	The GSS shall be capable of tracking the Garada Spacecraft at an altitude 600 km or greater.	Requirement	
GSFPS-341	The GSS shall be capable of program tracking using Two Line Element (TLE) set data.	Requirement	
GSFPS-340	The GSS shall be capable of being automatically switched between program tracking and autotracking using a programmable signal strength threshold.	Requirement	
GSFPS-607	The GSS shall be capable of being remotely switched between program tracking and autotracking.	Requirement	
GSFPS-338	The GSS shall provide a configurable "search" procedure to assist in the acquisition of signals.	Requirement	
GSFPS-339	The GSS shall provide local control of antenna azimuth and elevation.	Requirement	
GSFPS-330	The GSS shall send antenna tracking and ranging data to the MCS via the CS.	Requirement	
GSFPS-351	**3.2.4.6 RF Requirements**	Heading	
GSFPS-352	*Note: These requirements are for the reception, in Australia, of data from spacecraft Radarsat-1, Radarsat-2, Landsat-5, Landsat-7, Landsat Data Continuity Mission, Terra, Aqua, Sentinel series and ERS-2. These requirements need to be confirmed for operation with the Garada spacecraft.*	Advice	
GSFPS-358	The GSS shall have a minimum G/T, measured at the output of the Signal Distribution System (SDS) for both the Left Hand Circular Polarised (LHCP) and Right Hand Circular Polarised (RHCP) signal, of 34.0 dB/K under the following conditions: a. 5° elevation with no terrestrial obstructions; b. At all frequencies between 8.025 GHz to 8.400 GHz; c. Under clear sky conditions with 7.5 g/m3 water vapour; and d. At an ambient temperature of 23C.	Requirement	
GSFPS-357	The GSS Antenna System shall employ simultaneous reception of both LHCP and RHCP signals.	Requirement	
GSFPS-356	The receive frequency range of the GSS Antenna System shall be from 8.025 GHz to 8.400 GHz inclusive.	Requirement	
GSFPS-355	The overall GSS Antenna System gain (including antenna, LNA, BDC and cable losses) shall be such that at zenith, Garada presents a signal level of -10 dBm +/-3dB at the SDS under clear sky conditions.	Requirement	
GSFPS-354	The GSS antenna shall have a maximum sidelobe level for angles greater or equal to 100 λ/D or 1 degree, whichever is smaller; not greater than -14.0 dB compared with the peak of the main beam.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-353	The GSS antenna pointing accuracy shall be ±0.1° RMS or better when subjected to wind speeds up to and including 20 m/s.	Requirement	
GSFPS-359	**3.2.4.7 Telemetry Data**	Heading	
GSFPS-361	The GSS shall receive telemetry data from the Garada spacecraft in S band.	Requirement	
GSFPS-363	The GSS shall transmit telemetry data received from the spacecraft to the MCS in real time.	Requirement	
GSFPS-362	The GSS shall store telemetry data received from the Garada spacecraft.	Requirement	
GSFPS-360	The GSS shall transmit stored telemetry data to the MCS when commanded by the MCS.	Requirement	
GSFPS-364	**3.2.4.8 Command Data**	Heading	
GSFPS-365	The GSS shall receive telecommand data from the MCS.	Requirement	
GSFPS-369	The GSS shall transmit telecommands to the Garada Spacecraft in S band.	Requirement	
GSFPS-368	The GSS shall transmit telecommand data to the Garada Spacecraft in accordance with the telecommand schedule.	Requirement	
GSFPS-367	When no communication link with the Garada spacecraft is established, the GSS shall store received telecommand data and transmit the data when the spacecraft data link is established.	Requirement	
GSFPS-366	The transmission of telecommands by the GSS shall be possible at all times when communication links with the spacecraft are established independently of telemetry or payload data reception.	Requirement	
GSFPS-370	**3.2.4.9 Payload Data**	Heading	
GSFPS-371	The GSS shall receive payload data from the Garada Spacecraft in X band.	Requirement	
GSFPS-374	The GSS shall store payload data received from the Garada spacecraft.	Requirement	
GSFPS-373	The GSS shall transmit stored payload data to the MMDPS when commanded by the MMDPS.	Requirement	
GSFPS-372	The GSS shall be able to transmit all received payload data to the MMDPS within 30 minutes of being commanded by the MMDPS.	Requirement	
GSFPS-375	**3.2.4.10 Remote Monitoring and Control**	Heading	

ID	Function and Performance Specification	Type	Traceability
GSFPS-606	The GSS shall be capable of remote operation to configure, track and establish a communications uplink and downlink with the spacecraft.	Requirement	
GSFPS-328	The GSS shall receive GSS control commands from the MCS via the CS.	Requirement	
GSFPS-376	For the GSS, at a minimum, it shall be possible to control and status the following: a) Antenna, b) Each LRU, c) The GSS voltage, current and power, d) Each LRU power, e) GSS mode and state in accordance with GSS states and modes transition definition, f) Internal cabin temperature where the equipment is installed.	Requirement	
GSFPS-378	At a minimum, the following GSS parameters shall be remotely monitored: a) External temperature, humidity, wind speed and air pressure. b) Built in test status by LRU. (ie pass fail for each LRU) c) The parameter status of the built in tests, pass fail status and pass fail limits. (Report the actual result of the measured parameters for each LRU test to enable a remote operator to determine the reason for the test fail). d) Antenna park and lock status	Requirement	
GSFPS-329	The GSS shall send GSS parameter data to the MCS via the CS.	Requirement	
GSFPS-377	If loss of power to all or any part of the GSS occurs, on restoration of power the GSS shall return to a fully operational and remotely controllable state without local operator intervention.	Requirement	
GSFPS-609	On restoration of power the GSS Antenna System shall return to a fully operational and remotely controllable state without local operator intervention except in the case where the Antenna System was under local control at the time when power was lost.	Requirement	
GSFPS-600	The GSS shall incorporate an anemometer that is capable of measuring wind speeds of up to at least 88 m/s.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-379	The GSS shall display inside the cabin, the current wind speed.	Requirement	
GSFPS-608	Remote monitor, control and fault indication shall be provided within the GSS	Requirement	
GSFPS-347	The GSS shall be capable of remotely activating the antenna stow and lock function.	Requirement	
GSFPS-344	The GSS shall require operator intervention to release the Antenna from the stow position once the stow routine has been initiated. Operator intervention may be remote or local.	Requirement	
GSFPS-380	**3.2.4.11 Built In Test**	Heading	
GSFPS-381	The GSS shall perform Power On BIT that is initiated at power on.	Requirement	
GSFPS-390	The GSS shall perform continuous BIT that runs in the background during operation.	Requirement	
GSFPS-389	The GSS shall perform operator initiated BIT on request from the operator. (The operator may be remote or local).	Requirement	
GSFPS-388	The GSS continuous BIT shall not run when receiving or transmitting data to or from the spacecraft.	Requirement	
GSFPS-387	GSS BIT shall diagnose faults to LRU level.	Requirement	
GSFPS-386	GSS BIT shall include a test that tests the receive processing chain by externally exciting the antenna.	Requirement	
GSFPS-385	GSS BIT shall include a test that confirms correct operation of the receive processing chain by externally receiving a transmission from the antenna.	Requirement	
GSFPS-384	The results of all GSS BIT tests shall be recorded in a BIT log.	Requirement	
GSFPS-382	The GSS BIT logs shall be viewable by a local operator.	Requirement	
GSFPS-391	**3.2.4.12 Logging**	Heading	
GSFPS-392	The GSS shall have a GSS database to permanently store GSS data.	Requirement	
GSFPS-402	The GSS database shall be comprised of non volatile memory.	Requirement	
GSFPS-401	The GSS shall store all GSS monitored parameters and BIT logs in the GSS database.	Requirement	
GSFPS-400	The GSS shall store all GSS commands received from the MCS and their acknowledgment status in the GSS database.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-399	The GSS shall have a GSS spacecraft database to store spacecraft data.	Requirement	
GSFPS-398	The GSS spacecraft database shall be comprised of non volatile memory.	Requirement	
GSFPS-397	The GSS shall store all transmitted spacecraft telecommands in the GSS spacecraft database.	Requirement	
GSFPS-396	The GSS shall store logs of when each telecommand was transmitted and acknowledgment of response in the GSS spacecraft database.	Requirement	
GSFPS-395	The GSS shall store all received spacecraft telemetry in the GSS spacecraft database.	Requirement	
GSFPS-394	The GSS shall store all received spacecraft data in the GSS spacecraft database.	Requirement	
GSFPS-393	The GSS spacecraft database shall store the data for a minimum of 12 months.	Requirement	
GSFPS-654	When the GSS spacecraft database is 80% full, the GSS shall send a warning message to the MCS.	Requirement	
GSFPS-405	When the GSS spacecraft database is full, the oldest entries shall be overwritten.	Requirement	
GSFPS-404	The GSS database shall be remotely downloadable from the MCS.	Requirement	
GSFPS-403	The GSS spacecraft database shall be remotely downloadable from the MCS and MMDPS.	Requirement	
GSFPS-406	**3.2.4.13 Electrical Requirements**	Heading	
GSFPS-408	The GSS shall operate on 230/400 VAC, 50 Hz 3-phase mains power.	Requirement	
GSFPS-407	The GSS shall have an Uninterruptible Power Supply (UPS) capable of maintaining mission critical operation of the Antenna System (including slewing and tracking) for not less than 30 minutes.	Requirement	
GSFPS-655	The GSS shall have an emergency power system capable of powering all functionality in the GSS for not less than 48 hours.	Requirement	
GSFPS-656	After a failure of the mains power supply the GSS shall automatically switch over to the emergency power system within 15 minutes.	Requirement	
GSFPS-409	3.2.5 Communication System (CS)	Heading	
GSFPS-411	**3.2.5.1 States and Modes**	Heading	
GSFPS-412	The CS shall have an on state where all equipment is powered on and is operational.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-414	The CS shall have a self test state where all equipment undergoes BIT and all comms channels are tested for key performance parameters including max data rate and round trip response time.	Requirement	
GSFPS-413	The CS transitions between the on state and the self test state shall be by operator command from the MCS.	Requirement	
GSFPS-415	**3.2.5.2 Interfaces**	Heading	
GSFPS-622	The CS interfaces shall be implemented as described in this para and in accordance with Paras 3.3 and 3.4.	Requirement	
GSFPS-626	**3.2.5.3 External Interfaces**	Heading	
GSFPS-673	The CS shall implement interface "E02 Orbital Data" with the Conjunction Assessment Service.	Requirement	
GSFPS-674	The CS shall implement interface "E03 Conjunction Assessment" with the Conjunction Assessment Service.	Requirement	
GSFPS-675	The CS shall implement interface "E04 Email and web access" with the internet.	Requirement	
GSFPS-677	The CS shall implement interface "E05 Voice Comms" with the public phone network.	Requirement	
GSFPS-676	The CS shall implement interface "E06 Public Web Access".	Requirement	
GSFPS-679	The CS shall implement interface "E07 Requests for Data" with the customer.	Requirement	
GSFPS-681	The CS shall implement interface "E08 Invoicing and Payments" with the customer.	Requirement	
GSFPS-680	The CS shall implement interface "E09 Data Products" with the customer.	Requirement	
GSFPS-678	The CS shall implement interface "E10 EO Data" with external EO providers.	Requirement	
GSFPS-628	**3.2.5.4 Internal Interfaces**	Heading	
GSFPS-416	The CS shall interface with the GSS.	Requirement	
GSFPS-423	The CS shall interface with the MCS.	Requirement	
GSFPS-421	The CS shall interface with the MMDPS.	Requirement	
GSFPS-419	The CS shall interface with the SS.	Requirement	
GSFPS-425	**3.2.5.5 Data Communications**	Heading	
GSFPS-430	The CS shall provide two way data communications between the GSS and the MCS.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-429	The CS shall provide two way data communications between the GSS and the MMDPS.	Requirement	
GSFPS-428	For the GSS/MCS data link, the CS shall have a prime communication channel and a backup communication channel.	Requirement	
GSFPS-683	For the GSS/MMDPS data link, the CS shall have a prime communication channel and a backup communication channel.	Requirement	
GSFPS-427	The CS shall automatically switch to the backup communication channel when the prime communication channel is not available.	Requirement	
GSFPS-646	The CS shall enable a MCS operator to manually switch between the prime and backup communication channels.	Requirement	
GSFPS-684	The CS shall provide two way data communications between the MMDPS and the MCS.	Requirement	
GSFPS-685	The CS shall provide two way data communications between the SS and the MMDPS.	Requirement	
GSFPS-686	The CS shall provide two way data communications between the SS and the MCS.	Requirement	
GSFPS-431	**3.2.5.6 Voice Communications**	Heading	
GSFPS-682	The CS shall provide voice communications between each system and the public telephone network.	Requirement	
GSFPS-433	The CS shall provide voice communications between each system.	Requirement	
GSFPS-432	*Note: this may be implemented via an internal communication network or the public telephone network.*	Advice	
GSFPS-434	**3.2.5.7 Internet**	Heading	
GSFPS-435	The CS shall interface to the Internet for the purposes of email, general web access, the MMDPS public web server, and delivery of data products to customers.	Requirement	
GSFPS-436	**3.2.5.8 Network Monitoring and Reporting**	Heading	
GSFPS-437	The CS shall monitor the network for availability and performance.	Requirement	
GSFPS-442	The CS shall provide network monitoring reports to the MCS.	Requirement	
GSFPS-441	The CS shall perform trend analysis on the monitored parameters.	Requirement	
GSFPS-440	The CS shall provide trend analysis reports to the MCS.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-439	The CS shall send CS self test reports to the MCS.	Requirement	
GSFPS-687	3.2.6 Support Subsystem	Heading	
GSFPS-688	**3.2.6.1 Interfaces**	Heading	
GSFPS-689	3.2.6.1.1 External Interfaces	Heading	
GSFPS-691	The SS shall implement interface "E12 Ground software update requests and deliveries" with the ground software suppliers.	Requirement	
GSFPS-692	The SS shall implement interface "E11 Flight Software update requests and deliveries" with the flight software suppliers.	Requirement	
GSFPS-690	3.2.6.1.2 Internal Interfaces	Heading	
GSFPS-693	The SS shall interface with all ground systems for the purposes of receiving software and hardware maintenance requests.	Requirement	
GSFPS-695	The SS shall interface with all ground systems for the purpose of providing software and hardware maintenance.	Requirement	
GSFPS-697	**3.2.6.2 Configuration Management**	Heading	
GSFPS-701	The SS shall undertake configuration management of all ground segment hardware and software.	Requirement	
GSFPS-700	After spacecraft launch, the SS shall undertake configuration management of all spacecraft software.	Requirement	
GSFPS-699	*Note: Configuration management includes configuration status accounting and change management.*	Advice	
GSFPS-702	**3.2.6.3 Software Maintenance**	Heading	
GSFPS-711	The SS shall receive requests for software maintenance and enhancements from other ground systems.	Requirement	
GSFPS-703	The SS shall provide software maintenance and enhancements for all ground segment software.	Requirement	
GSFPS-704	The SS shall provide software maintenance and enhancements for all spacecraft flight software that is uploadable from the ground.	Requirement	
GSFPS-705	The SS shall undertake verification and validation on all software changes.	Requirement	
GSFPS-706	**3.2.6.4 Hardware Maintenance**	Heading	

ID	Function and Performance Specification	Type	Traceability
GSFPS-708	The SS shall receive requests for hardware maintenance and upgrades from the ground segment.	Requirement	
GSFPS-710	The SS shall undertake hardware maintenance and upgrades for the ground segment.	Requirement	
GSFPS-48	***3.3 Segment External Interface Requirements***	Heading	
GSFPS-49	3.3.1 Interface Identification and Diagrams	Heading	
GSFPS-444	**3.3.1.1 Interface Diagram**	Heading	
GSFPS-445	The Ground Segment external interfaces are shown in Figure 3.	Requirement	
GSFPS-446	**3.3.1.2 Spacecraft Interfaces**	Heading	
GSFPS-454	3.3.1.2.1 E14 Beacon	Heading	
GSFPS-458	TBD	Requirement	
GSFPS-455	3.3.1.2.2 E15 Telecommands	Heading	
GSFPS-461	TBD	Requirement	
GSFPS-457	3.3.1.2.3 E16 Payload Data	Heading	
GSFPS-459	TBD	Requirement	
GSFPS-456	3.3.1.2.4 E17 Telemetry Data	Heading	
GSFPS-460	TBD	Requirement	
GSFPS-462	**3.3.1.3 Customer Interfaces**	Heading	
GSFPS-463	3.3.1.3.1 E07 Requests for Data	Heading	
GSFPS-464	Requests from the customer shall be received electronically and shall be in vendor format.	Requirement	
GSFPS-536	Requests shall contain at a minimum, the area to be scanned, data type, data format, SAR mode, interpretation, date and time of scan.	Requirement	OCD iss1, para 3.4.1
GSFPS-529	3.3.1.3.2 E09 Data Products	Heading	
GSFPS-465	Data products shall be provided electronically.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-530	3.3.1.3.3 E08 Invoicing and Payment	Heading	
GSFPS-531	Invoicing and payment shall be in vendor format.	Requirement	
GSFPS-451	**3.3.1.4 E01 Mains Power**	Heading	
GSFPS-466	The Ground Segment shall interface with an external power supply meeting the requirements of AS 60038 and AS/NZS 3000.	Requirement	
GSFPS-467	**3.3.1.5 E05 Voice Comms**	Heading	
GSFPS-468	The Ground Segment interface with the public telephone network shall be in accordance with AS/CA S003.1:2010.	Requirement	
GSFPS-534	**3.3.1.6 E04 Email and Web Access**	Heading	
GSFPS-535	The interface with the internet shall be a minimum of 10Mbps upload and download.	Requirement	
GSFPS-469	**3.3.1.7 E06 Public Web Access**	Heading	
GSFPS-470	Access to the Ground Segment public web site shall be in accordance with ISO/IEC 15445:2000.	Requirement	
GSFPS-471	**3.3.1.8 E10 Earth Observation Data**	Heading	
GSFPS-472	The Ground Segment shall receive earth observation data from external databases in the following formats: a) GeoTiff, b) CCRS, c) CEOS, d) EOSAT, e) Fast7a and f) HDF	Requirement	
GSFPS-473	**3.3.1.9 Conjunction Assessment Service**	Heading	
GSFPS-474	Interface E02 Orbital data shall be provided as NORAD two line element sets.	Requirement	
GSFPS-528	Interface E03 Conjunction assessment data shall be in vendor format.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-475	**3.3.1.10 E11 Flight Software Vendors**	Heading	
GSFPS-476	Flight software shall be provided in vendor format with, at a minimum, documentation that describes the configuration and use of the software.	Requirement	
GSFPS-532	**3.3.1.11 E12 Ground Software Vendors**	Heading	
GSFPS-533	Ground software shall be provided in vendor format with, at a minimum, documentation that describes the configuration and use of the software.	Requirement	
GSFPS-477	**3.3.1.12 E13 Launch Services**	Heading	
GSFPS-478	The interface of the ground segment to launch services shall be in accordance with the requirements of the launch service provider.	Requirement	
GSFPS-50	3.3.2 Interface to GFE	Heading	
GSFPS-480	Not applicable.	Advice	
GSFPS-51	***3.4 System Internal Interface Requirements***	Heading	
GSFPS-629	The internal interface requirements will be determined during the system design phase and specified in the requirements specifications for system components.	Requirement	
GSFPS-52	***3.5 System Internal Data Requirements***	Heading	
GSFPS-479	The internal data requirements will be determined during the system design phase and specified in the requirements specifications for system components.	Advice	
GSFPS-53	***3.6 Adaptation Requirements***	Heading	
GSFPS-481	Not applicable.	Advice	
GSFPS-54	***3.7 Safety Requirements***	Heading	
GSFPS-580	3.7.1 General	Heading	
GSFPS-583	All of the GSS personnel access ways shall conform to AS 4024.1702.	Requirement	
GSFPS-582	The GSS shall comply with AS 1657.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-581	The noise levels within the occupied areas of the GS shall not exceed the levels specified in NOHSC:2009 (2004).	Requirement	
GSFPS-599	The GS Computer workstations shall comply with the requirements of AS/NZS 4443.	Requirement	
GSFPS-596	The GS Light levels within the inhabited areas shall conform to those recommended in AS/NZS 1680.	Requirement	
GSFPS-482	3.7.2 Electrical Safety	Heading	
GSFPS-483	The installation and earthing for all GS electrical equipment including racks, cabinets and associated equipment shall conform to the requirements of AS 3000.	Requirement	
GSFPS-658	All GS equipment that is capable of being connected to the 230/400V AC mains supply shall comply with the requirements of AS3100.	Requirement	
GSFPS-659	All GS equipment that is capable of being connected to the 230/400V AC mains supply shall comply with the requirements of AS60950.1.	Requirement	
GSFPS-598	The GSS shall protect personnel, equipment and facilities against direct and conducted effects of lightning in accordance with AS/NZS 1768.	Requirement	
GSFPS-575	Fibre systems used in the GS shall meet the requirements of AS/NZS 2211.2.	Requirement	
GSFPS-485	3.7.3 GSS Mechanical Safety Requirements	Heading	
GSFPS-486	Emergency stops, with a key release facility, shall be provided at the GSS Antenna and on all access platforms.	Requirement	
GSFPS-493	On activation of a GSS emergency stop, all drive motion shall be inhibited.	Requirement	
GSFPS-492	On activation of a GSS emergency stop the antenna shall be held in position.	Requirement	
GSFPS-491	Visual indication of GSS emergency switch status shall be available at the switch.	Requirement	
GSFPS-490	GSS Emergency stop switches shall be positioned for easy access and for non-hazardous operation.	Requirement	
GSFPS-489	Design and installation of emergency stop switches in the GSS shall conform to the applicable requirements of AS 60204.1 Section 10.7 Emergency stop devices and AS 4024.1604.	Requirement	
GSFPS-488	Where guarding is used as a control measure in the GSS it shall be designed and installed in accordance with AS 4024.1601.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-487	Safety related human-machine interfaces that are part of the GSS shall conform to the applicable requirements of AS 4024.1904.	Requirement	
GSFPS-579	On failure or deactivation of the control system and/or loss of power, the antenna shall not "back drive" (i.e. no azimuth or elevation movement will occur) as a result of the effects of static or imposed (e.g. wind) load.	Requirement	
GSFPS-494	3.7.4 Hazardous Materials	Heading	
GSFPS-495	Substances that are listed in Schedule 1 of the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* shall not be used in the GS.	Requirement	
GSFPS-576	For all Hazardous Substances incorporated into the GS, full details shall be provided to the Commonwealth in the format of a Material Safety Data Sheet in accordance with NOHSC: 2011 (1994).	Requirement	
GSFPS-660	The GS equipment containing dangerous materials shall be labeled in accordance with AS 1216.	Requirement	
GSFPS-577	3.7.5 Signage	Heading	
GSFPS-578	The GS shall include danger, caution and warning signs fixed to equipment to advice of specific hazards such as high voltage, high temperature and radiation in accordance with AS 1319 – 1994.	Requirement	
GSFPS-661	3.7.6 Radiation Hazard	Heading	
GSFPS-662	The GSS shall have a mechanically keyed interlock that prohibits transmission when the key is removed.	Requirement	
GSFPS-663	3.7.7 Power Protection	Heading	
GSFPS-664	The GS shall be protected against damage caused by excessive current.	Requirement	
GSFPS-665	The GSS shall be protected against damage caused by short circuit at all antenna ports, audio connections and control connections.	Requirement	
GSFPS-55	***3.8 Security and Privacy Requirements***	Heading	
GSFPS-498	All Ground Segment workstations shall have access requiring user login and password.	Requirement	
GSFPS-497	Users shall be granted permissions to access ground segment capabilities based on their role.	Requirement	
GSFPS-496	The MCS shall have a capability for an operator to manage user access and permissions.	Requirement	
GSFPS-657	The GS shall detect and prevent unauthorised access on the external data interfaces.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-56	***3.9 System Environment Requirements***	Heading	
GSFPS-594	3.9.1 Mainland Australia and Tasmania Location	Heading	
GSFPS-593	The GSS shall operate within specification, without any degradation in performance when exposed to the maximum operational wind velocity of 20 m/s for a ten minute mean at ten metre height.	Requirement	
GSFPS-592	The GSS shall survive without damage or permanent deformation when exposed to a three second gust of wind with a velocity of up to 69 m/s.	Requirement	
GSFPS-591	The GSS shall operate within specification, excluding G/T, when exposed to an ambient temperature range of 5 degrees to +50 degrees Celsius in direct sunlight with solar radiation of 1.02 kW/m2.	Requirement	
GSFPS-590	The GSS shall operate within specification, excluding G/T, when exposed to an ambient temperature range of 5 degrees to +50 degrees Celsius with a relative humidity of 95% (non-condensing).	Requirement	
GSFPS-589	The GSS shall survive without damage or permanent deformation when exposed to an ambient temperature range of 0 to +55 degrees with a relative humidity of 95%.	Requirement	
GSFPS-588	The GSS shall operate within specification, excluding G/T, when exposed to driving rain of up to and including 50 mm/hr at a wind velocity of 20 m/s for a ten minute mean at ten metre height.	Requirement	
GSFPS-587	The GSS outdoor equipment shall remain free from water ingress during driving rain of up to and including 200 mm/hr under wind conditions up to a three second gust of wind with a velocity of up to 69 m/s.	Requirement	
GSFPS-595	3.9.2 Locations outside of Mainland Australia and Tasmania	Heading	
GSFPS-499	For locations outside of mainland Australia and Tasmania the climatic conditions described in DEF(AUST)5168 shall be used as guidelines for determining the environmental requirements for operation and survival.	Requirement	
GSFPS-57	***3.10 Computer Resource Requirements***	Heading	
GSFPS-500	Each computer processor used in the Ground Segment shall use a maximum of 50% processor capacity.	Requirement	
GSFPS-502	Each computer processor used in the Ground Segment shall use a maximum of 50% of processor memory capacity.	Requirement	
GSFPS-501	Each computer processor used in the Ground Segment shall use a maximum of 50% of input/output capacity.	Requirement	
GSFPS-58	***3.11 System Quality Factors***	Heading	

ID	Function and Performance Specification	Type	Traceability
GSFPS-503	3.11.1 Availability	Heading	
GSFPS-504	The combined availability of the MCS, CS and the GSS shall be better than 99.85%.	Requirement	
GSFPS-505	The availability of the MMDPS shall be better than 99.85%.	Requirement	
GSFPS-506	3.11.2 Maintainability	Heading	
GSFPS-507	All components of the Ground Segment designated as Line Replaceable Units (LRUs) shall be removable and restorable without the need to remove other LRUs.	Requirement	
GSFPS-509	All cable terminations to the Ground Segment modules designated as LRUs shall be capable of disconnection and reconnection without the need to disturb third party cables.	Requirement	
GSFPS-508	All cable terminations to Ground Segment modules designated as LRUs shall be capable of disconnection and reconnection without the need to cut cable securing straps.	Requirement	
GSFPS-59	***3.12 Design and Construction Constraints***	Heading	
GSFPS-510	The Ground Segment shall use COTS hardware.	Constraint	OCD iss1, Para 3.6
GSFPS-512	Ground Segment payload data processing shall be based on COTS software.	Constraint	OCD iss1, Para 3.6
GSFPS-538	To minimise Ground Segment development and operating costs, existing infrastructure shall be used where possible.	Constraint	OCD iss1, Para 3.6
GSFPS-539	Where data formats are not specified here, standard industry data formats shall be used where possible.	Constraint	OCD iss1, Para 3.6
GSFPS-540	To accommodate possible future applications the Ground Segment shall be designed to allow for the separation of data and data processing into classified and unclassified classes.	Requirement	OCD iss1, Para 3.6
GSFPS-511	In the MCS and MMDPS, it shall be possible to test new algorithms in parallel with the operation of existing algorithms.	Constraint	
GSFPS-513	Ground Segment data processing chains shall be modular to allow modification of processing algorithms and upgrade of the hardware.	Constraint	
GSFPS-60	***3.13 Personnel-related Requirements***	Heading	
GSFPS-516	Software and hardware user manuals shall be electronically accessible from the computer workstations.	Requirement	

ID	Function and Performance Specification	Type	Traceability
GSFPS-515	Software applications shall have context sensitive help available to the operator.	Requirement	
GSFPS-61	***3.14 Training-related Requirements***	Heading	
GSFPS-537	The requirements for the simulator to support GS operational training are listed under the MCS in para 3.2.	Advice	
GSFPS-62	***3.15 Logistics-related Requirements***	Heading	
GSFPS-518	Not applicable.	Advice	
GSFPS-63	***3.16 Other Requirements***	Heading	
GSFPS-519	Not applicable.	Advice	
GSFPS-64	***3.17 Packaging Requirements***	Heading	
GSFPS-520	Not applicable.	Advice	
GSFPS-65	***3.18 Precedence and Criticality of Requirements***	Heading	
GSFPS-523	Order of precedence: In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.	Requirement	
GSFPS-66	**4 Qualification Provisions**	Heading	
GSFPS-521	TBD	Requirement	
GSFPS-67	**5 Requirements Traceability**	Heading	
GSFPS-522	Traceability to parent specifications is not applicable to system level requirements. Where applicable, traceability to other project documents is indicated with the requirement.	Advice	
GSFPS-68	**6 Notes**	Heading	
GSFPS-527	***6.1 Abbreviations and Acronyms***	Heading	
GSFPS-648	ASRP Australian Space Research Program BIT Built In Test	Requirement	

ID	Function and Performance Specification	Type	Traceability
	CCRS Canadian Centre of Remote Sensing CEOS Committee on Earth Observation Satellites COTS Commercial Off The Shelf CS Communication System EOSAT Earth Observation Satellite picture data format FPS Functional Performance Specification FTP File Transfer Protocol GFE Government Furnished Equipment GNSS Global Navigation Satellite System GS Ground Segment GSS Ground Station System HDF Hierarchical Data Format LEOP Launch and Early Orbit Phase LHCP Left Hand Circular Polarised LRU Line Replaceable Unit MCS Mission Control System MMDPS Mission Management and Data Processing System NOHSC National Occupational Health and Safety OFCS Optical Fibre Communication Systems PAWS Public Accessible Web Site RHCP Right Hand Circular Polarised SAR Synthetic Aperture Radar SDS Signal Distribution System		

ID	Function and Performance Specification	Type	Traceability
	SS Support System SSS System/Subsystem Specification TBD To Be Determined TLE Two Line Element V&V Verification and Validation		

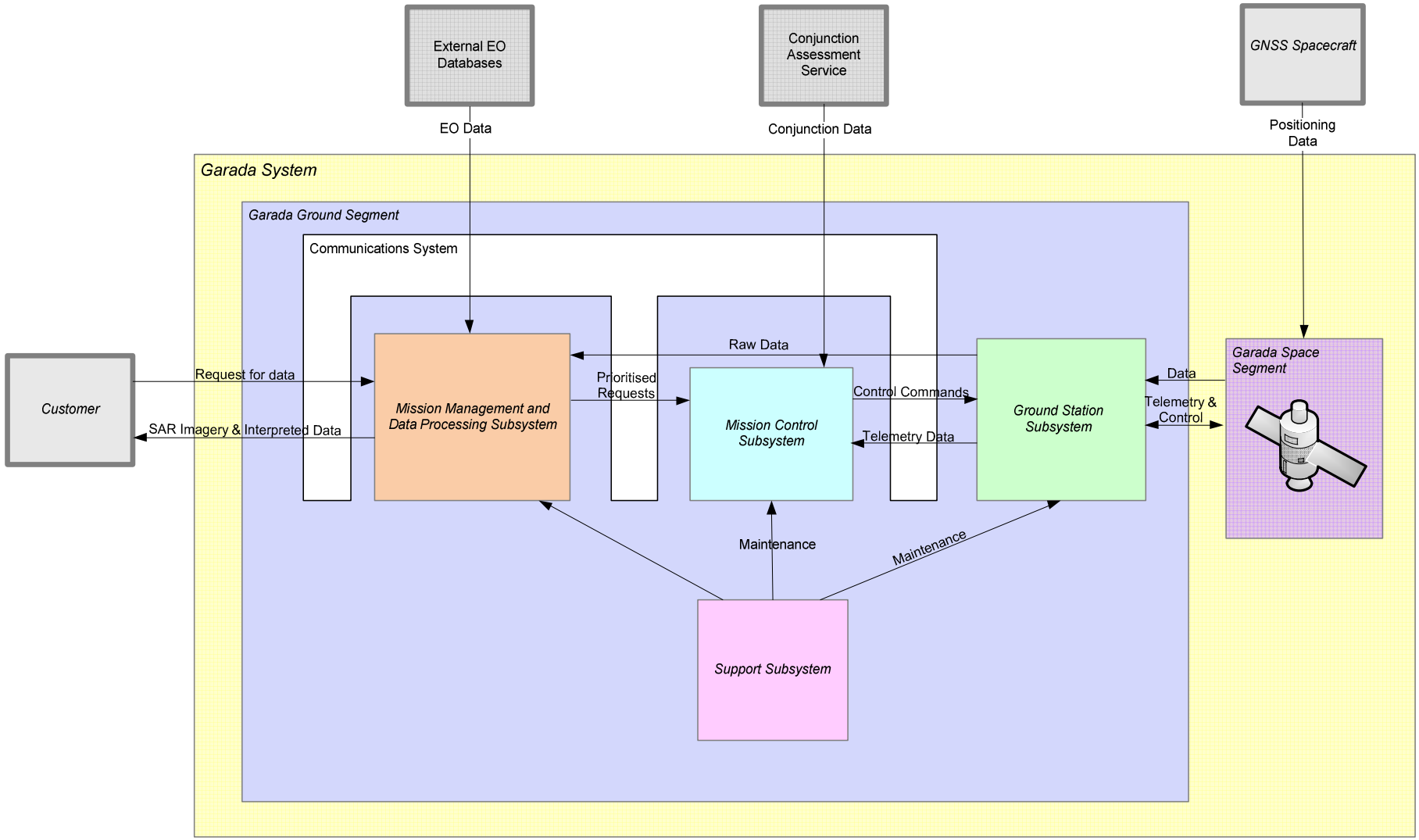


Figure 1: Garada System Context

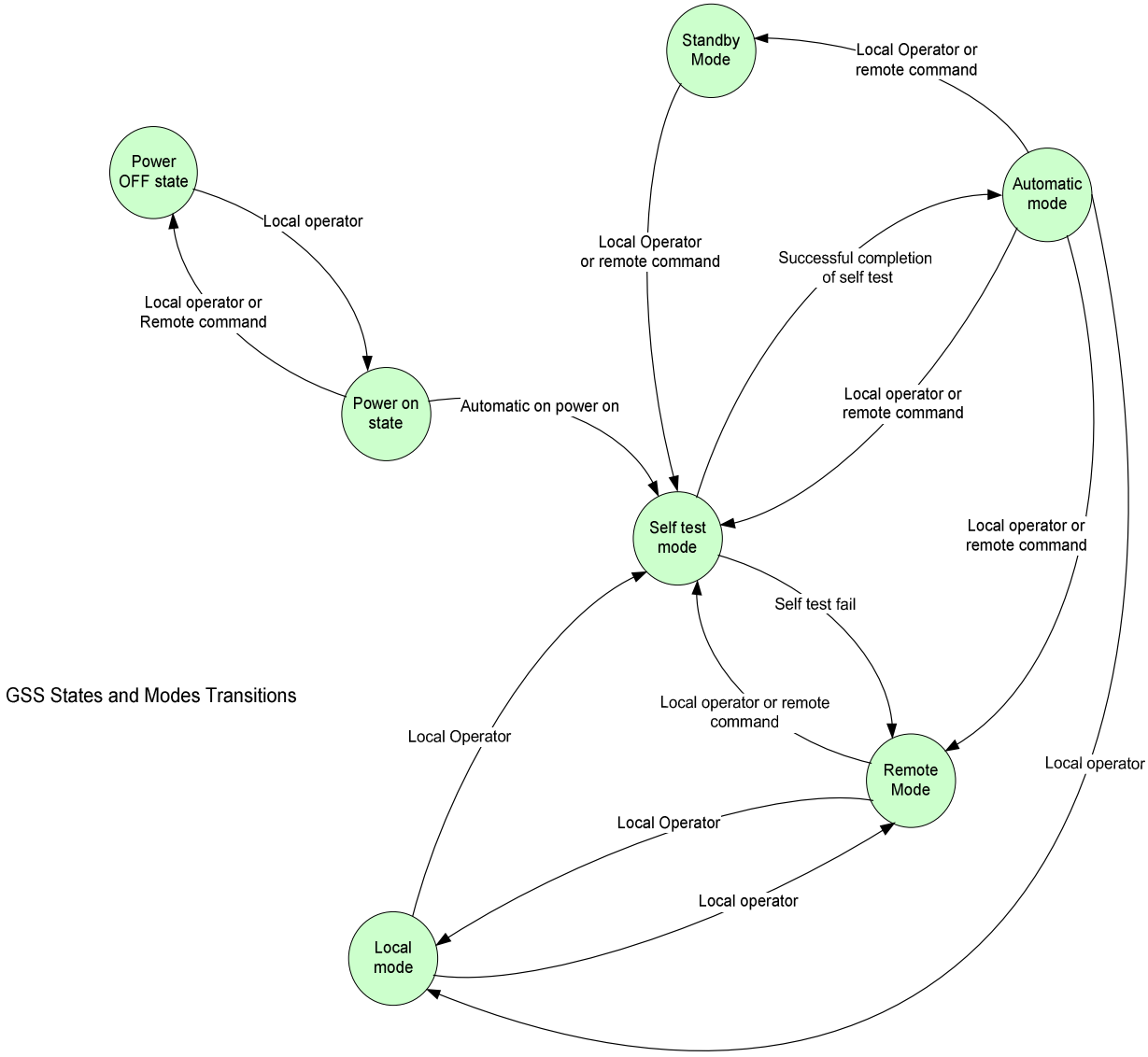


Figure 2: GSS States and Modes Transitions

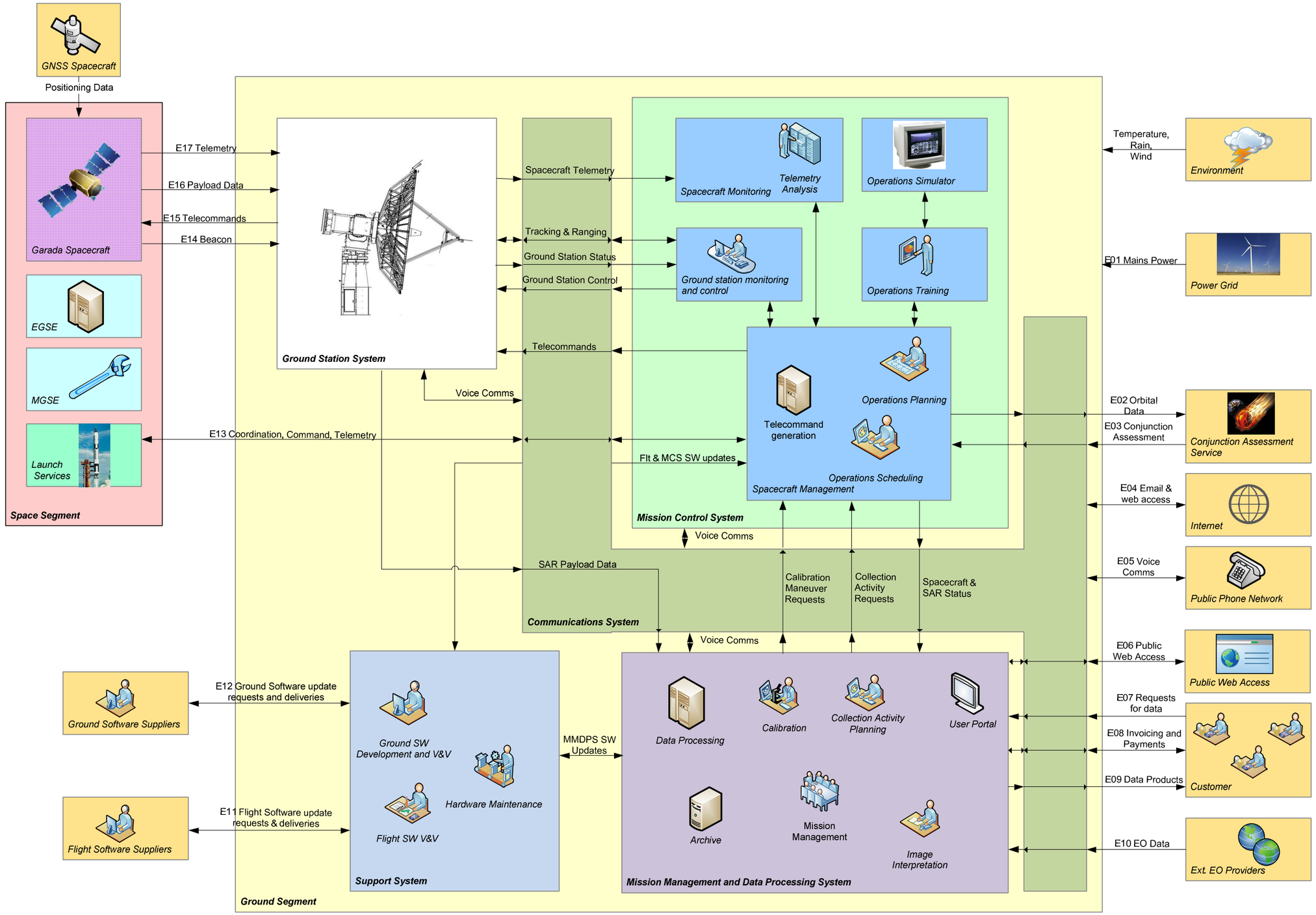


Figure 3: External Interfaces