SOLAR SYSTEM RESEARCH INFRASTRUCTURE REQUIREMENTS TECHNICAL NOTE

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1. INTRODUCTION

The aim of SpaceGRID in the Solar System Research (SSR) domain is to remove the barriers that currently limit the efficient analysis of distributed data by providing a framework for uniform access to, and manipulation of, local and distributed data sources. The SpaceGRID should not only endeavour to enable research that could not be done before. It should also facilitate analyses that up to now have been very difficult, but not impossible, by reason of data or information inaccessibility, or have only been possible by a chosen few by reason of resource limitations. The SSR part of SpaceGRID is, therefore, not only about handling large amounts of data or providing large scale high performance computing, but is equally about facilitating the handling of small but complex and diverse amounts of data. In the short-term the federation of existing SSR resources will result in improved and faster science return. Longer-term SpaceGRID will encourage the standardisation of design, promoting re-use of analysis systems, long-term security of data and reduced overall cost.

1.1 PURPOSE OF THE DOCUMENT

Task 5 of [SPCGRD-SOW] called on the SpaceGRID consortium to establish the requirements, assess the benefits and evaluate the implementation options for ESA development of a collaborative data analysis system for the Solar System Research community. The purpose of this document is to establish infrastructure requirements for the SSR portion of SpaceGRID.

Where appropriate a distinction is made between the infrastructure requirements “optimistic” and “realistic” scenarios defined in [SPCGRD-SSSR].

This document is issued in draft form for the User Requirements Review with first issue due for the Infrastructure Requirements Review.

1.2 DEFINITION, ACRONYMS AND ABBREVIATIONS

1.2.1 Acronyms

API	Application Programming Interface
CDF	Common Data Format
CD-ROM	Compact Disc – Read Only Memory
DBMS	Data Base Management System
ESA	European Space Agency
ESTEC	ESA Technology Centre
EU	European Union
FITS	Flexible Image Transport System
FTP	File Transfer Protocol
HPC	High Performance Computing
IDL	Interactive Data Language
ISTP	International Solar Terrestrial Physics
OGSA	Open Grid Service Architecture
OODT	Object Oriented Data Technology
PDS	Planetary Data System
RAID	Redundant Array of Independent Disks
RAL	Rutherford Appleton Laboratory
SCT	Special Conditions of Tender

SCSI	Small Computer Systems Interface
SOW	Statement Of Work
SP	Small Projects
SPCGRD	SpaceGRID
SSL	Science Systems Limited
SSR	Solar System Research
STP	Solar Terrestrial Physics
STPDF	STP Data Facility
UK	United Kingdom
US/USA	United States
WP	Work Package
WWW	World Wide Web
XDF	eXtensible Data Format
XML	eXtensible Markup Language

1.3 REFERENCES

1.3.1 Applicable Documents

[SPCGRD-SCT] AO/1-3863/01/I-LG, Invitation To Tender – Study of GRIDS and Collaborative Environments for Space Application – Appendix 3 – Special Conditions of Tender

[SPCGRD -SOW] AO/1-3863/01/I-LG, Invitation To Tender – Study of GRIDS and Collaborative Environments for Space Application – Appendix 1 - Statement of Work

[SPCGRD-PROP] P-A876/USA/PT-656-01, Is. 1.1, Proposal for “Study of GRIDS and Collaborative Environments for Space Application (SpaceGRID)”

[PSS5-SP] BSSC(96)2 Issue 1, Guide to applying the ESA software engineering standards to small software projects

1.3.2 Reference Documents

[GRID] I. Foster and C. Kesselman, Eds., The GRID Blueprint for a New Computing Infrastructure, Morgan Kaufmann, 1999

[SPCGRD-URSR] Solar System Research User Requirements Document, SGD-SSR-RAL-REQ-001, April 2002.

[SPCGRD-SSSR] Solar System Research System Specification Technical Note, SGD-SSR-RAL-SSTN-005, April 2002.

[CSDSNTFR] Cluster II Project, CSDS Network Task Force Report, CL-EST-RP-2025, February 1999.

[APACHE] http://www.apache.org/

[GEEKLOG] http://geeklog.sourceforge.net/

[OGSA] http://www.globus.org/ogsa

[OPENBB] http://www.openbb.net/

[TWIKI] http://twiki.org/

1.4 OVERVIEW OF THE DOCUMENT

The structure of this document is as follows.

- Section 2 describes the general infrastructure for the Solar System Research domain. In particular it provides an overview of the current status of the infrastructures used within the SSR domain and what is required for the “optimistic” and “realistic” scenarios of SpaceGRID.
- Section 3 lists the specific infrastructure requirements resulting from the User Requirements [SPCGRD-URSR] and draft system specification [SPCGRD-SSSR]. A set of orthogonal qualifiers has been assigned to assist with the requirement categorisation.

2. GENERAL DESCRIPTION

This section describes the general infrastructure for the Solar System Research domain. In particular it provides an overview of the current status of the infrastructures used within the SSR domain and what is required for the “optimistic” and “realistic” scenarios of SpaceGRID.

2.1 CURRENT SITUATION WITHIN SSR.

The SSR domain consists of a heterogeneous set of widely distributed resources based mainly on standard, commercial off the shelf, computing equipment and linked via the public (academic/research) internet. Existing infrastructure can be categorised as follows.

- Large archive sites – These are generally based on relatively high cost, mid-range workgroup servers, or better, large RAID systems and automated tape robots. They may make use of commercial DBMS and hierarchical storage management systems. Network links are supported by high-speed links on to the institutions backbone. The archive will usually have dedicated system management, technical and science support staff.
- Research groups and small archives – Usually based on high-end workstations or entry-level workgroup servers. RAID storage may be used but ad-hoc addition of standalone disks is more common. Tape systems are used for system and data backup but may require operator intervention to change tapes. Network connectivity is provided by standard 10/100 Mbit shared with the local workgroup. Support staff are usually part time (i.e. shared with other projects/activities).
- Users – Desktop based PCs and Linux/Unix workstations with good graphics capabilities. Standard IDE or SCSI disks provide local storage. 10/100 Mbit Ethernet, shared with the local workgroup, provides network access. Increasingly, security measures, such as site firewalls, are being used to restrict external access to user level machines. System and technical support are provided by central group or institution resources.
- Modellers – Dedicated High Performance Computing (HPC) or Low Cost Massively Parallel Processing (LCMPP) systems. Configurations in terms of memory, number of nodes and node-to-node inter-connects, are tailored to the specific requirements of the model. External access is provided through a master node that has similar characteristics to the research group servers described above.

In all categories external network access is typically via site backbone linked onto high-speed national and international academic/research networks. SSR data volumes are generally small compared to some of the other domains. The largest volumes are from the network distribution of raw instrument data (up to a few GB per day per instrument). With the exception of modelling activities, processing requirements are currently fairly modest with most work being done at the desktop. However, this is partly the result of the interoperability problems that SpaceGRID is aiming to solve. For example, combining data from several long time period data sets to look for correlations might involve processing 100’s GB of data. Currently, this is only practical for users that have direct access to the data, either because they are co-located with the relevant archive or they have the data on hard media that can be mounted locally.

2.2 SSR SPACEGRID – OPTIMISTIC SCENARIO

The proposed SSR SpaceGRID is based on the development of a new support infrastructure. It will promote collaborative working within the domain by providing services to aid the location and interoperability of existing and future resources supplied by the community. Since this is the development of a new infrastructure, rather than the GRID enabling of an existing application, we require a top-level view of the system that satisfies the user requirements [SPCGRD-URSR] in order to assess the infrastructure requirements. For this purpose we have used the proposed architecture as defined in [SPCGRD-SSSR], see Figure 2- 1.

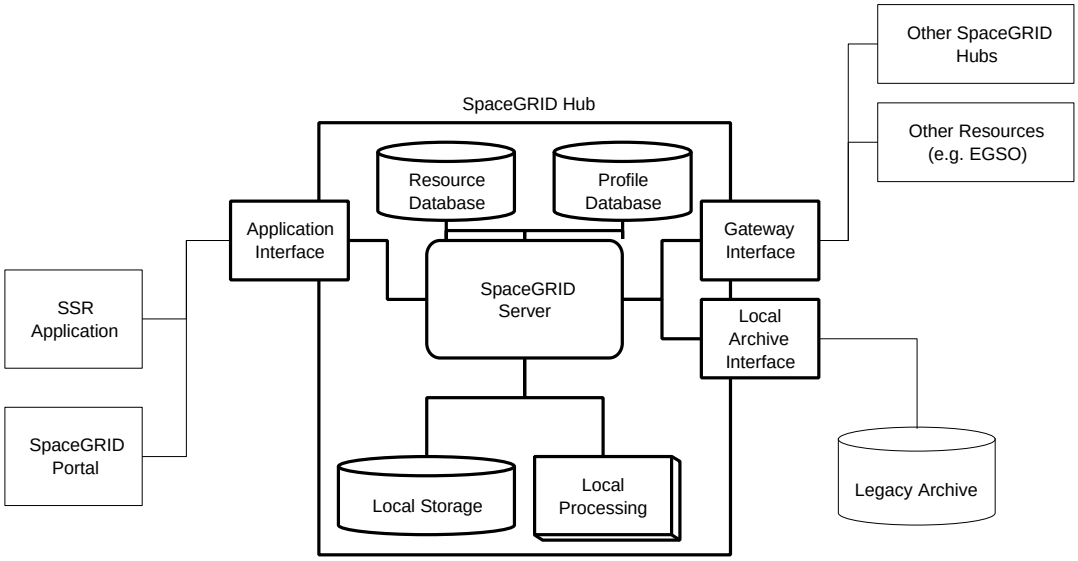

Figure 2- 1: Possible architecture of SSR SpaceGRID from [SPCGRD-SSSR]

The system can be split into two parts consisting of the SpaceGRID hubs that form the underlying services and the SpaceGRID portal, which is an application making use of these facilities. We consider infrastructure requirements for these two components in the following sections.

2.2.1 SpaceGRID Hub

The hubs constitute the core of the SSR SpaceGRID infrastructure. They handle, either directly, or through control of remote resources;-

- Resource and user management
- Authentication and access control
- Archive Interfaces
- Query handling & execution,
- Pre-delivery processing
- Standalone processing
- Inter-hub & application interfaces.

The processing demands on the system vary considerably based on the type and complexity of query or processing being undertaken, and on the number of concurrent users. However, the main issues to be addressed by the SSR SpaceGRID are interoperability rather than the delivery of high performance computing. A SpaceGRID hub shall require a minimum of a high-end workstation or

entry-level workgroup server running Linux (kernel 2.4 or later) or Sun Solaris (version 8 or later) (IR-SSR-HW-001). HPC is important for modelling tasks, but these are specialised activities run on dedicated hardware. For the purpose of the SSR SpaceGRID, HPC systems are considered to be analogous to legacy archives, requiring middleware interfaces to be developed for their use (IR-SSR-MW-001).

The data manipulation, translation and previewing tasks to be carried out by the hubs are memory intensive, particularly when multiple parallel sessions are operating concurrently. A SpaceGRID hub should have a minimum of 1 GB of physical memory to support memory intensive data processing and data mining tasks (IR-SSR-HW-002). From the user requirements analysis [SOCGRD-URSR] the typical size of current data requested was estimated to be between 10-100 MB range, with a small number of requests being in excess of a 1 GB. The SpaceGRID is planned to facilitate the combining of data sets so the overall size of requests is expected to increase. But, SpaceGRID is also intended to allow greater flexibility in the selection of data (i.e. data mining). This should allow users to focus their request thus minimising the delivered volume. A SpaceGRID hub shall provide a minimum of 50 GB of high-speed storage for temporary files and local caching (IR-SSR-HW-003). A SpaceGRID hub should provide a minimum of 200 GB of RAID-5 storage for results and user uploaded resources (IR-SSR-HW-004). The archive interfaces will need to translate data from the format used by the legacy archive to a standard format used by SpaceGRID and will need resources to hold both versions during this process. A SpaceGRID archive interface shall have dedicated storage allocated for the data translation function (IR-SSR-HW-005). The size will vary significantly depending on the volume and type of products supplied by the archive. Where possible SpaceGRID hubs should be located at large archives to support local processing capabilities and minimise network transfers (IR-SSR-OR-001).

Reliability and redundancy are important factors for the hubs, which will be expected to provide a high availability service. A SpaceGRID hub should make use of any automated system monitoring, diagnostic, hot-swap and automated recovery facilities provided by the hardware to maximise the availability of the system (IR-SSR-HW-006). Since the SpaceGRID will be responsible for holding user-supplied resources, infrastructure is required to ensure the integrity of these data. The use of RAID storage provides protection against single point failures but is insufficient for more dramatic system failures. A SpaceGRID hub shall have an automated offline storage system capable of completing a full backup of all system and user resources within an elapsed time of 24 hours (IR-SSR-HW-007). System support staff shall be available at the site of each SpaceGRID hub for system monitoring, administration, configuration and security (IR-SSR-OR-002). SpaceGRID technical support staff shall be available to assist with the development of new interfaces, gateways and resources (IR-SSR-OR-003).

SpaceGRID will need to transfer large (but not huge) volumes of data between widely distributed data facilities and users. High-speed dedicated links between the hubs is a possibility but is not expected to be cost effective unless already planned for other purposes. This was the experience from the distributed Cluster Science Data System (CSDS) that was based on dedicated links for the original Cluster mission. After a detailed investigation [CSDSNTFR], CSDS moved to the use of the public internet for Cluster II. Institutions hosting a SpaceGRID hub shall have good connectivity to national academic/research networks and from there onto international networks (IR-SSR-NW-001). The internal network throughput within the institutions hosting hubs shall be sufficiently high so as not to impose bottlenecks in the overall system connectivity (IR-SSR-NW-002). This is not just a question of the link speed; 100 Mb is now standard even on low-end equipment and gigabit is becoming more widely available. It is also important to ensure that the network topology at the local workgroup level or firewalls at the institution level do not pose a limitation. To minimise

unauthorised system intrusion, a SpaceGRID hub shall have all non essential network services disabled (IR-SSR-NW-003).

A standard set of middleware, installed at each SpaceGRID hub, shall be used to provide general communication, resource management, user authentication and system monitoring functions (IR-SSR-MW-002). The specification of this middleware is one of the main activities in the infrastructure definition phase of this study. The middleware for the SSR SpaceGRID is likely to consist of a combination of:-

- GRID based toolkits such as [GLOBUS], [OGSA] and possibly Web Services (IR-SSR-MW-003)
- General middleware components such as Java, DBMS for resource database handling, plotting libraries for simple previews. (IR-SSR-MW-004)
- Domain specific systems such as STPDF, and associated support libraries (e.g. CDF, FITS and XML/XDF). (IR-SSR-MW-005)

The [SPCGRD -SOW] requires that the middleware should be open source (IR-SSR-MW-006).

Application software run within the hub will fall into three categories:-

- General software for data processing and visualisation that is open source and shall be installed on all SpaceGRID hubs as part of the common infrastructure. (IR-SSR-SW-001)
- Domain specific software that may require specific resources in order to run and so will not be installed at every hub. For example SolarSoft will only run on systems running IDL. (IR-SSR-SW-002)
- User supplied software. (IR-SSR-SW-003)

2.2.2 SpaceGRID Portals

SpaceGRID portals are web servers providing single point access to the services and facilities provided by the SpaceGRID infrastructure. Portals may provide general access to the SpaceGRID or may be tailored to support a particular activity. A standalone SpaceGRID portal shall require a minimum of a low-end server, with 512MB of memory, 50 GB storage and running Linux (kernel 2.4 or later) or Sun/Solaris (version 8 or later) (IR-SSR-HW-008).

A SpaceGRID portal should have the same level of network connectivity as specified for a SpaceGRID hub (see IR-SSR-NW-001 and IR-SSR-NW-002) (IR-SSR-NW-004).

A SpaceGRID portal shall use the [APACHE] (version 1.3 or later) web server (IR-SSR-SW-004). The portal should support a set of general collaboration tools (e.g. [GEEKLOG], [OPENBB] and [TWIKI]) (IR-SSR-SW-005).

Interoperability between a portal and the associated SpaceGRID hub shall be via the SpaceGRID API (IR-SSR-MW-007). Where possible SpaceGRID portals should be located with SpaceGRID hubs to take advantage of the common infrastructure (IR-SSR-OR-004).

The portal client machine shall be running Internet Explorer (version 5 or later), Netscape (version 4 or later), or equivalent web browser with Java support (IR-SSR-SW-006). The client machine should have sufficient local storage to download the requested data (IR-SSR-HW-009). The client should have a good connection on to the public internet in order to download large requests in a reasonable time (IR-SSR-NW-005).

2.3 SSR SPACEGRID – REALISTIC SCENARIO

The main difference between the infrastructure requirements for the realistic and optimistic scenarios as described in [SPCGRD-SSSR] are:-

- The realistic scenario will only provide archive interfaces for a small number (3, TBC) of data sets.
- The realistic scenario will only implement three hubs, which are the minimum number required to properly assess the benefits of the architecture in terms of distributed queries and communications.
- Some detailed functionality will not be fully implemented in the realistic scenario.

The specification of individual components between the two scenarios will not differ greatly. The intention is that the realistic scenario could be incrementally scaled towards the optimistic case (by adding additional archive interfaces and/or hubs) as and when the necessary resources and community participation become available.

3. INFRASTRUCTURE REQUIREMENTS

This section lists the specific infrastructure requirements defined in Section 2. A set of orthogonal qualifiers has been assigned to assist with the requirement categorisation.

The infrastructure requirements will be numbered in the following way:

IR-SSR-ty-num

ty: one out of these values

HW: Hardware

NW: Network

FW: Firmware

MW: Middleware

SW: Application Software

OR: Organisational

The orthogonal qualifiers are:

FB: Fabric

ST: Storage

WM: Workload Management

DM: Data Management

MN: Monitoring

DE: Development Environment

SC: Security

GR: GRID

LC: LCMPP

3.1 HARDWARE

IR-SSR-HW-001	FB	A SpaceGRID hub shall require a minimum of a high-end workstation or entry-level workgroup server running Linux (kernel 2.4 or later) or Sun Solaris (version 8 or later).
IR-SSR-HW-002	FB	A SpaceGRID hub should have a minimum of 1 GB of physical memory to support memory intensive data processing and data mining tasks
IR-SSR-HW-003	FB, ST	A SpaceGRID hub shall provide a minimum of 50 GB of high-speed storage for temporary files and local caching
IR-SSR-HW-004	ST	A SpaceGRID hub should provide a minimum of 200 GB of RAID-5 storage for results and user uploaded resources
IR-SSR-HW-005	FB, ST	A SpaceGRID archive interface shall have dedicated storage allocated for the data translation function
IR-SSR-HW-006	MN	A SpaceGRID hub should make use of any automated system monitoring, diagnostic, hot-swap and automated recovery facilities provided by the hardware to maximise the availability of the system
IR-SSR-HW-007	FB, ST	A SpaceGRID hub shall have an automated offline storage system capable of completing a full backup of all system and user resources within an elapsed time of 24 hours
IR-SSR-HW-008	FB	A standalone SpaceGRID portal shall require a minimum of a low-end server, with 512MB of memory, 50 GB storage and running Linux (kernel 2.4 or later) or Sun/Solaris (version 8 or later)
IR-SSR-HW-009	FB, ST	The client machine should have sufficient local storage to download the requested data

3.2 NETWORK

IR-SSR-NW-001	FB	Institutions hosting a SpaceGRID hub shall have good connectivity to national academic/research networks and from there onto international networks
IR-SSR-NW-002	FB, SC	The internal network throughput within the institutions hosting hubs shall be sufficiently high so as not to impose bottlenecks in the overall system connectivity
IR-SSR-NW-003	SC	To minimise unauthorised system intrusion, a SpaceGRID hub shall have all non essential network services disabled
IR-SSR-NW-004	FB	A SpaceGRID portal should have the same level of network connectivity as specified for a SpaceGRID hub (see IR-SSR-NW-001, IR-SSR-NW-002 and IR-SSR-NW-003)
IR-SSR-NW-005	FB	The client should have a good connection on to the public internet in order to download large requests in a reasonable time

3.3 FIRMWARE

No requirements

3.4 MIDDLEWARE

IR-SSR-MW-001	FB	For the purpose of the SSR SpaceGRID, HPC systems are considered to be analogous to legacy archives, requiring middleware interfaces to be developed for their use
IR-SSR-MW-002	GR	A standard set of middleware, installed at each SpaceGRID hub, shall be used to provide general communication, resource management, user authentication and system monitoring functions
IR-SSR-MW-003	WM, DM, MN, SC, GR	Middleware – use of GRID based toolkits such as GLOBUS, OGSA and possibly Web Services
IR-SSR-MW-004	WM, DM,	Middleware – use of general middleware components such as Java, DBMS for resource database handling, plotting libraries for simple previews.
IR-SSR-MW-005	FB, WM, DM,	Middleware – use of Domain specific systems such as STPDF, and associated support libraries (e.g. CDF, FITS and XML/XDF).
IR-SSR-MW-006	GR	The [SPCGRD -SOW] requires that the middleware should be open source
IR-SSR-MW-007	WM, DM, SC	Interoperability between a portal and the associated SpaceGRID hub shall be via the SpaceGRID API

3.5 APPLICATION SOFTWARE

IR-SSR-SW-001	FB, WM, DM	Application software – use of general software for data processing and visualisation that is open source and shall be installed on all SpaceGRID hubs as part of the common infrastructure.
IR-SSR-SW-002	WM, DM	Application software – use of domain specific software that may require specific resources in order to run and so will not be installed at every hub. For example SolarSoft will only run on systems running IDL.
IR-SSR-SW-003	WM, DM, DE, SC	Application software – use of user supplied software
IR-SSR-SW-004	FB	A SpaceGRID portal shall use the [APACHE] (version 1.3 or later) web server
IR-SSR-SW-005	FB, GR	The portal should support a set of general collaboration tools (e.g. [GEEKLOG], [OPENBB] and [TWIKI])
IR-SSR-SW-006	FB	The portal client machine shall be running Internet Explorer (version 5 or later), Netscape (version 4 or later), or equivalent web browser with Java support

3.6 ORGANISATIONAL

IR-SSR-OR-001	FB, WM	Where possible SpaceGRID hubs should be located at large archives to support local processing capabilities and minimise network transfers
IR-SSR-OR-002	FB, MN, SC	System support staff shall be available at the site of each SpaceGRID hub for system monitoring, administration, configuration and security
IR-SSR-OR-003	FB, DE	SpaceGRID technical support staff shall be available to assist with the development of new interfaces, gateways and resources
IR-SSR-OR-004	FB, WM	Where possible SpaceGRID portals should be located with SpaceGRID hubs to take advantage of the common infrastructure

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