DEVELOPMENT AND CAPABILITIES OF A FUTURE SPACE DEBRIS PORTAL

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ABSTRACT

Web based information and data distribution services are currently widely used in all technical and scientific areas. In the past, several resources for accessing information and data in the area of space debris have been developed. However, a single and widespread entry point which provides an up-to-date overview and interfacing of data from these valuable resources is still non-existent. This paper demonstrates the possibilities of applying a software infrastructure similar to the approach used in ESA's Space Weather Network (SWENET) to a future European Space Debris Portal.

1. INTRODUCTION

1.1. Motivation of a Space Debris Portal

The main objective of a Space Debris Portal would be to provide a central access point for finding information, services and data related to space debris. The users of such a portal would include the scientific community and industry, but also non-scientific users like press and outreach services. A similar concept is currently being applied in the area of Space Weather, with the establishment of the Space Weather European Network (SWENET) in the frame of ESA's Space Weather Pilot Project. Furthermore, the future development of an Impact Test Results Database for the support and coordination of high velocity impact tests leads to the perspective of networking in the space debris community.

A future Space Debris Portal would provide access to:

- Existing databases and data sets
- Current space debris models
- Standards and guidelines
- Services and applications

In this paper, the technical principles of combining a database and a generic portal for services and models are described, demonstrating its capabilities and advantages to the user.

1.2. Existing Resources

In the past, several resources containing space debris information and data have been developed. The following list gives an overview of the capabilities of the most relevant ones.

- EDID (European Detector Impact Database) (Bunte, 2004) provides access to a database for all relevant science and housekeeping data from the space debris detectors GORID and DEBIE-1 (and DEBIE-2 in the future) (Kuitunen, 2001). The users can use its sophisticated web-interface for searching the database using complex queries. The interface also offers plotting capabilities for data analysis and display.

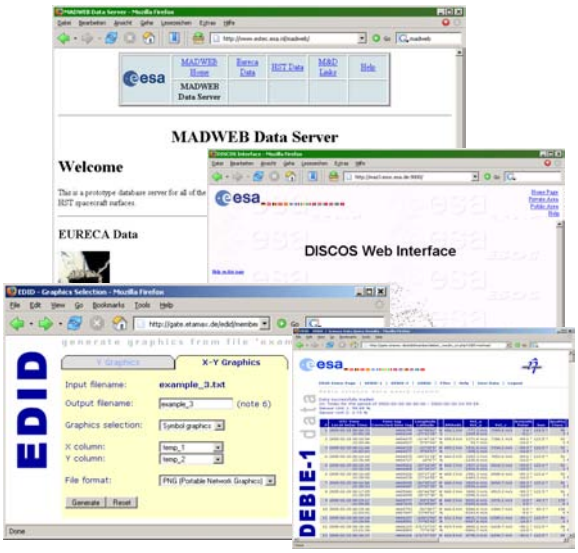

Figure 1. A large number of data and information resources on space debris are currently available and wound strongly benefit from a common infrastructure

- DISCOS (Database & Information System Characterising Objects in Space) (Caballero, 2001), operated by the European Space Operations Centre (ESOC), enables users to retrieve information on a variety of data associated with space activities, including space debris and space flight data. DISCOS contains information on the characteristic of practically all objects ever launched into Earth orbit. The scope of data covers launch information, object registration details, launch vehicle descriptions, spacecraft information (e.g. size, mass, shape, mission objectives, owner), as well as orbital data for all trackable, unclassified objects. Its ever growing database is kept up-to-date with input data from many different sources. DISCOS also offers a remote web interface for ESA's MASTER space debris model (Bendisch, 2002).

- IADC homepage. The primary purposes of the Inter-Agency Space Debris Coordination Committee are the of exchange information on space debris research activities between member space agencies, to facilitate opportunities for cooperation in space debris research, to review the progress of ongoing cooperative activities, and to identify debris mitigation options. Its homepage is meant to act as a communication platform for the IADC member agencies, and includes reports and information on international activities.
- MADWEB (Micrometeoroid & Debris Database) provides access to the different data sets which have been accumulated through various ESA-funded micrometeoroid and debris activities and in-house analyses. The data sets are available thought a web-interface and cover work performed during post-flight analysis on material recovered from the EURECA and HUBBLE spacecraft.
- ESA's Impact Tests Results Database is currently in development and will be a web-based database platform containing all available hypervelocity impact test data in Europe related to experimental micro-meteoroid and space debris impact simulation. Its main objective is to facilitate the analysis and design of spacecraft configurations with regard to pace debris effects and the coordination of future impact test studies.

These resources provide the users with relevant and up-to date data, and are widely used in the space debris community. However they all work individually. The user would greatly benefit from a portal providing a centralised access to these resources as well as common functionalities combining information from several or all of them.

1.3. Capabilities needed

The idea of a Space Debris Portal as presented here is intended to be much more than just a central webpage with links to external resources. It involves a complete software infrastructure fulfilling a series of user requirements common to most scientific communities. These requirements result from the needs of the users for certain "standardised" capabilities and can be grouped into the following categories:

- Data services: The infrastructure should provide access to a centralized database containing data extracted from the different external sources. This would allow the user to access, compare and download combined data from different sources. This could be e.g. impact data from different impact detectors.
- Applications: The Space Debris Portal infrastructure could also provide useful online tools like models, damage assessment tools, orbit predictions, etc. The implementation of these tools could be implemented in various ways. The tools could be executed on the server upon demand from the clients. Alternatively, the tools or models could be run for a series of parameter grids and the results stored into a database providing a series of look-up tables
- Search tools: An important function of the Space Debris Portal would be to facilitate access to specific information and web pages in the space debris domain. To fulfill this task, it should include flexible search tools considering the different expectations of each user group. A scientific user might be interested in data from impact detectors, while a user from the industry might be looking for documentation on standards and procedures. This would be solved through tailored "access paths", which classify the information displayed on the portal according to the category selected by the user.

These capabilities can be implemented independently of each other. The search tools would represent the most basic services, while the integration of on-line applications offers the most complex capabilities and would therefore require a greater development effort.

2. CONCEPT AND TECHNICAL APPROACH

eta_max space has developed a software infrastructure for the space weather community fulfilling similar requirements to those of the space debris portal.

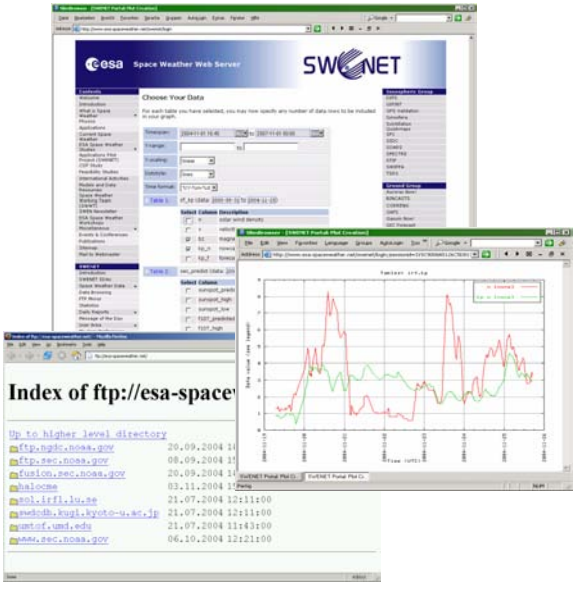

Figure 2. The SWENET infrastructure (http://www.esa-spaceweather.net/swenet) provides a central access point for space weather data and services.

The web-based infrastructure for ESA's Space Weather Network SWENET provides access to continually updated data generated by detectors, scientific institutions and software models. It also includes a search engine for a series of services developed to support those users affected by space weather. The data and services provided in SWENET are generated by resources both external and internal to the infrastructure.

In order to cope with all requirements resulting for such a portal, a three-tier architecture was implemented. This is a well tested approach which has proved to be very flexible and would also be used for the implementation of the Space Debris Portal.

2.1. The 3-tier architecture

The software for the space debris portal would consist of the following components:

- The Database Tier formed by two databases :
  - The space debris database contains numerical and binary data (e.g. images) extracted through the data interface from the external resources. The data would be automatically extracted at regular intervals from the different sources and processed as required in order to store it into the database. Thus the database would be basically a mirror of those resources integrated into the database.
  - The application/user database contains information on how to run the tools through the application tier and the user settings.

  This separation is due to scalability; especially, due to the volume required for the space debris data which may require a separate server. The data in the Application/User DB describes both user access and application requirements. This includes information on how to feed the application with the appropriate input files and command parameters, as well as how to display the results to the user.

- The Application Tier provides the interfaces to tools and services. This includes both internal tools (running in the portal server) and external tools (running on other servers). The applications can be either web based applications (i.e. already operating on browser level with database accesses) or file based application (i.e. reading input files and writing result files). An input/output layer, called the simulator, handles the various applications, generating the input parameters from the user input and the information stored in the application database. It also post processes the results into concrete physical objects (e.g. files, database tables) which are either stored in the Space Debris Database or displayed through the web interface. The design has no specific restrictions on user interface technologies; however, usage of servlet technology is preferred, as it offers a seamless integration into common web-browsers.

- The Interface Tier consisting of two component:
  - The external resource data interface, responsible for automatically extracting data from external resources
  - The user interface, providing access to the data and resources through the web.

  The external resource data interface consists of several interface modules. Each module accesses only one external resource and stores data into the Space Debris Database. This approach ensures flexibility from the operational and development point of views, since failure of one module will not prevent the operation of other modules. It also facilitates scalability since the number of interface modules can grow according to the number of external resources.
  The user interface layer uses an Apache / Tomcat servlet engine and facilitating access through the internet through both servlets and static html-files.

Figure 3 shows the relations between the different components described above.

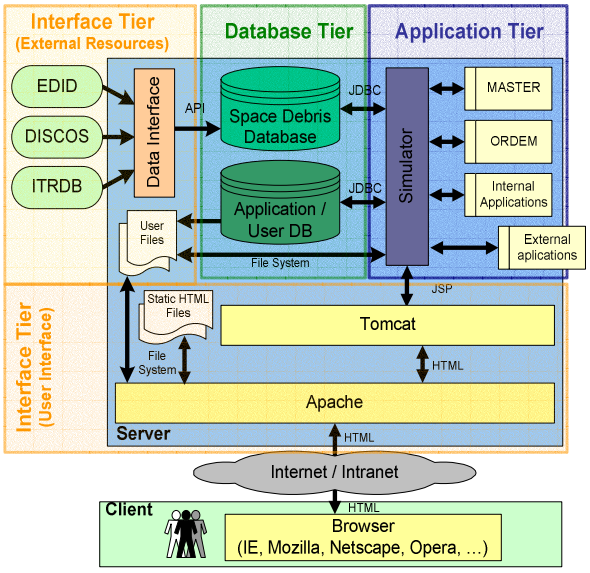

Figure 3. The approach for the development of the portal would involve a three-tier architecture.

2.2. Main advantages of the SWENET approach

The use of a common infrastructure would allow the development of complex technical solutions which could otherwise not be implemented individually for each source. The approach presented here offers advan-

tages to both the user community and the operators and developers of existing space debris resources. The main advantages are:

- The replication of data into a common database offers the possibility to combine and analyse data from separate sources. E.g. a single search query could provide a table with combined results from the EDID database and the MADweb data server.
- The infrastructure could offer sophisticated common graphic tools which are not available from the individual data providers. These graphic tools could be used for plotting both data mirrored in the database and results from tools integrated into the infrastructure (e.g. space debris models).
- The intended approach is very flexible and can be adapted to the different types of existing resources with minimum or no effort on the side of the developers or administrator of the resources integrated into the portal.
- FTP and direct SQL access allows data users and to automatically access the data through software interfaces. Developers could implement interfaces for the automated download of input data for analysis tools in the future.
- Those web-pages and resources integrated into the portal could benefit from common services for their users, like email alerts about new updates, regular delivery of data or daily email reports. Back-up and archive services would also be provided.

3. CONCLUSIONS AND OUTLOOK

Current efforts for coordination of space debris activities (i.e. IADC) would greatly benefit from the capabilities of a common infrastructure. While the development of tools like ESA's Impact Tests Results Database which will store data from most European high velocity impact experiments is already a step in the right direction, the space debris community could greatly benefit from a more ambitious Space Debris Portal. This web-based infrastructure would present a central access to distributed data resources and services and offer its users a series of capabilities not available individually from those sources. The development of a software infrastructure following the generic approach developed by eta_max space would result in a flexible and user friendly front-end for existing and future space debris resources, independently of their source. Its open ended architecture would minimise the effort needed to integrate disparate sources and allow it to cope with any current or future development.

4. REFERENCES

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DISCOS (Database & Information System Characterising Objects in Space), web interface available at http://mas3.esoc.esa.de:9000/

IADC Homepage (Inter-Agency Space Debris Coordination), available at http://www.iadc-online.org/

MADWEB Data Server, web interface available at http://www.estec.esa.nl/madweb/

SWENET Space Weather Network Infrastructure, available at http://www.esa-spaceweather.net/swenet