

INTERNATIONAL SPACE STATION(ISS)/COLUMBUS STRATEGIC AND TACTICAL PLANNING SUPPORT TOOLS PROTOTYPE

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ABSTRACT. The paper describes the results of the project "Strategic and Tactical Planning Support Tools Prototypes", conducted by SSI for ESA. It first presents an overview of the planning process as it is being developed for the ISS. Then, the prototypes of two Strategic and Tactical Planning support tools are described. The first prototype allows a what-if assignment of resources per year to the individual European level 1 payloads, starting from initial allocations. It allows different planning scenarios to be maintained in parallel, of which one can be selected as baseline for a particular year. The resources associated with a baselined scenario can be exported as files in different formats. The second prototype investigates the implementation of a World Wide Web (WWW) front-end to the planning databases, to minimize the efforts needed to compile user inputs to the planning process, and to provide a simple way of distributing the results of the planning process to the user community at large.

1. INTERNATIONAL SPACE STATION PLANNING PROCESS

The planning process adopted for the International Space Station is a multi-layered approach with progressive detail and complexity in the individual layers. The planning process has both a multi-lateral contents, and a partner-specific one. The results of the most recent developments in the definition of the Space Station planning process are listed below.

The multi-increment planning is the beginning of the planning process. It deals with transportation system planning and the maintenance of the overall Space Station capabilities. The main outputs of this process are the Multi-Increment Manifest (MIM), and the Operations Summary (OS). The MIM identifies the up- and down-load transportation support to the Space Station for crew support, maintenance and logistics, utilization, and consumable resupply. The OS summarizes the capabilities of the Space Station over the years to come, based on the MIM and other supporting services, and the accommodation capabilities of the Space Station.

The OS and MIM are used by strategic planners to provide long-range, high level direction and guidance for Space Station operations and utilization. They formally establish and control ISS resource capabilities and allocations, approved payload lists, increment start and end dates, servicing and resupply schedule, and Earth To Orbit (ETO) vehicle cargo manifests. The strategic planning process results are documented in the annually published Consolidated Operations and Utilization Plan (COUP), which normally covers the upcoming 5 strategic planning periods.

The COUP drives the tactical planning process which deals with the management of critical activities and resources necessary to plan and implement the operations, utilization and maintenance of the Space Station. It refines and integrates the definition and requirements for a specific increment. (An increment is defined as the period between two designated ETO vehicle visits.) The main results of this process are the Increment Definition and Requirements Documents (IDRDs), which contain the objectives, requirements, and allocations for each of the increments, and the On-orbit Operations Summary (OOS) which assigns system and payload operations activities to individual periods of nominally a week.

The final step in the planning process is to prepare the planning products needed to conduct Space Station real time operations. The principal output of this step is the short term plan, from which are derived the ISS On-board Short Term Plan (O-STP), the COF Master TimeLine (MTL), the crew activity plan, the various ground activity plans, and the resource allocation plan. The O-STP and MTL are time ordered sequences of commands/automated-procedures which are uplinked to the Space Station and executed automatically by the appropriate on-board systems.

ESA's involvement in the Space Station has changed significantly over the last several years and now also includes the provision of space transportation services (through the ATV). Within the context of the ISS programme, ESA will be responsible for performing element-related planning activities in Europe as part of the overall ISS planning process, as well as participate in the relevant multi-lateral planning teams residing at JSC and MSFC. To ensure effective long and medium range management of ESA's involvement in the Space Station programme, tools will have to be developed to support the strategic and tactical activities.

2. STRATEGIC AND TACTICAL PLANNING SUPPORT TOOL PROTOTYPE

A candidate tool identified to support ESA's planning activities is the Strategic and Tactical Planning support Tool (STPT). The purpose of the STPT is to help ESA's strategic and tactical planners during the planning process by providing the following functionality: access to databases relevant to the planning process; import of strategic and tactical parameters; "what-if" assignment of resources; electronic exchange of data with related applications. The subset of the STPT functionality implemented in the current STPT prototype is described in the following.

The STPT prototype runs on an IBM-compatible PC running Microsoft Windows version 3.1 or later. The STPT prototype has been developed using the Visual Basic tool version 3.0. The STPT prototype uses a database to store data, based on Microsoft Access Database Management System version 1.10, which is the native format for data storing in Visual Basic. The prototype can be used in a multi-user environment if a shareable network drive is available, on which the prototype executable file, the report files, and the database file have to reside.

Four types of users of the current STPT prototype have been defined: strategic utilization user, strategic system user, strategic generic user, and tactical user.

The strategic utilization user is the only one authorised to insert payload strategic parameters, while the strategic system user is the only one authorised to insert system strategic parameters. The strategic generic user cannot insert neither of the strategic parameters. These are the only differences existing in the way the prototype can be used by the different strategic users. All the other strategic functions provided by the STPT prototype are accessible by all the categories of strategic users.

Since the current STPT prototype does not implement any of the tactical planning functions, the only task the tactical user can perform up to now is the inspection of the CPDB data and viewing the ISSA capabilities and strategic assignments.

Once the user has started the prototype, the window shown in figure 1 is displayed, which is the prototype main window. This window shows three distinct frames, one for each of the main tasks the users can perform: Inspect Data Bases; Insert/Review Strategic Data; Assign Operation Activities.

The upper left frame of the main window, entitled "Inspect Data Bases", contains 6 icons representing the following databases: User Mission Data Base (UMDB), Strategic Planning Tool Data Base (SPT DB), Columbus Payload Data Base (CPDB), Tactical Planning System Data Base (TPS DB), On-orbit Operations Summary Data Base (OOS DB), .. (place holder).

The only database accessible for inspection through the prototype is the CPDB. It has been implemented as a full read-only access to data exported from the CPDB. The logic implemented to access the CPDB data follows as far as possible the logic implemented in the original CPDB application. The access to the other databases mentioned, all of which are NASA databases, has not been implemented in the prototype since their structure was being defined or modified at the time of the prototype implementation.

The upper right frame of the main window, entitled "Insert/Review Strategic Data", allows the user to perform yearly assignment of resources to overall system and utilization. It contains the following two command buttons: ISSA Capabilities and Strategic Parameters. The "ISSA Capabilities" button allows the user to edit/view the total capabilities provided by the ISSA and the supporting services for each year for all the partners and at partner level. The "Strategic Parameters" button allows the user to edit/view the system and payload strategic parameters.

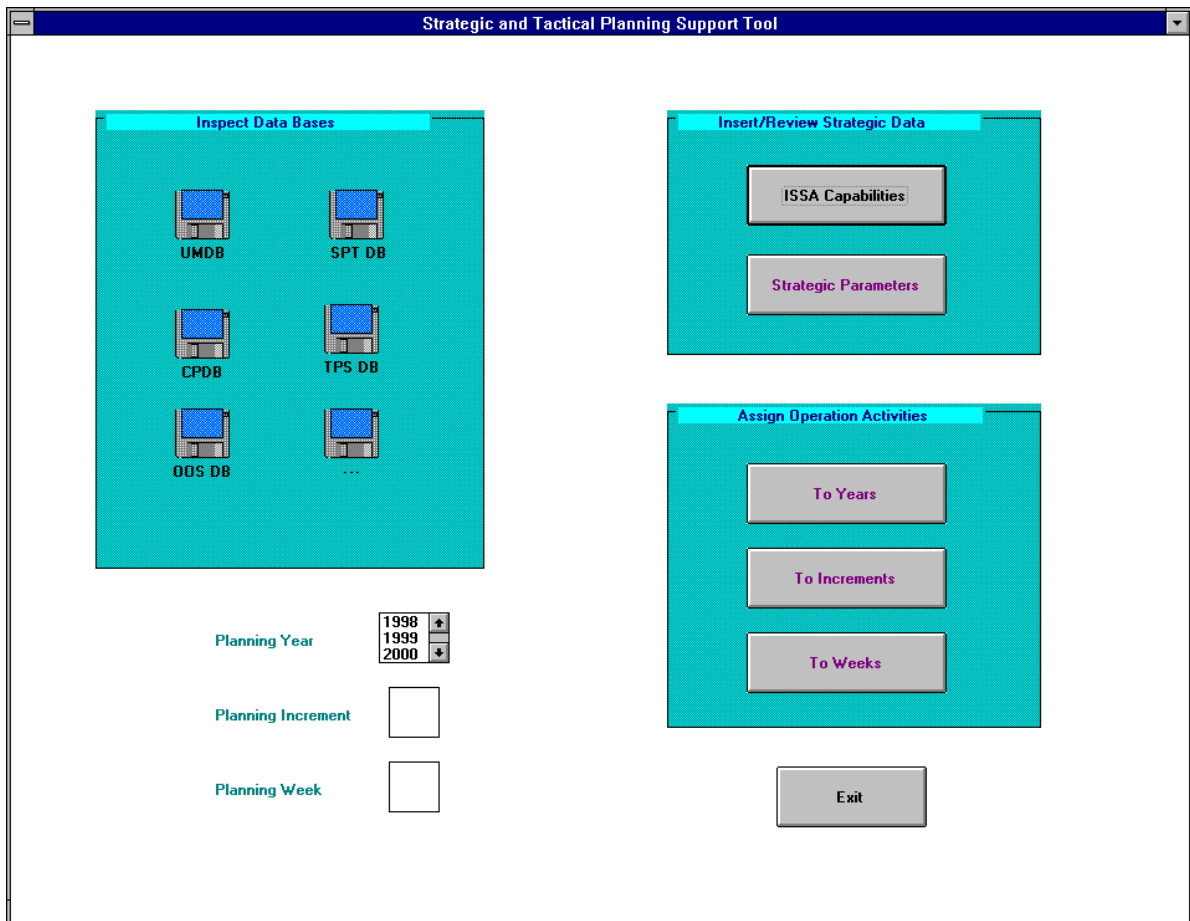


Figure 1. STPT Prototype Main Window

The lower right frame of the main window, entitled "Assign Operation Activities", allows the user to perform "what-if" assignment of resources to individual European facilities, starting from an initial allocation. Different scenarios can be created and maintained in parallel for the same period. The assignment of resources to increments and weeks has not been implemented in the current prototype.

To assign operations activities to years, the user must select a planning year and click the "To Year" command button in order to bring up the window shown in figure 2.

The frame in the right part of the window shows for each of the listed resources a bar with the related amount available for utilization, and a bar with the related amount required by all the payloads. The colour of the bars representing the resources required by the payloads changes from green (the percentage of the resource used by the payloads is less than 80% of the available resource) to pink (the percentage of the resource used by the payloads is between 80% and 100% of the available resource) up to red (the percentage of the resource used by the payloads is more than 100% of the available resource). The seven command buttons displayed on the window allow the user to perform the following functions:

New Scenario, to create a new scenario. The resources associated to the payloads when a new scenario is created are based on the initial allocation of resources to payloads defined by the payload strategic parameters. The resources required by a European payload can be viewed/edited by clicking the related picture. Figure 3 shows the Biolab Resource Requirements window. The user can change all the editable parameters. The parameters which are not editable are derived parameters. If the changes made to the parameters are saved, the contents of the frame in the right part of the window will be updated to reflect the new values of the resources allocated to the payloads. The resource requirements windows for the other European payloads contain similar parameters which can be changed in the same way as for the Biolab payload.

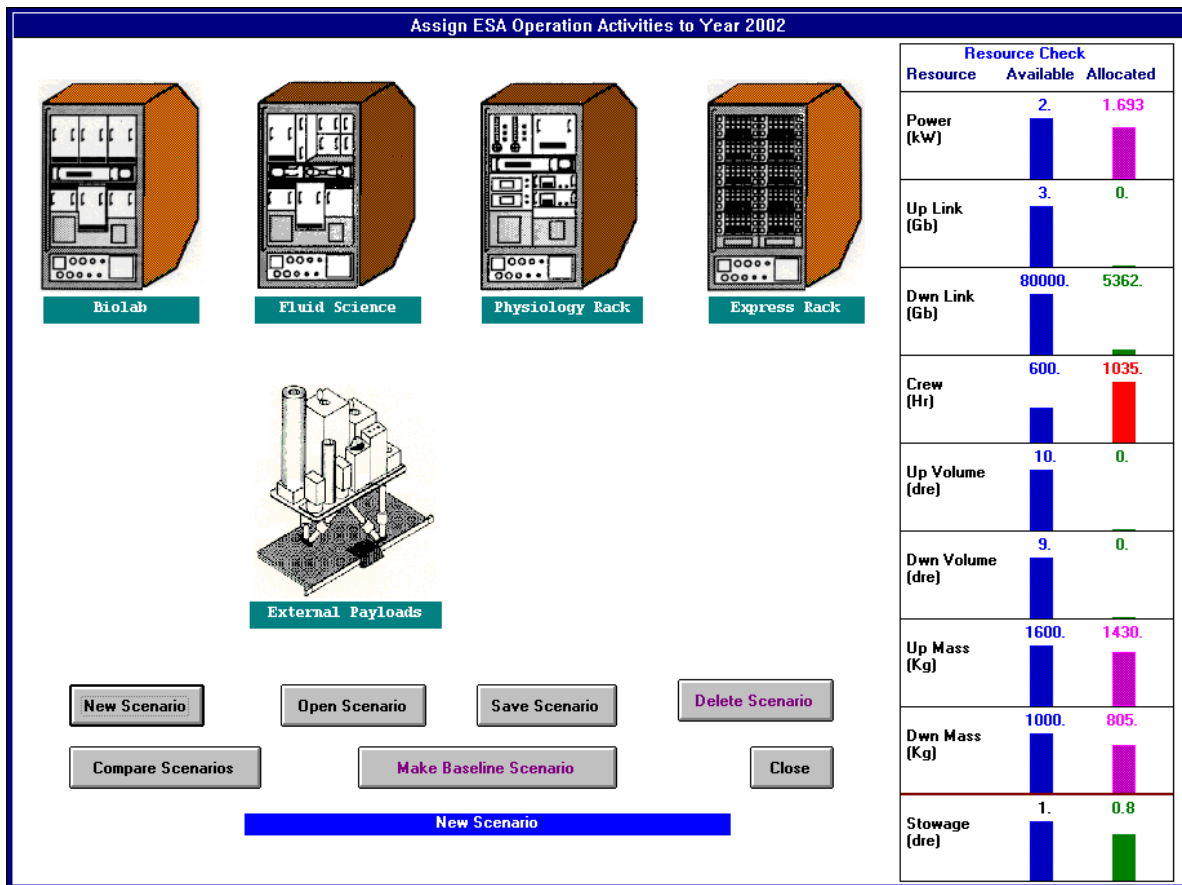


Figure 2. Assign ESA Operation Activities to Year

Open Scenario, to open an existing scenario.

Save Scenario, to save the current scenario.

Delete Scenario, to delete the current scenario.

Compare Scenarios, to compare the resources required by the defined scenarios.

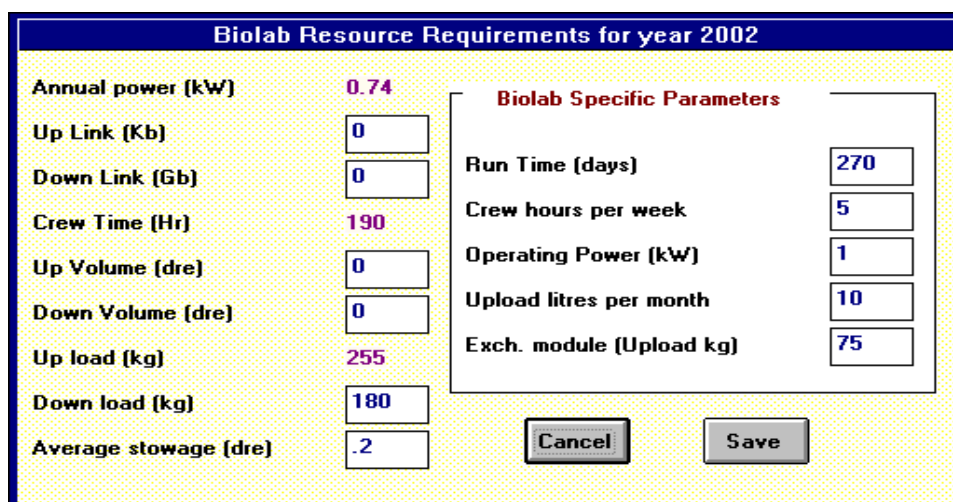


Figure 3. Biolab Resource Requirements for year 2002

At any time, the user can compare the resources allocated to the scenarios against the available resources for the planning year, to determine which scenario is most effective within the constraints of the available resources. One resource at a time can be compared, or all the resources at once.

Figure 4 shows the resource checks window for the absolute value of all the resources. It contains for each resource a bar with a label indicating the available value, and a bar with a label for each selected scenario indicating the value of the resources allocated to the payloads in the scenario.

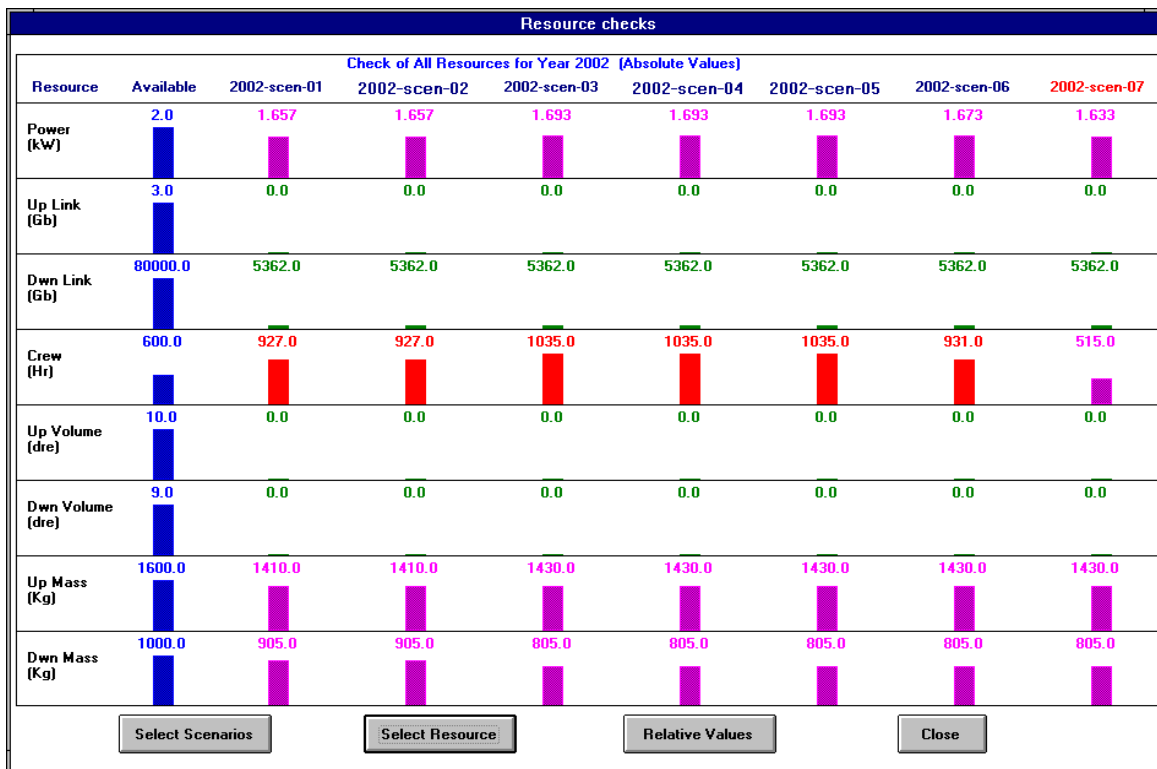


Figure 4. Resource Checks - All Resources, Absolute Values

Make Baseline Scenario, to make a scenario the baseline scenario. Once various scenarios for a planning year have been defined and analyzed, a scenario can be set as the baseline scenario. When baselining a scenario, two sets of data can be exported: information to be included into the ESA Partner Utilization Plan (PUP), and payload strategic parameters. Data for the ESA PUP can be exported in various file formats. Payload strategic parameters, related to the scenario being baselined, are exported in a format which can be imported into the User Mission Data Base (UMDB).

Close, to close the window

3. MISSION MANAGEMENT SUPPORT TOOL WWW FRONT-END

The MMST WWW front-end is aimed at providing both the user community and the ESA planning staff with a user friendly mechanism to view, enter, and maintain the information in the planning databases.

The MMST WWW front-end will collect input data for the STPT tool, and will obtain from the STPT tool the payload resource assignments to be displayed to the user community. The STPT tool and the MMST WWW front-end will eventually access the same set of databases, eliminating the need of data import and export mechanisms between the tools. The WWW service is established on an Apple server running WebSTAR server software. The WWW front-end has been developed by using the tools Tango and Butler. Tango is a full-featured visual development tool that integrates the WWW server with a SQL database system. Butler is a client-server relational SQL database which contains the data used by the application.

Figure 5 shows the main menu of the WWW front-end as implemented in the second prototype.

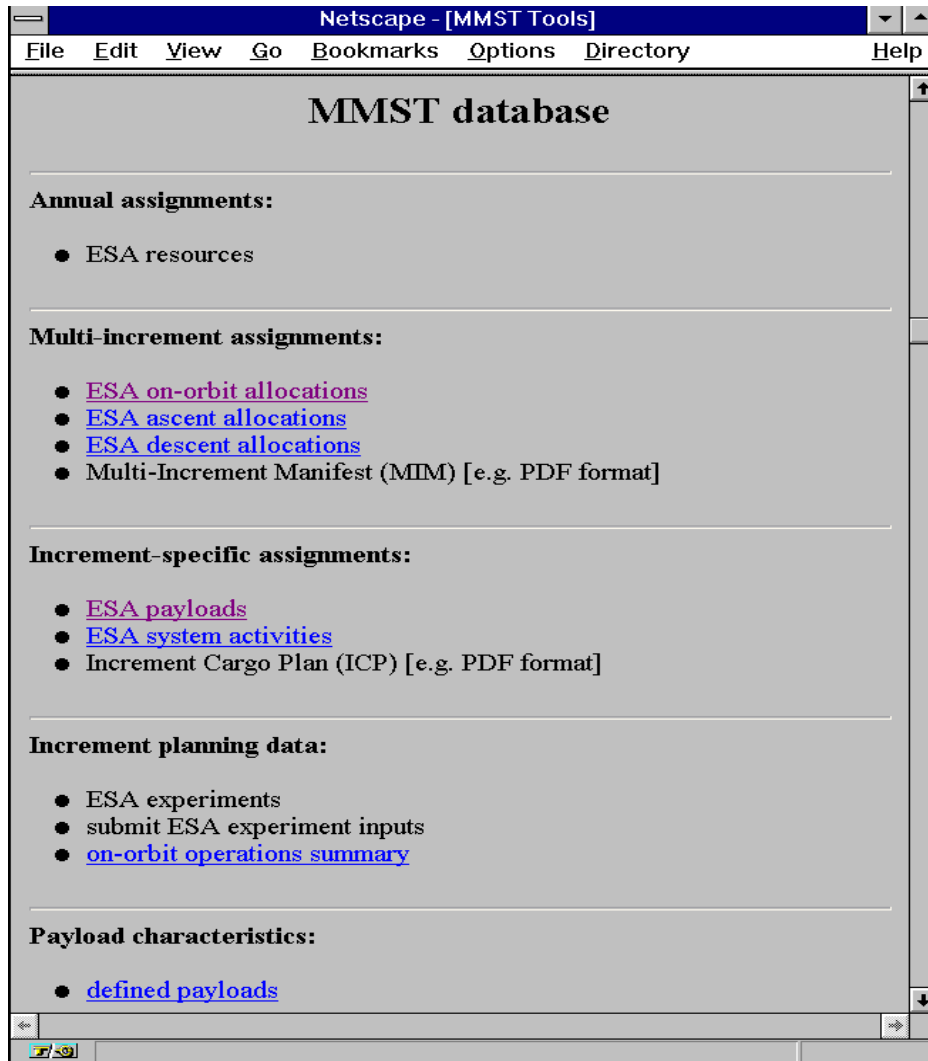


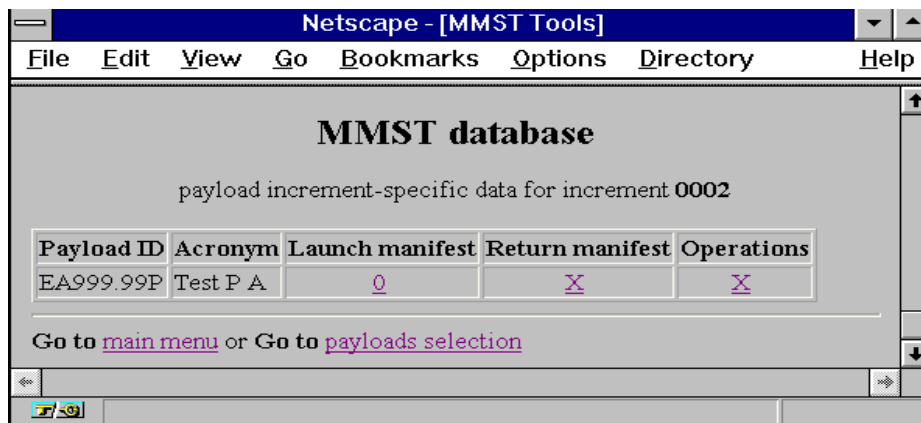
Figure 5. MMST WWW front-end main menu

The following four categories of users have been defined: user community, which has a read-only access to all the payload and system data; payload administrator, appointed by the agency, which is the only user allowed to enter and maintain the payload data; system administrator, appointed by the agency, which is the only user allowed to enter and maintain the system data; database administrator, appointed by the agency, which performs maintenance of the database.

The various users perform different tasks through the WWW front-end, and, as such, need to have different views of and access rights to the same information. For this reason, the WWW front-end main menu contains items which are visible to all the users and items which are visible only to a particular category of users. The menu shown in figure 5 is the WWW front-end main menu available to the user community. The main menu reserved to the payload administrator contains the same items shown in figure 5 plus some items which allow the creation and maintenance of payload data. The main menu reserved to the system administrator contains the same items shown in figure 5 plus some items which allow the creation and maintenance of system data. The main menu reserved to the database administrator contains links to the main database tables to allow the maintenance of the database itself.

The main menu lists some items which are plain text and, thus, are not linked to any information. These items have been included in the main menu only to present the complete layout of the final MMST WWW front-end. In fact, currently, only the tactical part of the MMST WWW front-end has been implemented.

The multi-increment assignments contain the ESA allocations for ascent, descent and on-orbit phases. The increment-specific assignments are related to payloads and system activities requirements at increment level. Figure 6 shows the increment specific requirements for the payload EA999.99P related to the increment number 0002. To view the specific requirements the user must click the related "X". The "0" means that the related requirements have not been entered yet.



MMST database

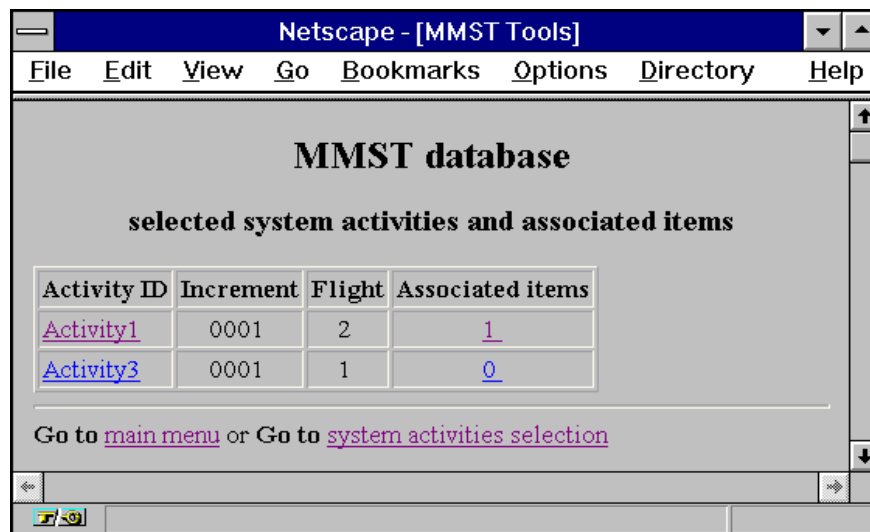
payload increment-specific data for increment 0002

Payload ID	Acronym	Launch manifest	Return manifest	Operations
EA999.99P	Test P A	<u>0</u>	<u>X</u>	<u>X</u>

Go to [main menu](#) or Go to [payloads selection](#)

Figure 6. Payload increment-specific requirement window

The system activities require system items in order to accomplish their objective (e.g., the activity "replace a battery" needs the item "battery"). Both the system activities and the associated items have increment-specific requirements. Figure 7 shows the selected system activities and the number of items associated to them. To view the system activity requirements the user must click the related "Activity ID". To view the item requirements the user must click the related "Associated items".



MMST database

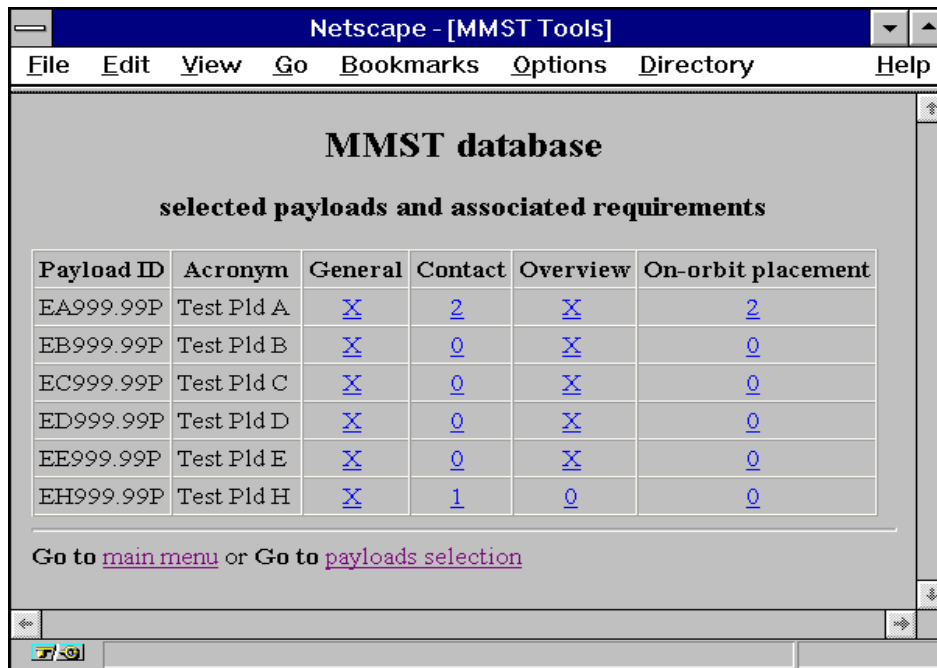
selected system activities and associated items

Activity ID	Increment	Flight	Associated items
Activity1	0001	2	<u>1</u>
Activity3	0001	1	<u>0</u>

Go to [main menu](#) or Go to [system activities selection](#)

Figure 7. System activities and associated items window

The payload characteristics contain information which is not specific to the increment, such as payload cover information; information related to the payload point of contact; payload overview information; and on-orbit placement information. Figure 8 shows the characteristics for the selected payloads. To view the specific requirements the user must click the related "X" or the related "number". A number appears instead of the "X" for the contact and the on-orbit placement information. For the contact information, the number indicates how many point of contacts have been defined for the payload. For the on-orbit placement information, the number indicates how many racks are required to accommodate the payload on board. A "0" means that the related information has not been entered yet.



Netscape - [MMST Tools]

File Edit View Go Bookmarks Options Directory Help

MMST database

selected payloads and associated requirements

Payload ID	Acronym	General	Contact	Overview	On-orbit placement
EA999.99P	Test Pld A	X	2	X	2
EB999.99P	Test Pld B	X	0	X	0
EC999.99P	Test Pld C	X	0	X	0
ED999.99P	Test Pld D	X	0	X	0
EE999.99P	Test Pld E	X	0	X	0
EH999.99P	Test Pld H	X	1	0	0

Go to [main menu](#) or Go to [payloads selection](#)

Figure 8. Payload characteristics window