TAVERNS and the Space Station Software Support Environment

by

Norman R. Howes
Lockheed Engineering and Management Services Co.
2400 NASA Road 1, Houston, TX 77058

Gary K. Raines
NASA Lyndon B. Johnson Space Center
Houston, TX 77058

Introduction

The Space Station Information System (SSIS) provides the data processing capability for the Space Station Program (SSP). It consists of the ground and onboard computers, networks and software that work together as a system to manage the operational and data handling requirements of the Space Station Program Elements. The Space Station Data Management System (DMS) is the onboard component of the SSIS that supports the various core and payload subsystems of the Space Station.

"The Software Support Environment (SSE) System for the SSP is the collection of software, procedures, standards, hardware specifications, documentation, policy, and training materials which, when implemented in hardware and a computer network(s), provides the environment that is to be used by the SSP for the life cycle management of all operational SSP software" according to the Request for Proposal for the SSE. It goes on to say that "The SSE is not a computer system that provides data processing services, but rather a set of methods, tools, rules, and standards that establish an environment for Space Station Program software support."

The Ada programming language has been baselined by the Space Station Program Office as the language for development and maintenance of all Space Station software including the software for the SSE itself. The use of program products not written in Ada will only be allowed on a waiver basis in accordance with criteria outlined in the SSE Software Management Plan. The SSE will include the Ada compiler(s) and run time environment(s) for the SSE and for the SSP baselined target space based and ground based processors.

Further, the RFP states that "The principle objective of the SSE concept is to provide a common environment for software support to the SSP. Therefore, all individuals and organizations with responsibility for the acquisition, integration, testing, configuration management, maintenance, or utilization of the

operational SSP software are potential SSE users. The following is a list of the general classes of user functions:

1. SSP Software Management,
2. SSP Software Development,
3. Systems Engineering and Integration,
4. Software Integration and Testing, including Safety, Reliability & Quality Assurance and Independent Verification & Validation,
5. Sustaining Engineering,
6. Operations of SSE,
7. SSP Operations, including flight crew and the various real-time ground support members."

The TAVERNS Concept.

TAVERNS is a distributed philosophy for development and validation of Ada applications software for the Space Station and as such is closely related to the SSE. The acronymn TAVERNS stands for Test And Validation Environment for Remote Networked Systems. The TAVERNS concept assumes that the different subsystems will be developed by different contractors who will be geographically separated.

The TAVERNS concept has not yet been baselined as the architectural concept for the SSE, but significant funding has be dedicated to developing and prototyping various aspects of TAVERNS and no doubt TAVERNS or something closely akin to TAVERNS will ultimately be the architecture for the SSE. In fact, the RFP for the SSE already embraces many of the concepts of TAVERNS in its present form.

To understand the TAVERNS concept, a few words are in order concerning the DMS. Figure 1 shows the core and payload subsystems connected to the core and payload networks via Network Interface Units (NIUs). Each subsystem is implemented on a Standard Data Processor (SDP). This does not imply that a standard computer has already been selected for this role but that all subsystem computers should have the same instruction set architecture (ISA). It is possible that a single SDP may host more that one subsystem.

The NIU is itself a computer, possibly with the same ISA as the SDP. The NIUs host the Network Operation System (NOS) component of the DMS where as the SDPs host the rest of the DMS. The SDPs, NIUs, networks and DMS software constitutes the DMS. The subsystem application software that runs on the SDPs is not considered part of the DMS.

In the TAVERNS approach, each software development contractor for the station will be provided with a miniature version of the Space Station DMS complete with three SDPs. One of the SDPs is for developing the subsystem software, one hosts the Displays and Controls software and the third hosts a simulation of the network

core subsystems (e.g., the Environmental Control & Life Support Subsystem or the Communications & Tracking Subsystem) and the network loads. A diagram of such a TAVERNS DMS System is illustrated in Figure 2.

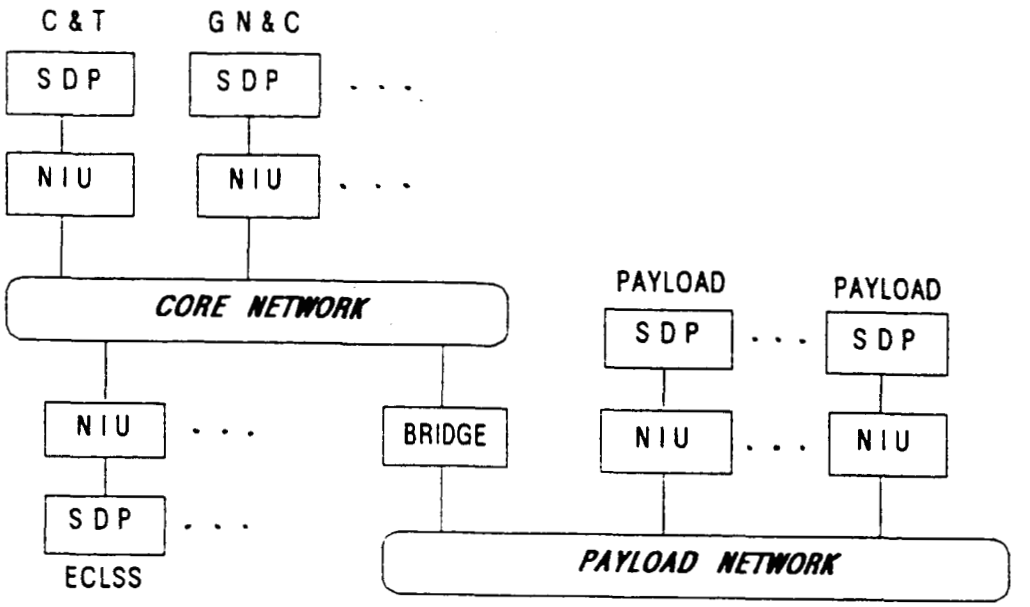

Figure 1.

The SDPs and NIUs on this mini Space Station DMS will host the same DMS Services as the real DMS, so to the applications programmer, it will appear that the entire Space Station DMS environment is present. In this way, software can be developed and checked out by different contractors at different locations. Completed and tested applications can then be transferred to the Integration Facility of the SSE for validation.

In the SSE RFP these individual software development elements are referred to as Software Production Facilities (SPFs). According to the RFP there will be SPFs at several NASA facilities and in various contractor facilities. These SPFs will be connected together via the Program Support Communications Network (PSCN) and other commercial networks as required. Also connected will be the SSE Integration Facility and the SSE Development Facility (SSEDF).

The SSEDF will be the SPF where the software for the SSE is developed, maintained, controlled and distributed to the other SPFs on the SSE network. A diagram of the SSE network is shown in Figure 3 and the elements of a typical SPF are shown in Figure 4. The TMIS Element shown in Figure 3 stands for the Technical

and Management Information System, a discussion of which is beyond the scope of this paper.

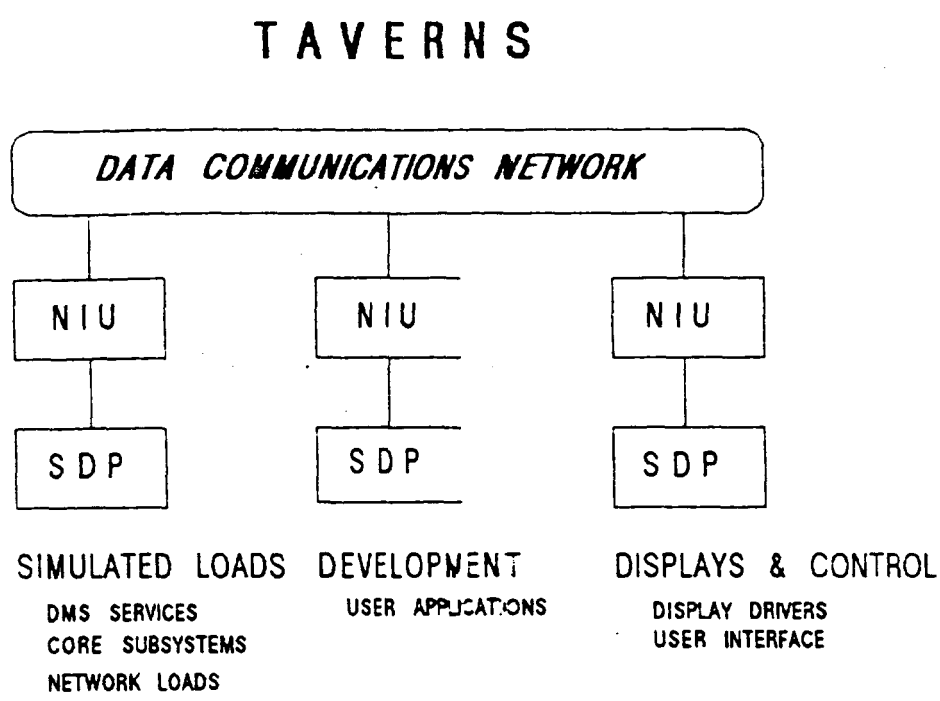

Figure 2

The TAVERNS Emulator Project is an Ada simulation of a TAVERNS System on the Avionics Systems Division (ASD) VAX at the Johnson Space Center. The purpose of this simulation is to

(1) provide a DMS software environment that consists of a library of DMS services that can be used by the various subsystem test bed developers to interconnect their test bed subsystems,
(2) gain experience with the Ada generic and overloading capabilities by implementing this library of services in such a way that the services will work equally well with any data type thereby maximizing code reusability,
(3) provide a library of testing tools (subsystem simulations) that can be used by subsystem test bed developers,
(4) test the functionality of these DMS Services,
(5) gain experience with the DEC Ada development environment in order to better understand what tools are needed in a development environment, and
(6) provide an environment where the TAVERNS concept itself can be evaluated and improved.

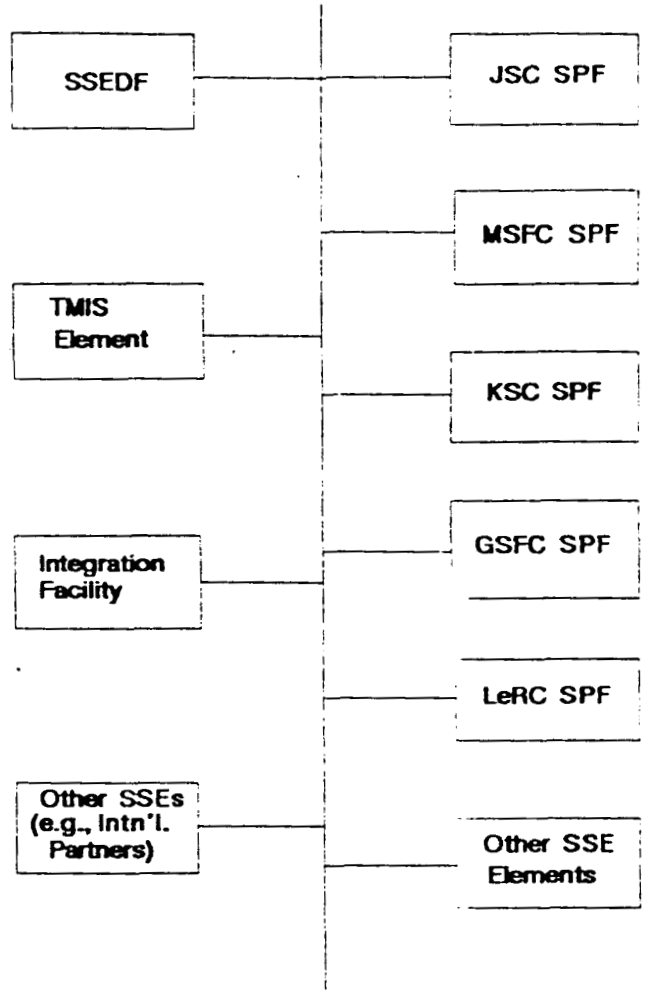

Figure 3.

To date, each of the DMS services to be simulated has been documented and an Ada specification written and compiled. About 25% of the services have been implemented in a first phase demonstration of a TAVERNS Emulator. Work will continue on implementing the remaining services through the next two years.

The library of DMS services can be subdivided into four classifications at present, namely the message handling services, the distributed file handling services, the data acquisition and distribution services and the data base management services.

Work on the specification of the crew workstation services and the operations management services are underway in other divisions at the Johnson Space Center. As these specifications emerge they will be integrated into the TAVERNS environment to the extent possible in a simulation.

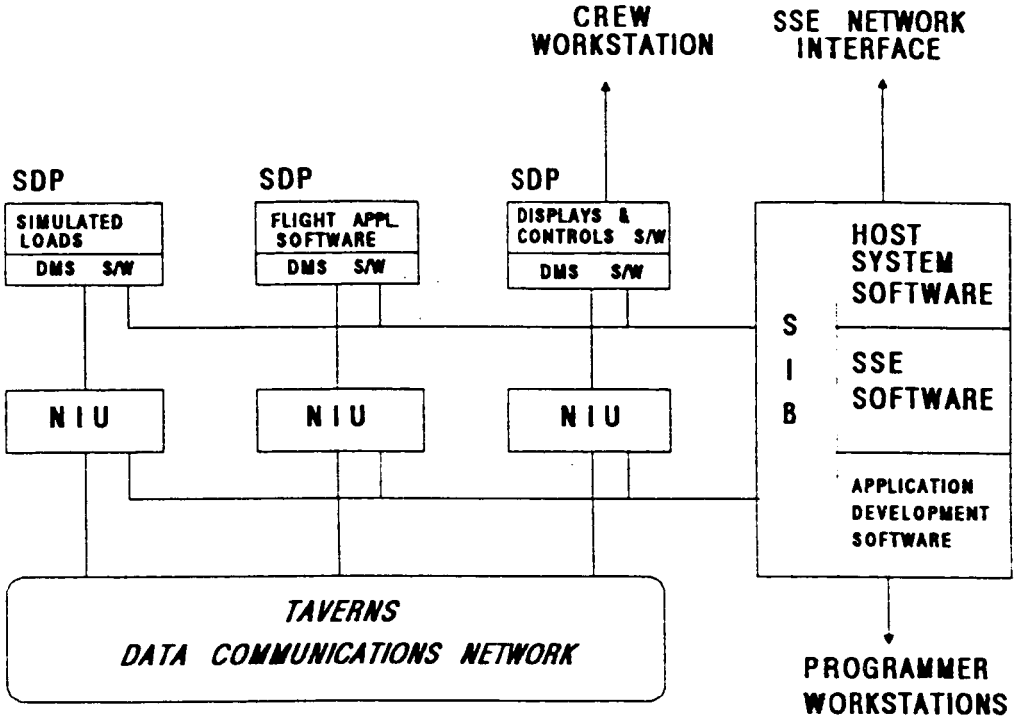

Figure 4.

The message handling services can be further subdivided into the datagram services and the virtual circuit services. The distributed file management services can be subdivided into the file handling services, the file access services and the file transport services. The data acquisition and distribution services can be subdivided into the data request services and data reply services (services that replace the master measurement reading function on the shuttle).

Currently, Ada specifications for the library of testing tools have not been written. A couple of test simulations have been implemented to support the first phase TAVERNS demonstration, but much more work needs to be done in specing the testing services to be made available.

A great deal of experience has been gained with the DEC Ada development environment in regards to its strengths and weaknesses and much has been learned about the peculiarities of the DEC Ada compiler. Partially as a result of this effort, the SSE RFP specifies a more sophisticated software development environment and an extensive set of testing tools.