Network Information Management Subsystem

C. C. Chatburn
DSN Operations and Engineering Support Section

The Deep Space Network is implementing a distributed database management system in which the data are shared among several applications and the host machines are not totally dedicated to a particular application. Since the data and resources are to be shared, the equipment must be operated carefully so that the resources are shared equitably. This article discusses the current status of the project and recommends policies, roles, and guidelines for the organizations involved in the project.

I. Introduction

Development of the Network Information Management Subsystem (NIMS) has now progressed into a phase where the uses of the NIMS and the roles and responsibilities of the organizations which are involved with it need to be considered in detail. A previous article (Ref. 1) described the initial phases of the project. This article discusses the NIMS network and node configurations, current status of the project, and the planned approach to full network operation.

II. NIMS Configurations

A. NIMS Hardware

The NIMS consists of a four-node network of intercommunicating minicomputers. Each node is similar and consists of a TANDEM Non-Stop II (NS-II) computer, disk drives, printers, terminals, and other peripheral devices (Fig. 1). The NS-II design features a unique multiprocessor architecture where each processor module is a totally autonomous computer system with its own memory, power supplies, and I/O capabilities. Processors are interconnected by a high-speed bus independent of the I/O bus. Each major hardware module is dual ported. If a processor or an I/O port fails, operating system backup processes take ownership of the failed component's peripheral devices and access them through the other I/O port, thus assuring nonstop operation.

B. NIMS Software

Each NIMS node is equipped with extensive commercial software to support the administrative data processing needs of various NIMS users. The software is grouped into seven major areas:

(1) General system interface programs including a command interpreter (COMINT), editor (ED), file utility program (FUP), peripheral utility program (PUP), sort/merge, backup/restore, and general-purpose procedures.

(2) The GUARDIAN operating system, consisting of a data base record manager (ENSCRIBE), a spooler, a performance monitor (X-RAY), and data communications software (ENVOY).

(3) Subsystem maintenance programs SYSGEN and INSTALL.

(4) Program development tools, consisting of the TANDEM Application Language (TAL), UPDATE, and DEBUG.

(5) A database management system (ENCOMPASS), consisting of a data definition language (DDL), a transaction processing system (PATHWAY), a transaction monitoring facility (TMF), a relational query/report writer (ENFORM), and a interactive application generator (ENABLE).

(6) The languages COBOL, FORTRAN, and BASIC.

(7) Other utilities, including electronic mail (T/MAIL), and word processing (T/TEXT).

III. Current Status

Hardware and software to support three NIMS nodes have been delivered. One node is installed at the JPL Hill Street facility. A second node is currently used to develop application software (Engineering Change Management Phase II) and is temporarily installed at a vendor facility in Glendora, California. At the conclusion of the software development, this equipment will be relocated overseas. A third node is installed at the Barstow facility of the Goldstone Deep Space Communications Complex (Fig. 2). A fourth node is currently funded for delivery in FY 86.

The nodes are connected together with leased telephone company circuits so that users at each node have access to the total resources of all nodes. Users from overseas complexes have access to the NIMS via high-speed NASCOM communications circuits using standard NIMS terminal equipment. These same lines will also be used for communications between nodes after overseas installations are completed (Fig. 2).

IV. Planned NIMS Implementation Approach

The NIMS concept represents a new approach to DSN information management in several ways. It is not totally dedicated to a single application, and the data handled are intended to be shared and thus are not necessarily the "property" of one application. Provisions are made for various levels of application, depending on the needs of the NIMS users. The "sharing" concept requires that information management support be provided impartially to a wide range of applications. This is a new NIMS function, and its role needs to be carefully considered to minimize conflicts between applications.

The implementation approach being used for the NIMS is divided into the following major areas:

(1) Organizational roles and tasks.

(2) NIMS Standards and policies.

(3) Application development.

(4) Organization roles and tasks.

Four geographically separate, functionally similar, but interdependent organizations are involved in NIMS operations. They are the management organizations at JPL and at each Deep Space Communications Complex (DSCC). Their responsibilities change as a function of the level of application (i.e., network, node, subnode) that they support. The roles and responsibilities of these organizations are more fully discussed in the sections which follow.

A. Organizational Roles

1. Operations planning. "Operations planning" addresses how the organization operates in the long term, existing standards or conventions that must be adopted, and any new standard procedures which must be developed and followed. Implicit in this activity is the need for a stable environment and a well defined base from which to evolve. This is established by making the process of change one which requires management approval. At the network application level, this is done via the ECM process. At the node level, it is delegated to local management.

2. Systems operations. "Systems operations" deals with short-term daily operations of the NIMS. This includes hardware/software maintenance activities and requested user/applications support.

3. Systems monitoring. "Systems monitoring" deals with ascertaining the ability of the total system (hardware, software, and people) to support assigned tasks. The NIMS does not exist as an independent entity; it is a support service that depends on users and user satisfaction for its existence. Performance standards are established and system performance is tested in order to verify that user needs are satisfied.

4. Configuration management. The NIMS configuration (both hardware and software) must be consistent across all nodes and controlled in order to support users and applications properly. Standard interfaces, naming conventions, definitions, protocols, and mnemonics, will be adopted for netwide use.

5. NIMS library. Each organization must have access to NIMS documentation necessary to support users and their applications. The library acts as the repository for this material and controls its distribution at each node.

B. Organizational Tasks

JPL and Deep Space Communications Complex management organizations must perform a similar set of general tasks

regardless of the level of NIMS application being supported. These can be divided into external (oriented to users) and internal (oriented to the organization).

1. **External.** External tasks are concerned with accepting data from a source, manipulating them, and providing useful information to users. Implicit in this process are the tasks of data entry, database creation, reporting, maintenance, and security. These are discussed below.

a. Data entry. This task includes activities required to accept data into the NIMS by any of the techniques that are available such as conversational, forms-mode, or batch input. If a forms-mode method is used, this activity may be done by some agent of the user, but it remains the responsibility of the NIMS organization to establish and/or develop the techniques. The objective is to minimize the special skills required of users.

b. Database creation. This task includes all activities required to develop the application database using utility software packages (tools) supplied with the NIMS. It includes analyzing existing databases to determine which data are shared, establishing linkages, considering security aspects, and creating or modifying data dictionaries and directories. Also included is full documentation of the database.

c. Reporting. This task includes activities associated with the manner, form, and content of the information presented to users. Depending on circumstances, these may range from formal reports to informal responses.

d. Maintenance. This task includes maintenance of software as well as hardware. It includes all activities that are associated with database upkeep, such as "tuning" for more efficient operation, and audits for completeness and correctness.

e. Security. This task includes activities required to guarantee that the data are not compromised, either by being made available to the wrong user or by being changed inadvertently. Included are the assignment of pass words and access levels and routine examination of those who have access to the various databases resident on the node.

2. **Internal.** Internal tasks verify that the man-machine system is providing the necessary external support that is needed by the various users and is cost-effective overall.

C. Special Organizational Responsibilities

1. **JPL node.** The JPL node organization is responsible for all support required for network applications. This support includes but is not limited to the following areas:

(1) NIMS and networking applications training.

(2) Hardware procurement.

(3) Utility software procurement.

(4) Standards and protocol development.

(5) Applications registration.

(6) NIMS configuration management.

2. **DSCC node.** Each DSCC node organization is responsible for all support required to develop local and subnode applications and for conforming to established NIMS standards and protocols. It also will support the portions of network databases that reside on the local node. It will maintain local hardware and provide local follow-on user training.

V. NIMS Standards and Policies

The following standards and policies have been established for developing applications on the NIMS to insure optimum use of resources and to encourage logical, well-ordered program development:

(1) All NIMS software developed for network-level applications will follow the policies for generating DSN software as established in *Software Implementation Guidelines and Practices*, Document 810-13, August 1, 1977 (JPL internal document). Node and subnode software will follow the intent of the standard insofar as practical.

(2) New NIMS networking applications will be planned and reported according to the technique of "Network of Demonstrable Functions", Ref. 2.

(3) All networking applications will be reviewed in accord with *DSN Engineering Change Review Program*, Document 810-10, June 1, 1979 (JPL internal document).

(4) Specific standards, such as file-naming conventions, peripheral names, user identifications, etc., are discussed in detail in the NIMS Software Operators Manual, SOM-DTN-5536SP, January 3, 1985 (JPL internal document).

(5) JPL and DSN computer security standards currently being developed will be adapted for NIMS. Local node management will be responsible for local node security and for complying with Network standards.

VI. Application Development

A. Levels of Applications

The NIMS is intended to support three levels of information management applications: network, node, and subnode. These are defined and discussed below.

1. **Network level.** Network-level applications involve data that may reside at several nodes and information that may be used by personnel at other nodes. An example of a network level application is the Engineering Change Management System (ECMS).

2. **Node level.** Node-level applications involve data that may come from several sources, but are of interest only to the personnel at a single node. Generally, these data will be input by personnel at the local complex and the information derived from this data will be used by the various levels of local management. Examples of this application are telephone and address lists.

3. **Subnode level.** Subnode-level applications involve private databases that are created, monitored, and controlled by the user/creator and are not shared with other applications.

B. Development Methodology

The development of new applications requires resources and must therefore have management approval before they are implemented. The level of approval will depend upon the application. New network applications require approval through the Engineering Change Management (ECM) process. Node applications require local node management approval. Subnode applications require approval of the appropriate database administrator.

The data to be managed should be available in a form that can be collected and entered into the appropriate database. The data should be clearly identified and defined, and the effect of data errors should be understood. Access to both the data and the resulting information must be established. The requirements for the application must be accurately and clearly specified.

1. **Requirements definition.** A formal requirements document is required for proposed applications that are network-wide in scope. Node and subnode application requirements will be documented in accord with local management policies.

2. **Software development.** Applications software will be developed by a sustaining contractor under the supervision of the DSN Database Administrator (DBA).

Local applications programs can be generated and implemented on local nodes. Control of these activities is the responsibility of local management.

3. **Documentation requirements.** The three application levels have different requirements for supporting documentation. Since network applications are long-lived and affect many aspects of DSN operations, they must be carefully documented. Node and subnode applications have less impact and consequently have less stringent documentation requirements. The detail of proposed documentation for each level of application is shown in Table 1.

4. **Changes or modifications to applications.** Changes or modifications to NIMS-hosted applications require management approval prior to being implemented. Generally, the level of approval follows precedents established by ECMS. Applications that are under ECM control require ECR/ECO activity.

Changes to node and subnode applications require the approval of the appropriate database administrator and management levels. DBA approval is required because NIMS resources, e.g., disc space, can be impacted by the changes.

5. **Testing.** All new applications require testing during the design and installation process. The application level will determine the formality and detail of the tests. The tests will be further defined in the Software Test and Transfer document STT-DTN-5536SP, January 3, 1985 (JPL internal document) for network applications. Testing of node and subnode applications is under the control of local node management.

References

1. Wales, K. J., "The Network Information Management System (NIMS) in the Deep Space Network," *DSN Progress Report 42-73*, Jet Propulsion Laboratory, Pasadena, Calif., pp. 85-88, May 15, 1983.

2. Jacobson, G. N., and Spinak, A., "Top Down Implementation Plan for System Performance Test Software," *DSN Progress Report 42-70*, Jet Propulsion Laboratory, Pasadena, Calif., pp. 190-199, August 15, 1982.

3. Tausworthe, R., *Standard Classifications of Software Documentation*, Technical Memorandum 33-756, Jet Propulsion Laboratory, Pasadena, Calif., January 15, 1976.

Table 1. Application level documentation standards

Applications documentation		Applications level					
		Network		Node		Subnode	
Name[a]	Purpose	Class[b]	Format[b]	Class	Format	Class	Format
SRD	Program requirements schedule and resource for design phase	B	3	C	3	–	–
SDD	Architectural design, interfaces test and design goals	B	3	C	3	–	–
SOM	Operating instructions	B	2	C	2	D	4
STT	Acceptance tests and transfer criteria	B	3	–	–	–	–
SSD	Program design and code listings	C	3	D	3	D	4

Class B: sufficient for skilled programmers with minimum CDE consultation.
Class C: sufficient for skilled programmers with dialog with the CDE.
Class D: suitable for maintenance only by original programmer.
Format 2: external report quality.
Format 3: internal report quality.
Format 4: freehand documents, internal quality.

[a]SRD: software requirements document
SDD: software definition document
SOM: software operators manual
STT: software test and transfer document
SDD: software specification document

[b]Definitions of Class and Format per Ref. 3.

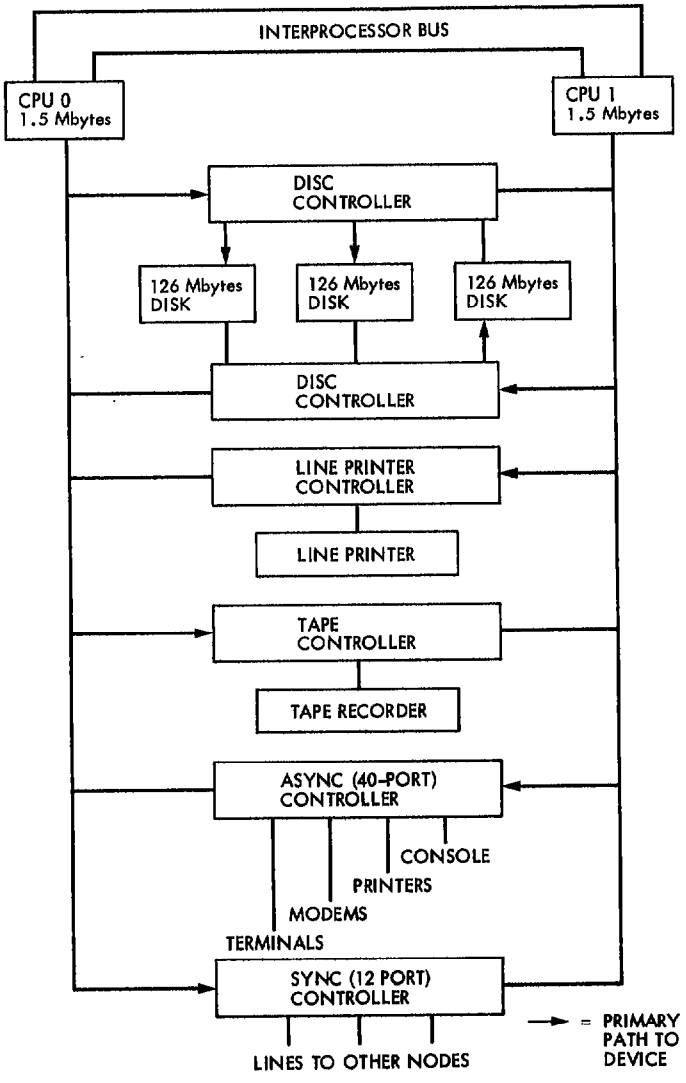

Fig. 1. Typical NIMS node block diagram

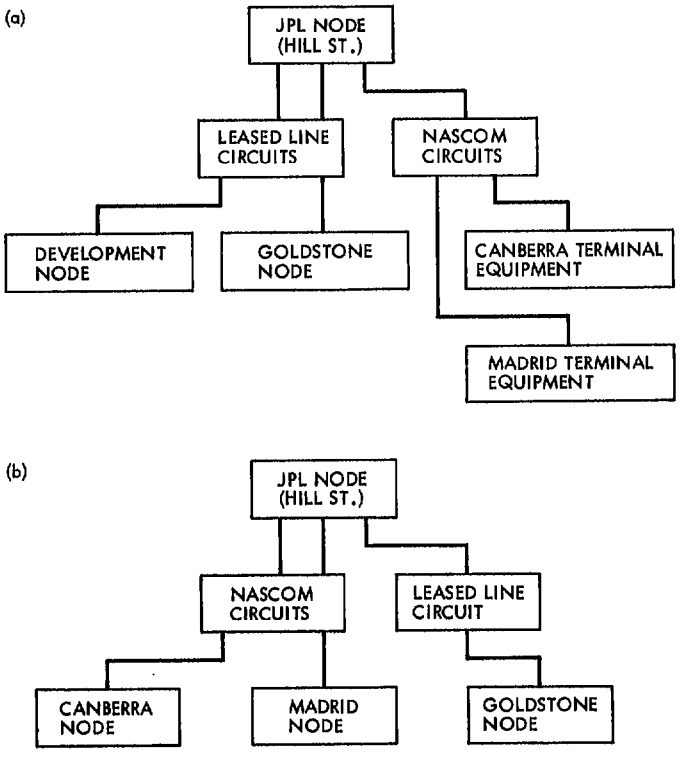

Fig. 2. NIMS network configuration: (a) current; (b) final