



Apr 1st, 8:00 AM

# Open System Interconnection (OIS): NASA Program Communications of the Future

Charles D. Brady

*Manager Information Systems Information Resources Management Division NASA-Headquarters*

Follow this and additional works at: <http://commons.erau.edu/space-congress-proceedings>

---

## Scholarly Commons Citation

Charles D. Brady, "Open System Interconnection (OIS): NASA Program Communications of the Future" (April 1, 1987). *The Space Congress® Proceedings*. Paper 3.

<http://commons.erau.edu/space-congress-proceedings/proceedings-1987-24th/session-8/3>

This Event is brought to you for free and open access by the Conferences at ERAU Scholarly Commons. It has been accepted for inclusion in The Space Congress® Proceedings by an authorized administrator of ERAU Scholarly Commons. For more information, please contact [commons@erau.edu](mailto:commons@erau.edu).

OPEN SYSTEM INTERCONNECTION  
NASA Program Communications of the Future

Charles D. Brady  
Manager Information Systems  
Information Resources Management Division  
NASA-Headquarters

ABSTRACT

Open Systems Interconnection (OSI) standards are being developed by the International Organization for Standardization (ISO) and the Consultative Committee on International Telephone and Telegraph (CCITT) with the support of industry. These standards are being developed to allow the interconnecting of computer systems and the interworking of applications such that the applications can be independent of any equipment manufacturer. Significant progress has been made, and the establishment of government OSI standards is being considered.

There is considerable interest within NASA in the potential benefits of OSI and in communications standards in general. The OSI standards are being considered for possible application in the onboard Space Station Data Management System. The OSI standards have reached a high level of maturity, and it is now imperative that NASA plan for future migration to OSI where appropriate.

INTRODUCTION

The phrase Open Systems Interconnection (OSI) is used to characterize a set of data communications standards developed by the International Organization for Standardization (ISO). These standards define protocols for interconnecting computer systems and for supporting interworking between applications such that the applications can be independent of any equipment manufacturer. The OSI standards are being developed by ISO and the Consultative Committee on International Telephone and Telegraph (CCITT) with the support of computer manufacturers, communications carriers, large users, and the governments of such countries as the U.S., France, Canada, U.K., Japan, and West Germany. The effort is also supported by other standards organizations including the American National Standards Institute (ANSI), the European Computer

Manufacturers Association (ECMA), the Institute of Electrical and Electronics Engineers (IEEE), and the National Bureau of Standards (NBS).

OSI REFERENCE MODEL

The purpose of the reference model is to provide a framework for a modular approach to the development of the OSI standards. The model is divided into a seven-layer hierarchy. The layered approach, which has its origin in the design of computer operating systems, allows clear identification of the functional goal of each module and clear definition of the interfaces between modules. Associated with the functional goals and the interfaces are two types of specifications: protocols and service specifications respectively. Protocols define the rules for message exchange between equivalent modules in the same layer in two different systems at different network nodes which are communicating with one another. Service specifications define the interfaces between a module in one layer with modules in the layer above and the layer below.

The model partitions the functions involved in communications into communications-oriented functions at the lower layers and user-oriented functions at the upper layers. The lower levels represent a "bit-pipe" that moves the data intact between end data systems. These layers provide the interconnection function. The upper levels allow the applications one each end to decipher the data and use it. These layers are principally responsible for providing the interworking or interoperability capability. The model is shown in the diagram and is described below.

Physical Link Layer - represents the model's interface with the physical transmission media. The physical layer provides the electrical and mechanical means of interfacing to a physical medium for transmitting data, as well as setting up, connecting, maintaining, and disconnecting

physical links. This layer includes modems and the interface devices which provide physical interface with the communications lines. It also includes any software in the device driver for each communications device. Standards existing at this level are primarily electrical standards such as RS-232-C and RS-422-A and modem standards such as V.22 and V.27.

Data Link Layer - provides the functional and procedural means to establish an error free communications path between network nodes for the physical channel and to frame messages for transmission, check integrity of received messages, correct errors, manage access to and use of the channel, and ensure proper sequence of transmitted data. (The physical layer provides the electrical and mechanical means, and this layer provides the functional and procedural means.) Examples of the protocols of this layer include the ISO High Level Data Link Control (HLDC) and the IEEE-802.2 Logical Link Control (LLC).

Network Control Layer - performs uniform connection services for the transport layer by controlling the interconnection of the data circuits within the physical layer. This layer addresses messages, sets up the paths between communicating nodes, routes messages across intervening nodes to their destination, and controls the flow of messages between nodes. Protocols at this level include CCIT X.25 Packet Level-1984, ISO 8473 Connectionless Internetwork Protocol, and CCIT Q.930/Q.931 ISDN.

Transport Layer - provides the liaison between the user systems at the upper end and the network at the lower end. It isolates the user systems from the network such that the applications are independent of network implementation. It provides an external shell of end-to-end control of a communication session once the path has been established, allowing processes to exchange data reliably and sequentially, independently of which systems are communicating or their location in the network. If the Network Service provides reliable data transfer, little functionality is required in the Transport Layer. Protocols include CCIT X.224, ISO 8043, and ISO DIS 8602-Connectionless.

Session Control - controls the back-and-forth communication (dialog) between systems during communications sessions. Provides synchronization and resynchronization which allow dialog to be restarted from a mutually agreed upon place in the event of loss of data. Protocols include CCITT X.225 and ISO 8327.

Presentation Control - determines appropriate syntax at the beginning of sessions (and during if a change is called for) thus allowing encoded data that has been transmitted to be translated and converted into formats that can be understood and directly manipulated by users. This enables proper display on terminal screens and printers for example. The ISO protocol is ISO 8823.

Application/User Layer - provides services that directly support user and application tasks and overall system management. Examples of services and applications provided at this level are resource sharing, file transfer, remote file access, data base management, and network management. This layer is the interface between the OSI communications environment and the applications which use it. There are a number of different protocols available that are designed to allow end-to-end interoperability of applications on different vendors' hardware. Two of the major protocols that are of broad general applicability are the File Transfer Access and Management (FTAM) protocol (ISO DIS 8571-FTAM), which enables remote file manipulation between systems from different vendors, and the Electronic Mail protocol (CCIT X.400-MHS).

There are two types of standards associated with each layer of Reference Model: the service specification defines the functions and facilities offered to the layer above, while the protocol definition defines the actions and responses exchanged between systems in order to provide the service. The service specifications were not mentioned above, but for each protocol there is an applicable service definition. It should be noted that given network architectures can fit the seven layer model but not be compatible with one another; protocols and service definitions must be compatible.

## GOVERNMENT ACTIVITIES

The NBS in 1983 organized a workshop for implementors of OSI. The workshop is held five times a year to bring together future users and potential suppliers of OSI protocols for the purpose of developing detailed implementation specifications that are needed to build compatible commercial products. These implementation specifications are based on the OSI protocols. (OSI protocols include such variables as classes of service, options, and parameters. Agreements must be reached concerning these variables, or systems manufactured in compliance with the same protocol may not be interoperable.)

The workshop has influenced the adoption of ISO standards by large user organizations. The Manufacturing Automation Protocol (MAP) and the Technical and Office Protocol (TOP) being used by General Motors and Boeing, respectively, are subsets of the standards derived from the workshop. Several other companies are implementing the MAP and TOP specifications. The NBS has participated with General Motors, Boeing, and many vendors in demonstrations of multi-vendor local area networks (MAP and TOP). Also, as a workshop activity, an OSI network is being implemented to verify test methods, for vendor to vendor testing, and for OSI research.

The Office of Management and Budget (OMB) is developing a policy on OSI. It is anticipated that the policy will be in effect by FY 1989, and it will require agencies to implement OSI standards for all new systems and to develop transitions strategies that will move agencies from their existing architectures to the OSI architecture.

## GOVERNMENT OSI USERS COMMITTEE

If the Government is to adopt the OMB policy, it is necessary to establish a Government OSI specification that is closely related to the MAP and TOP developments. It is also necessary to involve Government users to insure that their needs are met. The Government OSI Users Committee was organized for that purpose and has three primary objectives:

- 1) develop an implementable OSI specification reflecting Federal Government user requirements,
- 2) cooperate with industry to accelerate OSI products that meet Government requirements, and
- 3) focus Government resources on OSI standards development for unmet requirements.

The first meeting of the committee was held September 9, 1986 at NBS. There was considerable interest in and wide spread support for the aims of the group; seventeen agencies were represented at the meeting. Presentations were given by representatives of DoD and NBS. NBS reviewed its OSI activities and DoD presented its ISO-DoD coexistence plan.

The ISO-DoD Coexistence Policy is that, "Whenever international standards are available and can be used to support military requirements, they will be implemented as rapidly as possible to obtain maximum economic and interoperability benefits." DoD has a strategy to convert from the DoD Transmission Control Protocol/Internet Protocol (TCP/IP) to OSI which includes:

- 1) Coexistence of full parallel data communication protocol suites.
- 2) Filling of ISO "Management Protocols" holes with DoD fillers.
- 3) Development of products to permit coexistence and interoperability:
  - a) Application level gateways.
  - b) DoD IP and ISO IP gateways.
  - c) Network supplied ISO-DoD terminal devices.

Three subcommittees were formed during the business portion of the meeting. These were:

- 1) The Initial Specification Working Group - to develop a draft initial Government OSI Specification based upon work completed, e.g., the NBS/OSI Implementors' Workshop Agreements Document and the TOP Specification.

2) The Methodology Working Group - to develop a draft work plan addressing how the Government OSI Specification will be used in the implementation of the anticipated OMB OSI policy.

3) The Advanced Requirements Working Group - to draft a list, in priority order, of new protocols and extensions to existing protocol standards to accommodate government requirements not currently met.

The first subcommittee submitted its report, and from it a Government Open System Interconnection Procurement (GOSIP) specification was adopted. NBS distributed the specification to government agencies on December 22, 1986 for review as a proposed Federal Information Processing Standard/Federal Telecommunication Standard. At the time of the writing of this paper the results of the review were not available.

#### NASA ACTIVITIES

As one would expect, NASA has a wide variety of networks and data communications products from many vendors. There are special networks and numerous proprietary networks. The IBM SNA and the Digital Equipment Corporation DECnet technologies are used widely throughout NASA. DEC/IBM gateways are in use to give some degree of interoperability. There is also, however, some move toward standardization. Several centers are using the DoD TCP/IP protocols. These include ARC, LeRC, MSFC, JPL, and possibly others. The network that is to link the NASA class six computers, the Computer Network System (CNS), will be TCP/IP. Some of the systems do use certain protocols that are either OSI standards or are progressing toward OSI ratification. Examples of these latter standards are the X.25 packet level protocol and the Carrier Sense Multiple Access/Collision Detection (CSMA/CD) Ethernet protocol.

At least one center, ARC, has recognized the need for NASA to participate in the movement towards the use of international standards in computer networking. The ARC Information and Communications Systems Division is initiating a project to investigate

the use of international protocols. The main tasks of the project will be to (1) test commercial software products for operability and interoperability and then as elements in prototype networks, (2) evaluate performance of protocol modules using emulation/simulation networking tools, and (3) develop conversion and migration plans for embodying the international standards in evolving ARC and NASA networks. A final report will be produced which will include proposed plans incorporation of the OSI protocols into ARC and NASA computer networks.

At Headquarters the NASA Data Systems Steering Group (DSSG) has been established to coordinate the development of standards to enable the end-to-end interoperability of space data systems. The phrase space data systems is defined to encompass the payloads and/or platforms; the space links; the space and ground networks; the data handling systems; the archiving, retrieval, and distribution systems; and the command, control and operations systems. The emphasis to date has been on the space link formats and command and control. Several standards, which are in various stages of development and approval, are being developed in cooperation with international space agencies and organizations. The Consultative Committee for Space Data Systems (CCSDS) is the principal international participant with the DSSG.

Laboratory evaluations of implementations of OSI standards have been conducted to determine the feasibility and advisability of adopting the OSI model for the Space Station Project. As a result of these evaluations and other preliminary studies it has been recommended that the OSI model be specified for the onboard Space Station Data Management System (DMS).

#### CONCLUSION

It is clear that NASA must establish an overall data communications standards program that includes and possibly is directed toward the OSI architecture. None of the current NASA activities is directly addressing, for all applications, the potential, future impact of OSI.

The DSSG is primarily concerned with space data systems. The Automated Information Management (AIM) Council is concerned with the development and implementation of agencywide administrative systems. The AIM program is concerned about compatibility and interoperability as a user but is not concerned about which specific methodologies are chosen to successfully meet the requirements. The Program Services Communications Network (PSCN) is being implemented and managed through the Marshall Space Flight Center by the Office of Space Tracking and Data Systems (OSTDS) in Headquarters. The PSCN is being used to meet the immediate program communication needs of other NASA users and thus must adopt standards and products which are available today. The PSCN can, however, accommodate OSI and other standards as required.

Irrespective of whether an OMB policy is implemented, NASA should consider the merits of migrating to the OSI architecture. OSI standards represent a very promising means of solving the compatibility and interoperability problems and thus offering increased utility at lower life cycle costs. There is major support for OSI in government and industry, and OSI products are very rapidly becoming available very rapidly. NASA must determine its future needs and develop a long range data communications standards and implementation plan. If OSI provides an appropriate answer, the plan should provide for the migration to OSI. If OSI is not acceptable for some applications, in whole or in part, NASA must make provisions for OSI interfaces and gateways.

## THE OSI REFERENCE MODEL

