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A COMMUNICATIONS MODEL FOR AN ISAS TO NASA SPAN LINK

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I. INTRODUCTION

With the advent of modern computer-to-computer electronic networks, international collaborative science is entering a new age of data exchange and joint projects. In a shared international development of spacecraft flight experiments such as that being undertaken by the Institute of Space and Astronautical Science (ISAS) in Japan and the National Aeronautics and Space Administration (NASA) in the United States on the Geotail mission, the existence of direct electronic links greatly facilitates rapid communication among the various experimental groups and project offices in both countries and the joint development and checkout of flight hardware.

In recognition of the potential importance of such a network to the overall success of the Geotail mission, NASA's National Space Science Data Center (NSSDC) has been directed by the Geotail Joint Working Group to prepare a plan for a pilot effort to link ISAS into NASA's Space Physics Analysis Network (SPAN). The following document outlines the specific science and project requirements for such a network link. It then describes a technical approach developed by NSSDC for how such a link might be implemented

In summary, we propose that an initial computer-to-computer communication link use the public packet switched networks (PPSN) Venus-P in Japan and TELENET in the United States. When the traffic warrants it, this link would then be upgraded to a dedicated leased line that directly connects into SPAN. The proposed system of hardware and software will easily support migration to such a dedicated link. It therefore provides a cost-effective approach to the network problem. Once a dedicated line becomes operational, we suggest that the public networks link as described here should continue to coexist, providing a backup capability.

It must be emphasized that the following study is only one suggested communication model or approach to the problem of a network link between ISAS and NASA to support their joint activities. This study should not be interpreted in any way as a binding commitment on either agency or on any of the involved projects. The plan presented here, however, does provide a cost-effective, "strawman" communications scenario for linking together the ISAS and NASA data systems.

II. COMMUNICATION REQUIREMENTS

The importance of rapid and reliable electronic mail communications among investigators and project officials during instrument development, instrument integration, prelaunch testing, and postlaunch data analysis is self-evident. Currently, the GTE-Telemail service in the United States is being used by ISAS and ESA for message transmission and reception to and from NASA. This mail service greatly facilitates cooperation between the NASA and ISAS agencies and their associated science communities.

In addition to Telemail use, several Japanese investigators are now able to gain terminal access to the NSSDC and SPAN through the public packet switched networks (PPSN). Figure 1 shows the configuration of the PPSN's Venus-P, TELENET, and the NASA Packet Switched System (NPSS) with SPAN. In Japan, the international PPSN is called Venus-P; in the United States, SPAN is connected to the PPSN called TELENET through another network, NPSS. Venus-P, TELENET, the NPSS, and SPAN are transparently bridged to allow traffic to flow between these networks. The general procedure for terminal connection to SPAN from Japan is described in Appendix A of this report. Complete reference lists to all SPAN and related SPAN user group reports are also included as Appendices B and C. Copies of these documents are available upon request from the NSSDC.

Note that accessing SPAN is very similar to accessing the Telemail computer system for terminals in Japan. There are two major computer systems on SPAN (one at the Marshall Space Flight Center or MSFC and another at the NSSDC) that can be accessed like the Telemail computer as shown in Figure 1. Through either of these two host machines, any other computer node on SPAN with authorized accounts can be easily reached. It is important to note that the present connections shown in Figure 1 and discussed above are limited to ASCII (or text) communications only.

In order to enhance the scientific return from joint agency spaceflight missions, science investigators must have the ability to transfer binary data and ASCII (text) files in addition to having electronic mail and being able to log onto computers at remote sites. By logging onto remote computers, appropriately authorized scientists will have immediate access to remotely stored binary calibration and flight data. The transfer of text files will allow an easy and timely exchange, editing, and distribution of many needed documents, e.g., technical specifications, project-generated requirements and notices, prelaunch instrument descriptions, and postlaunch data analysis papers. The transfer of binary data files will allow remote testing and control of instrument operations and analysis of instrument checkout data by programs running on remote machines. Binary transfers will also make possible the rapid exchange of high-resolution flight data or device-independent graphics plot files among cooperating investigators and in support of agreed-upon collaborative studies. Currently, SPAN is the only NASA-sponsored multi-mission correlative network that exists to satisfy the above requirements for a major portion of the U.S. space plasma physics community and several other disciplines.

A series of solar terrestrial spacecraft is expected to be launched in the early 1990's by NASA, ISAS and the European Space Agency (ESA) making up the International Solar Terrestrial Physics (ISTP) program. The Geotail spacecraft is a major element in the ISTP program. For ISTP the NSSDC will be maintaining a central online archive of "key parameter" and orbit/attitude data for the various planned ISTP spacecraft. An extension of the existing SPAN network to Japan would allow Japanese investigators to easily tap NASA and appropriate research investigator resources for the ISTP program. Access to the NSSDC, for instance, would allow ISAS scientists to either generate plots directly on NSSDC computers for display at their local facilities or to electronically transfer such key parameter data from NSSDC to their local facilities for local access and display. Although not fully defined in detail, NSSDC is also anticipated to become a repository for ISTP "event data." Again, an ISAS connection to the SPAN network will greatly enhance the accessibility and utility of these NSSDC computer resources and these NSSDC-held data to the investigator community in Japan.

III. SYSTEM AND COMMUNICATION CONFIGURATION

A compatible SPAN computer-to-computer network connection from ISAS to NASA will require additional equipment at ISAS. The computer hardware and software needed for this connection are specified in the Table below. In order for ISAS to have access to the full range of SPAN functions (i.e., file transfer, electronic mail, and remote logins), a VAX/VMS based host computer such as a micro-Vax-II is recommended. This machine would interface to the Venus-P PPSN in Japan.

HARDWARE AND SOFTWARE COMPONENTS

Part Number	Description
DH-630Q5-EA	micro-Vax-II System Package (with 9 Megabyte of memory)
TSV05-AA	1600 bpi Magnetic Tape Drive
QZ002-C5	8-User Key for VMS Software
QZ100-UZ	FORTRAN License
QZD04-UZ	DECnet License
QZD04-H5	DECnet Documentation
PSI-J	PSI License and Documentation
DPV11-AA	Synch Controller (for PPSN host connection)
QZZ990UZ	VMS Driver Software for TSV05
RD53A-AA	71 Megabyte Winchester Disk
RQDX3-AA	R053A-AA Controller Module
VT241-AA	Color Graphics Terminal
VT24K-AA	Keyboard for VT241-AA [U.S.A. Style]

The communications to utilize the proposed equipment are shown schematically in Figure 2. The most cost-effective approach is to let the communication capability of the ISAS system grow with demand. Two communication links are shown: an initial configuration and an upgrade to that configuration.

The initial connection with the proposed computer hardware and software at ISAS, as shown in Figure 2, uses the public packet switch networks in both Japan and the United States in much the same way as the terminal communications discussed in the previous section. The host computer at ISAS interacts with the PPSN using the international X.25 protocol. X.25 specifies the network protocol up to the end-to-end communications layer. The software package called PSI-J running on the ISAS micro-Vax implements the X.25 specifications for host to PPSN communications. DECnet, a more sophisticated communications protocol, will be used to augment the capabilities of X.25 to ensure the reliable transport of data and binary file transfers. The DECnet protocol of SPAN is a standard option with the VAX/VMS system and can be used in conjunction with PSI-J to provide a fully functional ISAS to SPAN connection. It is important to note that the Digital Equipment Corporation (DEC) has set up a similar system from the US to Japan for their internal use and has been completely successful. We also note that the SPAN project has used a similar procedure for connecting SPAN to a the European Space Operations Center (ESOC), a major ESA center. This link has operated so successfully during the last 1 1/2 years that it has now being upgraded to a dedicated 9.6 kbps (kilobits per second) line.

It is expected that as traffic increases between ISAS and NASA facilities with the approach of the Geotail launch, the initial configuration as outlined will not be adequate, and an upgrade to the initial configuration will be necessary. A high-speed, dedicated trans-Pacific line connecting the ISAS micro-Vax II system directly into one of the west cost SPAN routing centers such as the Jet Propulsion Laboratory (JPL) is recommended. Various speeds between 9.6 and 56 kbps are now available for such a trans-Pacific line. This type of dedicated connection is shown in Figure 2 as a dotted line.

IV. DATA SECURITY AND PROTECTION

The proposed hardware and software configuration will allow the ISAS investigators to have complete control over what data are accessible to network users outside of ISAS. There are two levels at which data security can be addressed. The following paragraphs outline the options.

1. Data that are resident on a micro-Vax disk can be protected on a per file, per directory, or per system basis. For instance, an ISAS user may wish to load data onto the disk for processing but not want the data available to outside users. Such data files can be locked against access by other users by using the VMS SET PROTECTION command. As another example, users who wish to have an account on the micro-Vax, but do not want to allow access of any kind to this account from SPAN, may software lock the account against any network access by using the VMS AUTHORIZE utility.

2. A second approach to data security is quite simple. If data are not loaded onto the ISAS host machine disk, then they cannot be accessed by SPAN users. Data are transferred to the host disk by copy from tape to disk. If the data have not been copied from tape to disk, then no outside access to the data via SPAN is possible.

V. COMMUNICATIONS COST SHARING

If the approach of a micro-Vax host computer installation and connection at ISAS is taken as suggested in this proposal, several communications services costs will be incurred. These costs are:

1. The charge (as of July 1986) for a dedicated or leased telephone connection from ISAS to Venus-P at a rate of 9600 is as follows:

   - Installation 100,000 yen ($625)
   - Monthly change 114,000 yen ($713)

2. A transport charge for any traffic on the Venus-P network and through the international public network system. This means that the originator of a "call" (where a call initiates the packet traffic to and from ISAS and NASA) must pay for all traffic in both directions, although payment is only for what is actually transported plus virtual circuit connect time. If the call is initiated by ISAS then the following rates apply:

   - 40 yen (or 25 cents)/minute of use.
   - 2.4 yen (or 0.015 cent)/segment, where one segment has a maximum capacity of 64 bytes.

In order that cost sharing for this initial capability be done fairly, one suggestion is that ISAS pay for item #1 and NASA pay for item #2. Within item #2, it would thus be up to NASA to initiate the link. Once a link has been initiated, then any traffic going to or coming from ISAS would be paid for by NASA. Communications traffic should be monitored closely until the cost for the use of the PPSN approaches the cost of a dedicated communications line.

VI. FUTURE ENHANCEMENT OF AN ISAS TO SPAN LINK

The initial method proposed here for connection of ISAS to SPAN allows the respective agencies to exchange mail, manuscripts, and small quantities of data in a timely and cost-effective way. This method of connection has been proven successful by links using the same method to connect Canada's Data Analysis Network (DAN) and the European Space Agency (ESA) to SPAN. As the use of these lines has increased dramatically, it has proven more cost effective (in the case of the ESA to SPAN link) to install a dedicated 9.6 kbps line, with an upgrade to 56 kbps expected in the near future. A dedicated SPAN to ESA line now allows the NSSDC to optimize the DECnet packet size for the best throughput without the constraints imposed by the X.25 standards that are in use by the respective PPSN's. This results in a greater effective throughput to SPAN users.

If the ISAS to SPAN line over the PPSN's proves to be heavily utilized (as it was for ESA as described above), then the installation of a dedicated 9.6 kbps line would be used to increase performance. A further natural evolution of this concept would be an upgrade of this dedicated line to a line that has a data rate of 56 kbps, again as traffic on the line increases.

For cost comparison purposes (as of November 1986) a dedicated 56 kbps service from ISAS to JPL, the closest SPAN routing center, would cost nearly $18,000 per month. If the JPL SPAN routing center is not used and the line had to reach to GSFC from ISAS it is expected that the leased cost could be as high as $26,000 per month. Cost, such as this, make the use of the public packet networks as an initial step very appealing.

Once a trans-Pacific dedicated service has been installed and is in operation, it still may be highly desirable for the connection to Venus-P to remain in place at ISAS. There are several advantages for retaining such a link. In addition to the public network link providing a backup capability to a dedicated link, a link to Venus-P would facilitate ISAS communications to other Japanese investigators, universities, and data centers. This capability could also form an initial nucleus from which ISAS might choose to start a Japanese space science network.

APPENDIX A: EXISTING COMMUNICATIONS

It is important to note that SPAN is currently configured to allow terminal traffic coming from a variety of public packet switched networks (including Venus-P). Figure 1 is a schematic of the configuration of the SPAN gateways connected to the NPSS, the NPSS being in turn connected to GTE/TELENET. Note that the two SPAN computers that have TELENET addresses are at Marshall Space Flight Center (MSFC) and at the National Space Science Data Center (NSSDC). For ISAS personnel and US scientists visiting Japan to connect to SPAN now, the following procedure can be used to initiate a terminal connection along the path shown in Figure 1.

1. Place local call to Venus-P pad and upon receiving the prompt, type;

```
.PPP=HE
```

Note: this command is dependent on your local terminal configuration and allows Venus-P to recognize and properly communicate with your terminal. Please consult the Venus-P terminal configuration documentation for other responses.

Venus-P then responds with:

```
VENUS-TOK  NODE=003  PORT=010  PROF=HE
```

2. Type your authorization/charge number and password along with the NASA SPAN gateway address. NASA currently does not have an authorized account on Venus-P for US investigators visiting ISAS.

As an example, supposing an authorization number 000000 and a password PPPPPPPP, then use the following to access the gateway at NSSDC :

```
:000000PPPPPPPP-311032107035
```

For the gateway at Marshall Space Flight Center use:

```
:000000PPPPPPPP-311032100160
```

The Venus-P response (for NSSDC) should be:

```
COM 311032107035
```

3. The next response should be from the SPAN system you are logging onto. For the NSSDC system the following will appear:

NSSDC COMPUTING FACILITY VAX 8650

USERNAME:

This computer is named NSSDCA on SPAN. If MSFC is selected, the username response will be coming from the computer named SSL on SPAN. It is important to note that step 3 may change in the near future to include an NPSS network access password procedure before the NSSDC USERNAME prompt is obtained. If this occurs it is necessary to contact the NSSDC for the exact procedure.

Once you receive the USERNAME prompt respond with either SPAN (no password) or a special account that has been arranged through the NSSDC. If you are logging into the NSSDC facility with the SPAN account, you will then be prompted for the SPAN computer you wish to access (example: IOWASP, for the University of Iowa Space Physics computer).

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APPENDIX C: SPAN AND DSUWG NEWSLETTER REPORTS

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APPENDIX D: LIST OF ACRONYMS

ASCII	- American Standard Code for Information Interchange
DAN	- Data Analysis Network based in Canada
DATEXP	- A PPSN in Germany
DEC	- Digital Equipment Corporation
DECnet	- DEC networking products generic family name
DSUWG	- Data System Users Working Group
ESA	- European Space Agency
ESOC	- European Space Operations Center
GSFC	- Goddard Space Flight Center
GTE	- General Telephone and Electric
ISAS	- Institute of Space and Astronautical Science (Japan)
ISTP	- International Solar Terrestrial Physics
JPL	- Jet Propulsion Laboratory
kbps	- Kilobit per second
MSFC	- Marshall Space Flight Center
NASA	- National Aeronautics and Space Administration (US)
NPSS	- NASA Packet Switched System (using X.25 protocol)
NSSDC	- National Space Science Data Center (at GSFC)
PPSN	- Public Packet Switched Network
PSI-J	- The DEC Packetnet System Interface for Japan
SPAN	- Space Physics Analysis Network
SSL	- Space Science Laboratory (at MSFC)
Telemail	- A GTE computer reachable on TELENET, used for mail
TELENET	- A PPSN owned by GTE in the United States
Venus-P	- A PPSN in Japan
X.25	- A "level II" communication protocol for packet switched networks

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Figure 1 - The current routes available to terminal traffic from ISAS to NASA/SPAN are shown. Two computer hosts that are connected both to SPAN and to the NPSS are at MSFC and the NSSDC. Through these two host machines, any node on SPAN where authorized accounts exist can be easily reached.

CURRENT TERMINAL CONFIGURATION

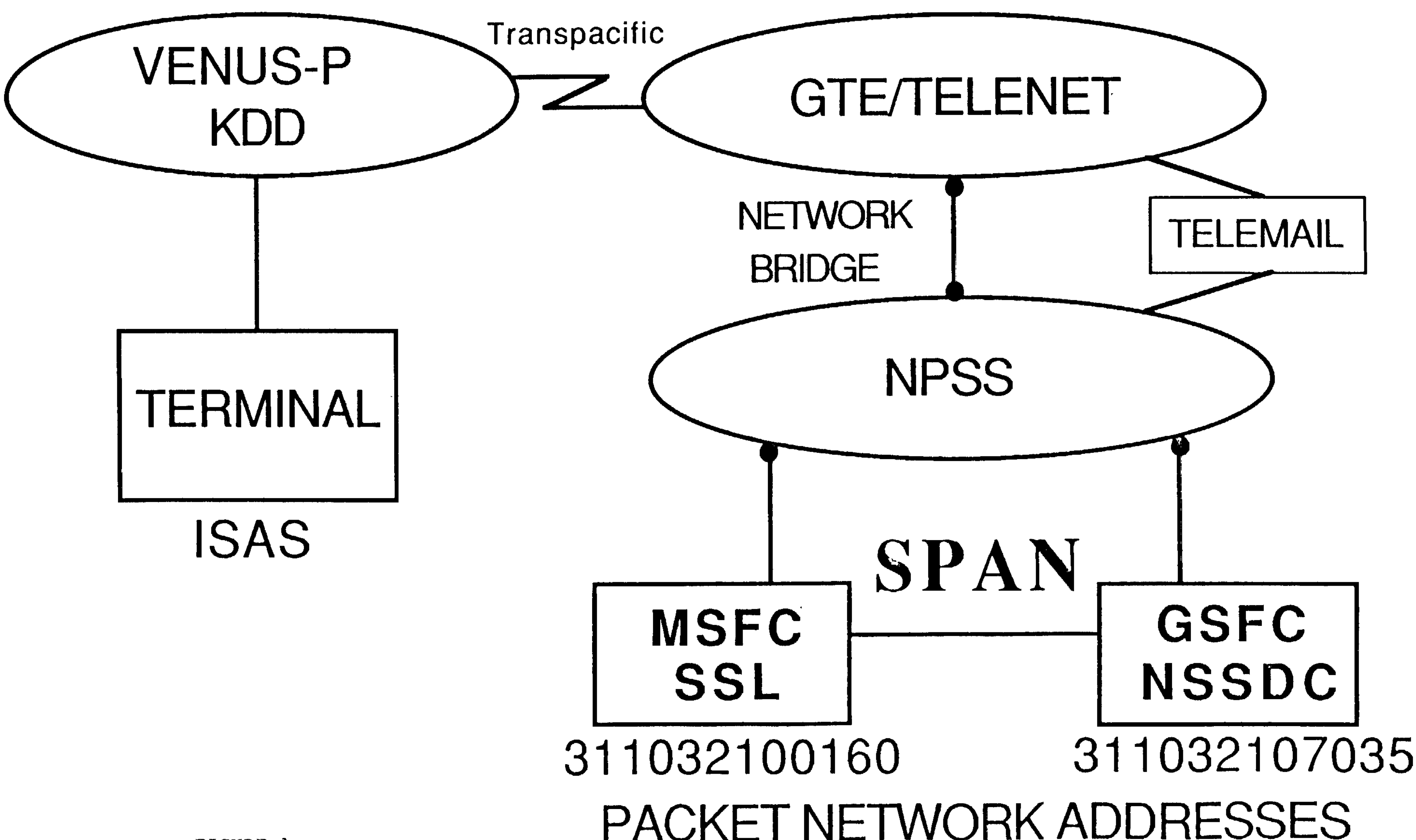

FIGURE 1

Figure 2 - The communications model for ISAS to NASA/SPAN as proposed in this study. The Public Packet Switched Networks using X.25 protocol are Venus-P, GTE/TELENET, and the NASA Packet Switched System. The key element for full interconnection of the ISAS and NASA systems is the micro-Vax-II computer at ISAS, which would serve the dual purpose of communication front-end and science processing system. Two stages in implementing communications are proposed, first to connect the ISAS system to Venus-P and, second, to upgrade this capability with a dedicated communication line from ISAS to the closest NASA/SPAN routing center.

COMMUNICATIONS MODEL FOR ISAS TO NASA/SPAN

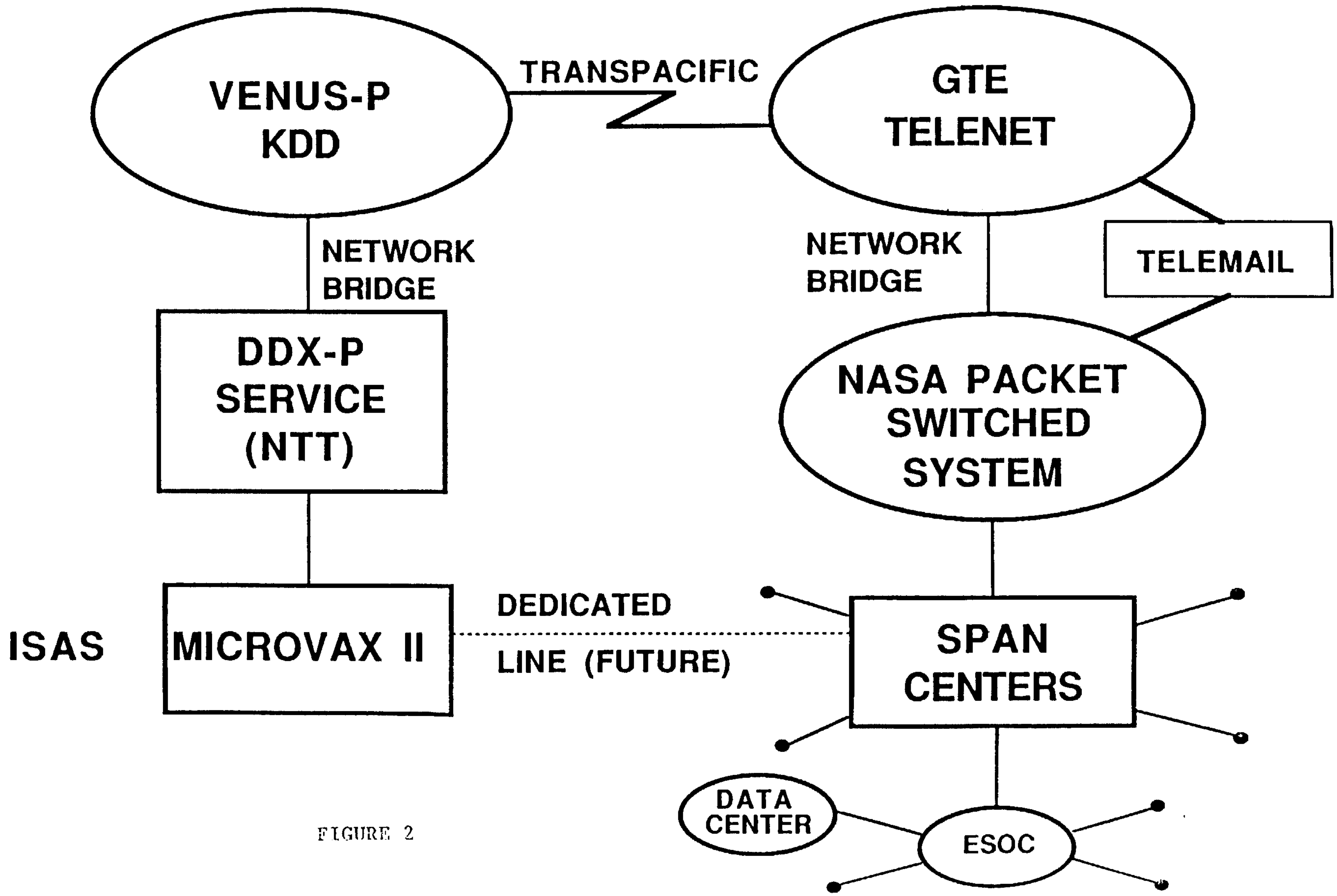

FIGURE 2