EIS-TR-79-3/0

THE EXTENSION OF TACONET

—An Academic Computer Network—

by

Shoichi Noguchi
Junki Yaegashi
Yoshihiko Ebihara
Hidetoshi Kawai
Juro Oizumi

January 20, 1979

INSTITUTE
OF
INFORMATION SCIENCES AND ELECTRONICS

UNIVERSITY OF TSUKUBA

THE EXTENTION OF TACONET
- An Academic Computer Network -

Shoichi Noguchi, Junki Yaegashi, Yoshihiko Ebihara
Tohoku University,Sendai,Japan Tsukuba University,Ibaraki,Japan
Hidetoshi Kawai and Juro Oizumi
Electronical Lab.,Tokyo,Japan Chiba Institute of Technology,Narashino,Japan

Abstract

The experimental computer network (T-NET) with public telephone lines has been operational, providing for extensible structures of application for user protocols, tailored to reconfiguration of communication pathes over the net. The architectures and technical processing of reconnection are outlined.

1. INTRODUCTION

In the computer network, not only network control functions but also user level protocols are concentrated into front end processors, each of which is put between a telephone network and host computers. The networking technique is aimed at solving the following major problems. 1) off-the-cuff use of the public telephone network. 2) Heterogenous networking without significant impact on host operating system. 3) To establish network oriented operating system on front end processors. 4) To facilitate reconnection function (1), providing for clients to access to remote common resources distributed among multiple host computers by submissions of command files.

As for the item 4), a new method of reconnection procedures have been introduced in T-NET and operational now. Here we describe mainly the technical problems of the item 4) up to date. A prime motivation for reconnection processing is to support clients with a mean of access to T-NET where they would share network resource as if they were using a single computer system without awareness of physical existence of destributed hosts. The historical background of T-NET is described at section 2, the general configuration of T-NET at section 3, the basic concept of reconnection protocol at section 4, and the further work and some conclusions at section 5 are discussed.

2. BACKGROUND OF T-NET

The TACONET (2) was a prototype of T-NET and the academic experimental computer network as a model of local computer network under the plan (3) of Japanese inter universities computer network which started from 1974. There were, however, some problems not only in its scale but also in the generality of communication protocols. Then the extended computer network (T-NET) has been developed to overcome the problems and strengthened espetially the following functions.

1) Bit length of data is extended to "8 bit data + 1 parity" per one character.
2) Dynamic socket number assignment to processes from fixed one.

3) Facility of binary file transfer.
4) Sharing of destributed data bases, drived under the control of data base protocol.

3. THE EXTENDED NETWORK (T-NET)

3.1. The outline of the extended network (T-NET)

The extended network has been developed among 4 nodes. The physical connecting structure is shown in Fig.1. The logical control hiererchy is shown in Fig.2. The concept and function of symbols in Fig.2 are summarized in the following:

1) IMP (Interface Message Process)··· Controlling the physical communication link (telephone line) and offering the transparent data network to host computer.
2) NCP (Network Control Process)··· Controlling the logical links and message flow on them.
3) PI (Process Initiator)··· Initiating process connection.
4) Other ULP (TELNET, FTP, RJE, RCP, etc.)··· User level processes which can be divided into some sub-processes depending on the control hiererchy.

The logical link (4) is so installed at each sub-process (Multi-leveled structure as shown in Fig.2) that the control overhead of inter process is increased a few, but it is not harmful to practical use. This concept is basic philosophy of the T-NET.

4. RECONNECTION PROTOCOL

4.1. General concept of reconnection protocol (RCP)

RCP (Reconnection Protocol) manages a command table and a status table at one submission. When a network user issues a "switch line" command (@ SWITCH) the server front end processor hangs up the telephone and begins to interpret the command table. It is believed that the top command in the file is a command "log on to the third host" and that the bottom command is a command "log off". Therefore, server front end processor dials out to the third host and, when it has been through all the commands, it will connect the telephone line again to the first host. The network user would retrieve the status table, which is list of responses corresponding to commands in the command table.

In T-NET there are two ways to generate a command file.

1) User's interactive creation of the command file from his terminal.
2) To use the command file already stored in file system.

In case of 2), a user needs only to notify the file id. of the command file to his front end processor as the option of RCP.

4.2. Network system structure for the reconnection

The following brief scketches show how our proposals described at 4.1 had been implemented on the T-NET with the introduction of the reconnection protocol and also present a rough mechanism to support reconnection proce-

dures.

1) Each host computer is constructed with the network oriented operating system consisted of a nucleus, system level processes and user level processes. (See Fig.5)
2) The nucleus concentrates on interrupt handling, the synchronous of process-control and so on.
3) A communication path between processes whether they may be on the different hosts (Inter-process communication) or within the same one (Intra-process communication) is set up by NCP (Network Control Process). (See Fig.4 and Fig.5 in the first case)
4) The RCP (Reconnection protocol) has been established definitely to support that a network user at host $H_i (i \neq j)$ can access plural hosts $H_j (j=1 \sim m)$ automatically by means of user's presentation of command tables, reconstructing to move a communication path from one host to another in the T-NET.
5) The RCP had been implemented onto RCP processes and a pair of RCP processes, i.e., one at user site and the other at server site (called as user and server RCP process, respectively), communicating each other to complete the execution under the reconnection procedures.

4.3. Service commands related with the reconnection

The RCP process accepts the network commands authorized by the RCP specification and executes a reconnection processing. The followings are fundamental network commands closely related with the reconnection. Other service commands were ommitted here because they are not essential for the reconnection. (See Table 2)

1) Submit command (SUB)
   To create a command table (CT) which is consisted of a sequence of network commands submitted by a network user and transferred to the destinated host.
2) Switch command (SWITCH)
   To instruct the destinated host to start the execution of commands on the CT one by one.
3) Status command (STAT)
   To inform a network user with status informations consequent upon reconnection processing from the destinated host. All informations generated at plural hosts gathered finally on the status table of the destinated host.

4.4. Command sequence definition

Network users must follow the specified order of network command sequence when they create a CT from their terminal. The following shows the typical network command sequence(Q_{ij}) with symbolic format as a matter of convenience.

$$Q_{ij}=L(j):P:F:D:LF(j) \quad \cdots(a)$$

Detailed explanations of symbols used in (a) are described at the Table 1. In the case of that a user at host(i) supposed to access to host (j) as the

destinated one, he would input network commands interactively as shown in the below.

1) To connect physically to the destinated host(j) at first.
2) To select protocol ID., namely to instruct the execution of process connection.
3) To input various service commands specified by the protocol.
4) To disconnect the process connection.
5) To terminate from host(j) finally.

4.5. Reconnection flow

The RCP process permits network users to submit combinations of network command sequences at their beck as the application for reconfiguration of communication pathes. As a consequence they are proceeded invisibly for network users.

1) Multi-command tables for one submission

$$Q_{ij}^{(M)}=L(j):RCP:SUB(Q_{jm}):SUB(Q_{j1}):SWITCH:STAT:D:LF(j) \quad \cdots(b)$$

2) Nested structure of command table

$$Q_{ij}^{(N)}=L(j):RCP:SUB(Q_{jk}^{(M)}):SWITCH:STAT:D:LF(j) \quad \cdots(c)$$

4.6. Global behavior of reconnection

Some examples of reconnection flow on the illustrated network configuration with numbered host-ID in Fig.6 are demonstrated how a communication path moves from one host to another in the case of command sequences of (b) and (c) described at the section 4.5.

1) By the submission of (b) where i=1, j=2, m=5 and 1=7, RCP processes execute the reconnection procedures and results in the following reconnection flow shown in Fig.7.
2) In case of (c) where i=1, j=2, k=3, m=6 and 1=8, the RCP processes execute the nested command sequences as shown in Fig.8.

4.7. Some applications of reconnection

The reconnection procedure, according to RCP, has been required to be available for a third host of plural hosts, and is helpful for combining multiple processes, existing in independent hosts. The reconnection processing in T-NET have been found to be usable in the following advanced applications.

1) It is great helpful, for learning network resources intelligence, that the command selecting a data base in Data Base Protocol (DBP) provides guidance about the newly developed data base for a network user.
2) It is powerful, for periodical network measurements, that the command collecting network statistics data measured at each site in Network Measurement Protocol (NMP) saves a user much time and trouble.

5. FUTURE WORK AND CONCLUSION

The progress of experimental computer network T-NET has been made successfully in the implementation of the first planed version where network users can access network resources, i.e., Time sharing system, Data base service system (ERIC;Educational Resources Information Center, CAS;Chemical Abstract Services), File transfer and Reconnection services up to date.

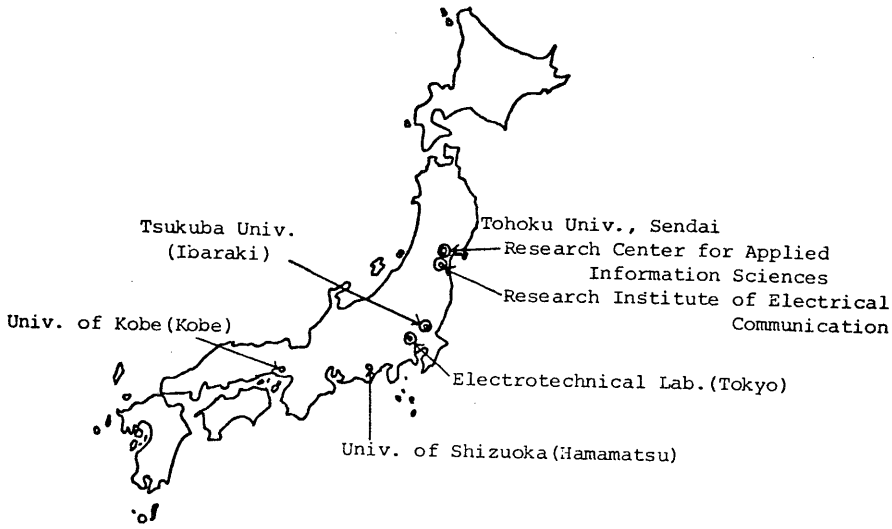
As the future work, we have been planning to introduce a network file directory manager (NDM) into the T-NET to apply the reconnection mechanism for sophisticated network file management. Therefore, with the support of reconnection procedure, T-NET will admit network users to direct file accessing with file name, asking the NDM for physical address of the file at first, then reconfiguring the communication path from the NDM to the host with the file.

ACKNOWLEDGEMENT

The authors are grateful to Prof.Emeritus.T.Kitagawa (Kyushu Univ.), Prof. K.Kido (Tohoku Univ.), Prof.K.Nakayama (Tsukuba Univ.), Dr.K.Nakayama (ETL) and Dr.H.Nishino (ETL) for strong supporting to this work and thanks to Mr. K.Takahashi (Tohoku Univ.), Mr.T.Yuba (ETL), Mr.S.Ogishima and Mr.Y.Mikami (Rikei Computer Co.) for joint effort of discussion of protocol and development of the control program.

REFERENCE

(1) Thomas, B "Reconnection Protocol, ARPA network information center" No.13011, Jan. 1973
(2) J.Oizumi, T.Takahashi, Y.Ogawa "Local Computer Network in Tohoku District" PACNET symposium proc. Aug. 1976
(3) H.Inose, T.Sakai, M.Kato "Experimental Network for Inter-University Computer Center" PACNET symposium proc. Aug. 1976
(4) C.Stephen Carr, Stephen D.Cocker, Vinton G.Cerf "HOST-HOST Communication Protocol in the ARPA Network" SJCC 1970



Note: ◎ Under the operational.
○ Under the developping.

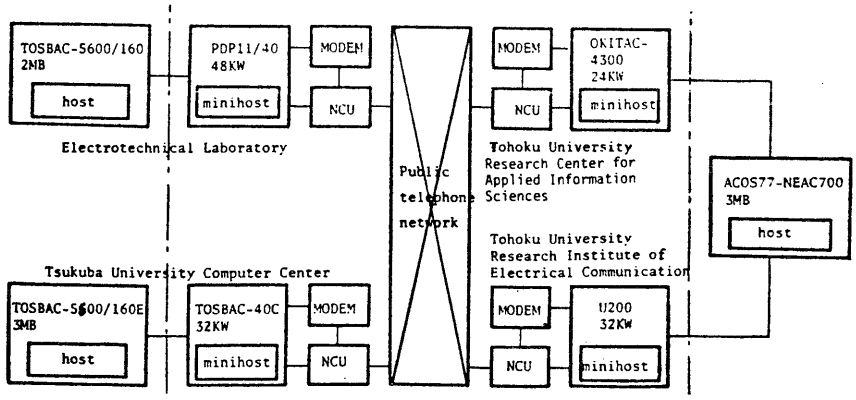


FIG. 1 PHYSICAL STRUCTURE OF EXTENDED NETWORK (T-NET)

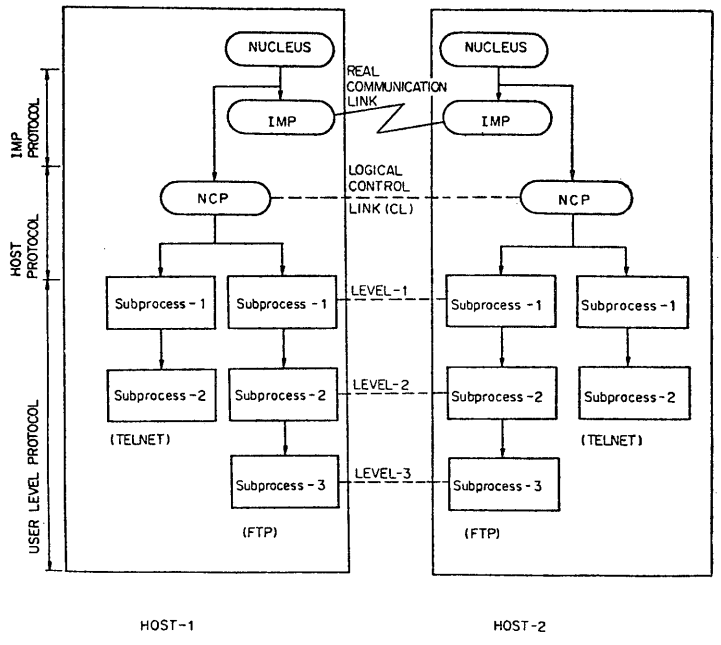


FIG. 2 LOGICAL CONTROL HIERARCHY OF T-NET

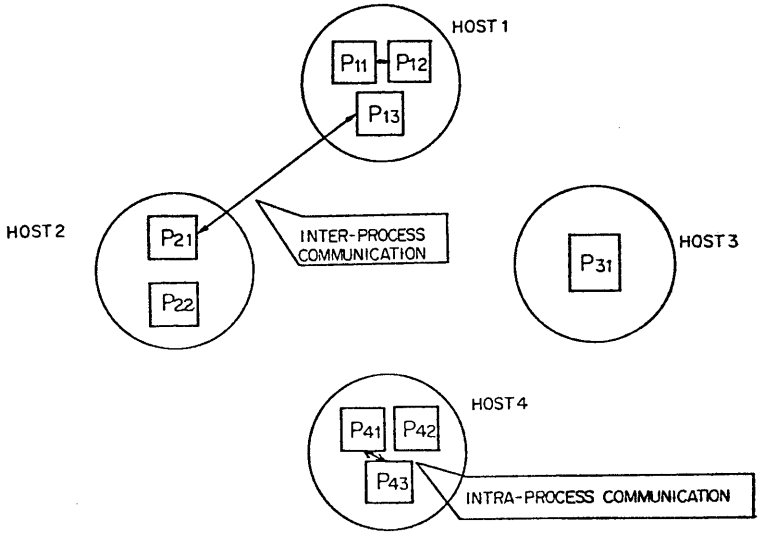
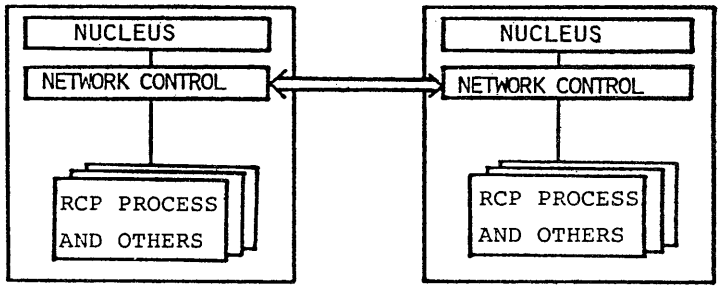


FIG. 3 PROCESS ORIENTED COMMUNICATION IN COMPUTER NETWORK



RCP: RECONNECTION PROTOCOL

FIG. 4 PROCESS-PROCESS CONNECTION

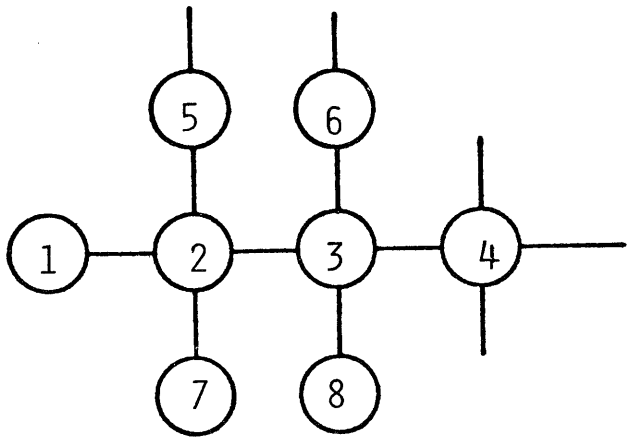


FIG. 5 AN EXAMPLE OF NETWORK CONFIGURATION WITH NUMBERED HOST-ID

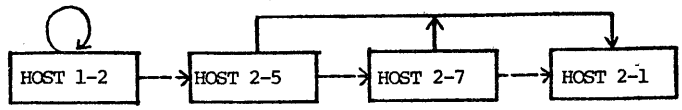


FIG. 6 GENERAL RECONNECTION FLOW (1)

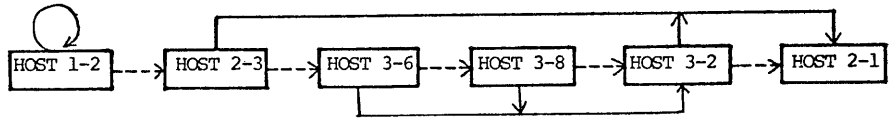


FIG. 7 GENERAL RECONNECTION FLOW (2)

Note; Host i-j indicates RCP process connections between host(i) and host(j).

----> indicates entire reconnection flow in computer network.

——→ indicates the case of occurrence of miscellaneous errors in reconnection processing.

NETWORK ACCESS COMMANDS	USER-PROTOCOL SELECTION COMMANDS	SERVICE COMMANDS	
		RESOURCE CONTROL COMMANDS	TRANSFER COMMANDS
@LOGON connect to a host @LOGOFF disconnect from a host	@TELNET TELNET protocol @DISCONNECT disconnect logical link between processes	command language of a destinated host @BYE exit from protocol	
	@FTP file transfer protocol @DISCONNECT	@CATA list a file catalogue @DEFINE define a file @DELETE delete a file @BYE	@STORE store a file @RETRIEVE retrieve a file
	@RCP reconnection protocol @DISCONNECT	@SUBMIT create a command table @SWITCH execute commands in command table @STATUS retrieve results of reconnection @BYE FTP commands	FTP commands
	@DBP data base protocol @DISCONNECT	data base access commands of a destinated host @BYE	
	@NMP network measurement protocol @DISCONNECT	@TIMES number of times of measurement @BYE	

LOCAL COMMANDS WERE OMITTED
TABLE 2 NETWORK COMMANDS

L(j); Logon command to host(j)

P ; Protocol command to select one of NMP (Network measurement protocol), FTP(File transfer protocol), TELNET protocol, RJE protocol, DBP(Data base protocol) and RCP (Reconnection protocol).

F ; Service commands autholized by each protocol.

D ; Command for disconnecting process connection.

LF(j); Command to logoff from host(j).

TABLE 1 EXPLANATION OF SYMBOLS