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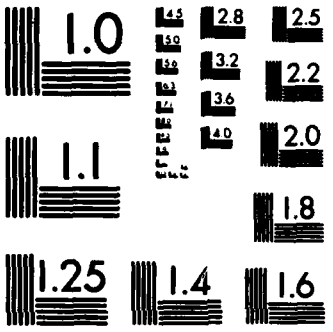

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PREPRINT - Extended Summary

The LLNL "META-MACHINE"
A Flexible, Extensible and Practical Technique for Interactive Data Management, Modeling, and Distributed Networking

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Laurie E. Gallo, John E. Swanson

Prepared for presentation at the "Work in Progress" Session
of the Fourth Berkeley Conference on Distributed
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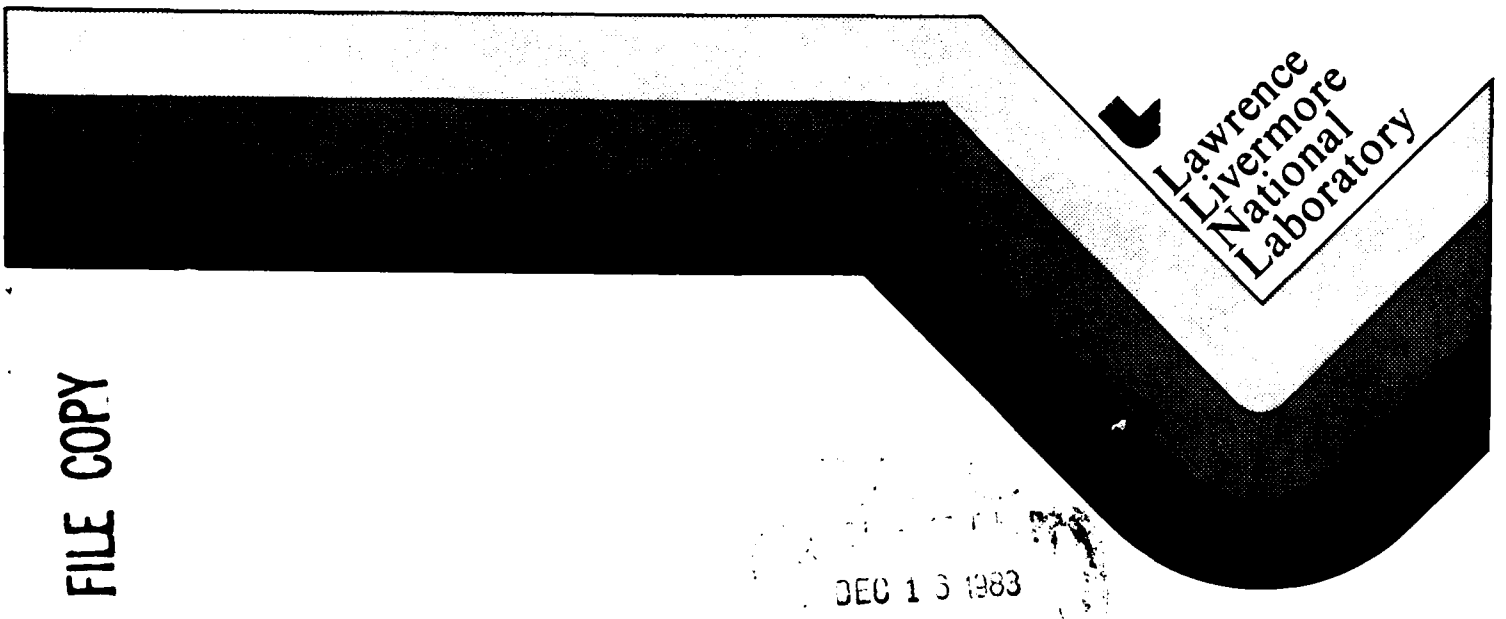
May, 1979



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The LLNL "META-MACHINE"
A Flexible, Extensible and Practical Technique for Interactive Data Management, Modeling, and Distributed Networking*

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Laurie E. Gallo,# John E. Swanson

May, 1979

Technology Information System
LAWRENCE LIVERMORE NATIONAL LABORATORY
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EXTENDED SUMMARY

This is a report
~~We would like to report~~ on the performance of a unique User/Interface that we designed and developed for a fully self-guided, integrated information system. This system is capable of interactive information retrieval, modeling, electronic mail delivery, and distributed networking. This interface is the central controller for all man-machine and machine-machine communications of the DOE Technical Management Information System (TMIS) of the Division of Energy Storage. It is currently installed on a PDP-11/70 machine at the Lawrence Livermore National Laboratory (LLNL) using INGRES, the relational data base management system developed at the University of California, Berkeley, as the primary underlying means for data storage and retrieval, [1]. INGRES and other subservient programs are, however, invisible to the user, [2].

The TMIS META-MACHINE, Integrated Information System (IIS), simulates in software a pseudo-computer where sequential instructions are retrieved from a 5 domain database relation. These domains, consisting of the primary address, a state function type, a forwarding address, an execution string, and a functional clustering attribute, can be arranged and manipulated by the System Administrator online, in real-time, without recompilation. See Fig. 1.

* Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract number W-7405-ENG-48.

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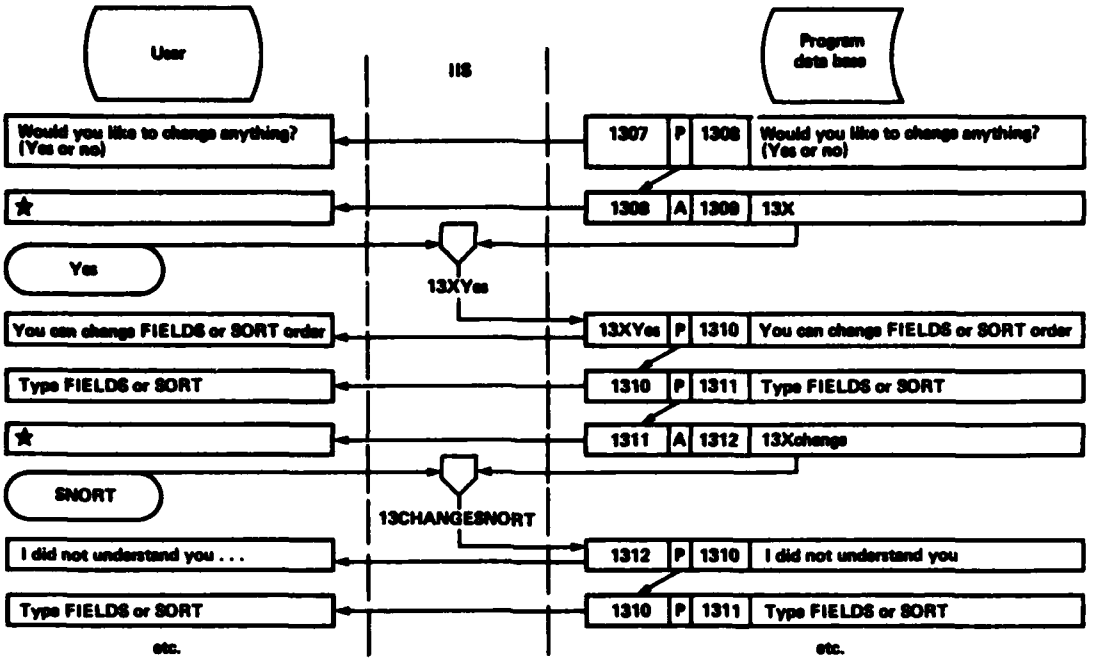

Fig. 1. Logical layout of the Program Data Base, containing the 5 domains: (1) Address (2) State Function Type (3) Forwarding Address (4) Execution String, and (5) Clustering Code. Only the first four domains are shown.

Meta instructions in the execution string contain prompting statements to be forwarded to a user, expected user responses, command strings for the underlying database management system, INGRES, [1,2] or instructions for other programs being executed under TMIS control [3]. See Fig. 2. The user is prompted by a uniform

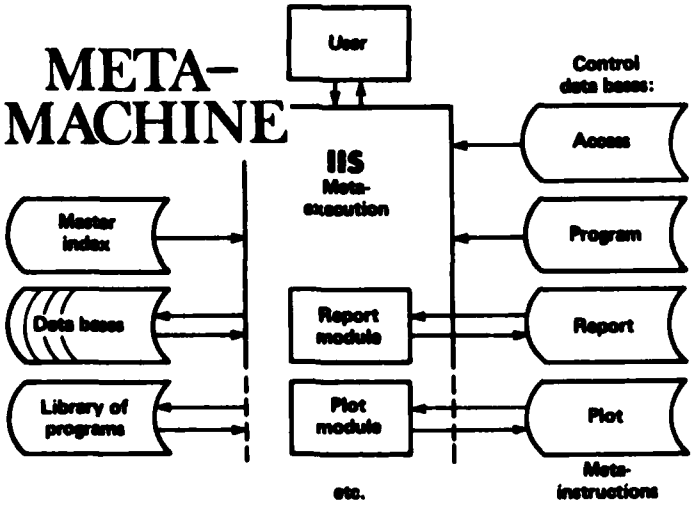

Fig. 2. Schematic layout of the LLNL "META-MACHINE" Technical Management Information System (TMIS). All instructions and data are deposited in underlying, relational data bases. The user interacts with TMIS via the 40,000-byte Integrated Information System (IIS) software kernel.

command language. The requests are matched against the available options in the hashed primary address domain of the TMIS program relation, and are exchanged and assembled into corollary command strings for whatever program TMIS is directed to execute. The transmittal of the prompting strings to the appropriate user at a terminal, or the transfer of a command stack to a program, is carried out by a 40,000-byte long program residing in memory. The 12 state functions determine the destination and type of string delivery.

The TMIS META-MACHINE approach is unusual in its use of one data management technique for access to all information, data, and executive capabilities. This includes control of access rights by user for each of the several major databases, the individual relations within each database, the user commands, and the pre-formatted reports and graphical displays. See Fig. 3.

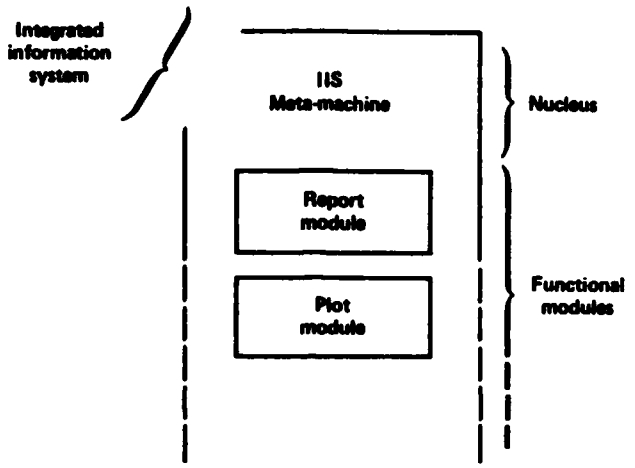

Fig. 3. Functional organization of the Technical Management Information System (TMIS) also known as the LLNL "META-MACHINE," showing the 40,000-byte kernel with its built-in report and plot modules. The meta instructions for the report and plot generators are deposited in INGRES relations. (Refer to Fig. 2.)

The flexibility of the META-MACHINE has been demonstrated by the successful integration of bibliographic, numeric, project-oriented, administrative, and budgetary relations in one system. The report writer, exceeding the ANSI COBOL74 capabilities, is also driven by instructions from the META-MACHINE. Using this unified technique, the report writer was written in 2 man-weeks. Preliminary inquiries made for this task gave us estimates of six months and about $30,000 for the delivery of a report writer by conventional programming.

The extensibility of the META-MACHINE was demonstrated earlier this year when in three days we converted an electric car performance prediction model from batch to interactive use [4]. This model, developed by the Transportation Systems Research Group at LLNL for the DOE Division of Energy Storage, prompts the user for different scenarios: vehicle type, electric battery selection, time period, Department of Transportation (DOT) driving cycle, confidence level, etc., and compares calculated results with the performance of vehicles equipped with internal combusion engines. Fourteen other models are now in preparation for different hybrid vehicles, using

flywheels, batteries, and other energy storage methods. The user of the interactive models can enter his own preferred technical values if he wishes to explore conditions that are not part of the prepared options. Validation of these models is greatly simplified by having the input data stored in individual database relations from which they are extracted, manipulated, compared, and plotted. The results of these calculations can be saved for parameter studies and for time-series analyses [5].

Multi-Lingual Interaction with users is potentially possible by simple translation of the user interaction and command language, deposited in the program relation, into languages other than English. The corollary command strings to the underlying database management system, or to other programs, remain the same. A sample interaction in Latin has been demonstrated.

Different Command Languages can be activated by the extensible TMIS database language by translating the instructions from the available INGRES command language into that of a different local, or remote, database management system or execution program. Where additional options are offered by a new system, additional prompts are appended to the TMIS program relation with the appropriate addresses and state function types in the first domains. In this case, the user interaction strings remain the same. We will explore this capability of the META-MACHINE when we duplicate TMIS capabilites with ORACLE as the underlying database management system as an alterative to INGRES [6].

Networking and Distributed Processing became operational with the incorporation of the NBS Network Access Machine software into the TMIS system [7]. Fully automated and transparent connections are available to several host machines over the ARPA National Computer Network and by telephone dial-out. These include DOE/RECON, NASA/RECON, MACSYMA at MIT, NIC at SRI, LBL-UNIX, and LBL-VAX. To connect to DOE/RECON, for example, the user simply specifies the target by requesting: connect doe-recon. The connection requires 7 to 45 seconds, depending whether ARPANET or telephone lines are used. In some cases we use the NAM software to activate, at the remote host, the needed resource immediately, in which case the target name is made identical to the resource, e.g.: connect macsyma.

Electronic Mail has been augmented by integrating the local directory and the ARPANET online user directories into the electronic mail option directory for TMIS. When the user wishes to inquire whether he can transmit electronic mail to a particular person on the ARPANET, we connect to the NIC-SRI machine in a transparent manner and use NAM to perform an online search of their up-to-date directory. The netmail address, if available, is returned to the TMIS user. Connection with the DOE/PLANET conferencing facilility at MIT is carried out analagously.

During man-machine interaction with the user, while the command execution strings are being assembled, partial transmission to the target program, local or remote, can be made in anticipation of the full command string. In this manner, and by anticipating permissible attributes and paramenters expected from the user, considerable speed can be gained by parallel execution.

We are providing an expanding number of user-oriented options on the DOE/STOR Technical Mangement Information System. Users are encouraged to create their own relations, report formats, and graphical displays. The self-guided create, append, replace, print, and plot commands for example, lead the user through the data definitions and naming of domains. When completed, relations, reports, or plots are given unique user-specified names and can be activated at any later time or shared with others. For

security reasons, all data, files, and programs are initially created for personal use only and require a positive act by the owner to permit their use by others. A link command has been established permitting tutorials to be given to individuals or to a group of users, nationwide. Here we offer the option of simultaneous creation of transcript files containing all interactions encountered during the tutorial sessions. This gives the student a printable log of the linked interaction, and can be made to monitor inadvertent abuse. See Fig. 4.

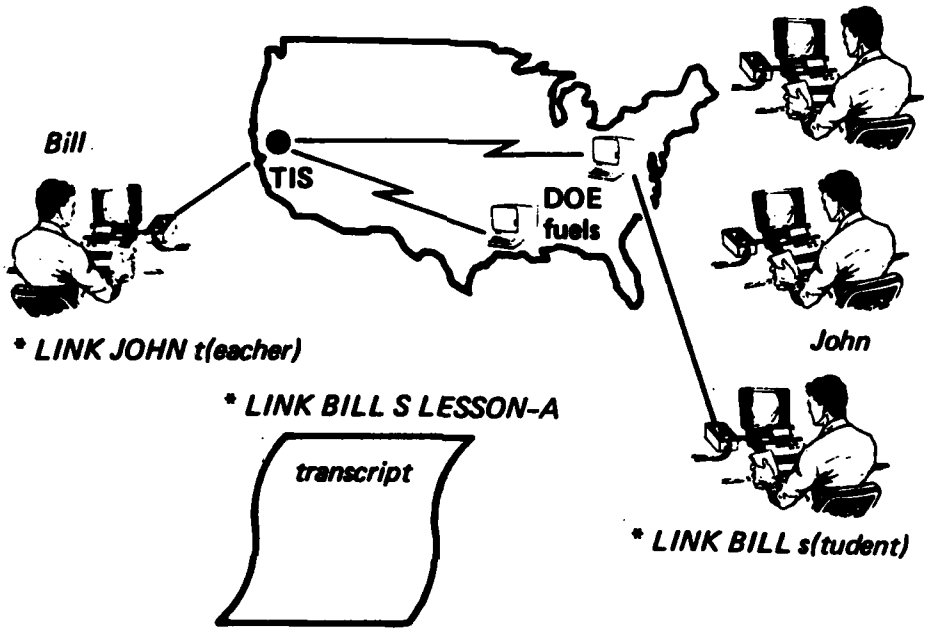

Fig. 4. In this example, Bill and John link their terminals, making their keyboards and CRT screens equivalent, by giving corresponding link commands. The teacher works by convention in the student's account who may have different resource authorizations. Simultaneous use of the voice phone provides for audio-visual help and technical consultation across time zones and geographic distances.

The META-MACHINE user interface is the foundation for the Technical Management Information System of the DOE Division of Energy Storage. At the present time, we offer over 50 data relations that describe in a hierarchical manner material properties for energy storage materials, technology characterization data, systems data that are aggregates of components used in conjunction with energy storage applications, and a number of interactive models. Econometric data are being added to permit market penetration studies. The results can be viewed in 200 pre-defined display formats. The user community of program managers and project leaders working for the DOE/STOR national program can refer to the project-oriented information on the machine as a focal point, providing a timely means of inter-communication across time zones and geographical distances [8]. We are planning to increase the data held by TMIS, add more computer systems to its network, and enhance its user interface. The management of dissimilar information and data in an integrated manner, and the use of the machine by computer scientists and casual users, provides us with challenging tasks that will require joint efforts to achieve.

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