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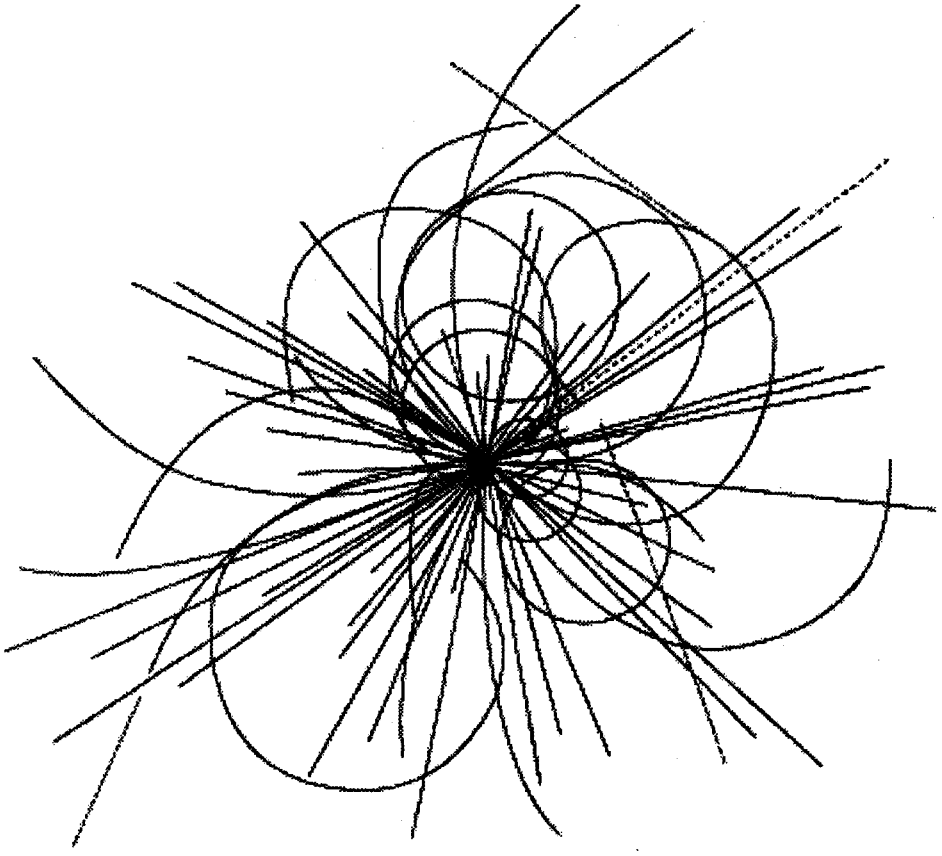

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MTL DISTRIBUTED MAGNET MEASUREMENT SYSTEM

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INTRODUCTION

The Magnet Test Laboratory (MTL) at the Superconducting Super Collider Laboratory will be required to precisely and reliably measure properties of magnets in a production environment. The extensive testing of the superconducting magnets comprises several types of measurements whose main purpose is to evaluate some basic parameters characterizing magnetic, mechanic and cryogenic properties of magnets.

The measurement process will produce a significant amount of data which will be subjected to complex analysis. Such massive measurements require a careful design of both the hardware and software of computer systems, having in mind a reliable, maximally automated system. In order to fulfill this requirement a dedicated Distributed Magnet Measurement System (DMMS) is being developed.

HARDWARE CONFIGURATION

The existence of multiple test stands for testing magnets, the inherent parallelism of the testing process and the distribution of the measurement system led naturally to the concept of applying multiple computers connected via a local area network. Such a computer network will serve two purposes: (1) monitoring and control of measurement test stands, and (2) operation of the system, data storage and analysis of measurement results. This requires the computer system to possess real-time system features as well as user-computer dialog oriented features. In order to fulfill these different requirements, two categories of computers are used. VME-based Motorola 68030 computers running the VxWorks real-time operating system are used for data acquisition and monitoring. Analysis of results and operation of

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the measurement systems are implemented on Sun Sparc workstations. Some of the measurement instrumentation is connected to the computers using the IEEE-488 interface system. A dedicated Sun server is used for long-term data storage purposes. All the computers are connected, and form a subnet, separated from the outside traffic via a router (see Figure 1).

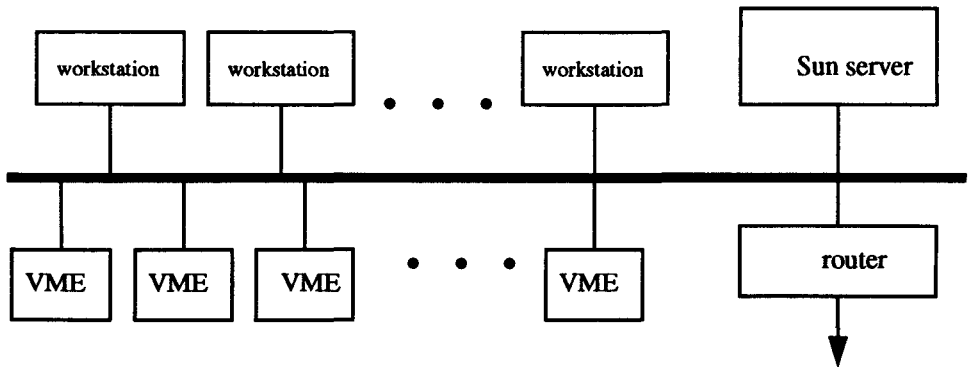

Figure 1. DMMS computer configuration

SYSTEM ORGANIZATION

One can distinguish the following elements which compose the DMMS: measurement subsystems (called also data acquisition subsystems), services, and a data handling subsystem.

The core of the DMMS is composed of measurement and quench characterization subsystems. The measurement subsystems consist of communicating processes running on two computers: (1) a workstation that hosts the user interface and stores data, and (2) a VME based computer that controls the measurement process by directly interacting with hardware modules.

The distributed character of the system introduces problems associated with managing resources and synchronization in a network of computers. Our approach to these problems is to view the distributed system not only as a collection of multiple local systems but also as a single coherent system. There will be no central authority in the DMMS to resolve problems of several activities (applications) competing for limited resources (test stands, data acquisition computers, power supplies etc.). Instead, the need for synchronization in a system sharing resources will be satisfied in a distributed fashion. Resources are available in the DMMS through services. Each service is accessible and fully controlled by a single manager process. A manager decides which requested operations to perform and in which order. The decision is made based on the current resource status and the client authorization to request service.

There will be a number of services that differ in complexity, reliability requirements, and implementation. A partial list of anticipated services follows:

1. *Protection service.* The DMMS will be protected against the use by non-authorized people by using passwords for authentication purposes and access privileges for authorization definition purposes.

2. *Interlock service.* The interlock service is an interface to the interlock system that will enable users to obtain current interlock status, reset an interlock status, and access the interlock log file.

3. *Power supply service.* The power supply service will be responsible for communication between the magnet power supply control hardware and software processes requesting changes in magnet current values. It will also coordinate requests coming from the different client processes and maintain a current change history log.
4. *Transporter service.* The transporter service is responsible for positioning probes inside magnets.
5. *Electronic logbook.* The logbook service will enable operators to write all the comments, notes, problems, questions etc. to the common log. All entries will have assigned origin data (operator name, computer) and timestamps.
6. *Exception and event logger.* The exception and event logger servers use a log technique to permanently store information about exceptions and important events that take place during operation of the system. The logs can be examined later for debugging and maintenance purposes. The present version of the service is logically centralized, implemented as a central multiple process server and distributed sub-servers, running on every computer which is under control of the system.
7. *Checklist service.* The progress of testing of a particular magnet will be reflected in the magnet checklist.
8. *System news service.* The system news service will be responsible for storing and making available to operators information which concern the recent changes in operation of the system.

DATA MANAGEMENT

The storage and retrieval of various data produced by the DMMS is based on the centralized Sybase data base system. Three logically separated data bases have been defined: magnet measurement, operation, and configuration data bases. The magnet measurement data base will contain data collected during measurements and data produced as a result of analysis. The operation data base will contain data necessary to facilitate and automate the operation of the MTL, whereas the configuration data base will maintain data describing hardware and software configuration of the DMMS.

Data produced by magnet measurement subsystems of the DMMS will be passed in files to the data handling subsystem that will be responsible for loading data to the data base and archiving original files. To facilitate the archival part of the system, the dedicated catalog data base is under construction. The purpose of this data base is mainly to maintain information about location of all original data files stored in the archives.

A simplified data flow diagram is shown in Figure 2. Dotted lines mark boundaries between logical phases in the process of measuring magnets and analyzing measurement results.

SUMMARY

The DMMS is a distributed computer system devoted to measuring properties of accelerator magnets. In this system several applications can run simultaneously and distributed resources are allocated dynamically using a non-centralized solution. In contrast to this, the data management part of the system is based on a central data base server. The data acquisition parts of the system and the data handling part are loosely coupled that eliminates the possibly negative influence of a non-real-time data base on the performance of real-time constrained measurement subsystems.

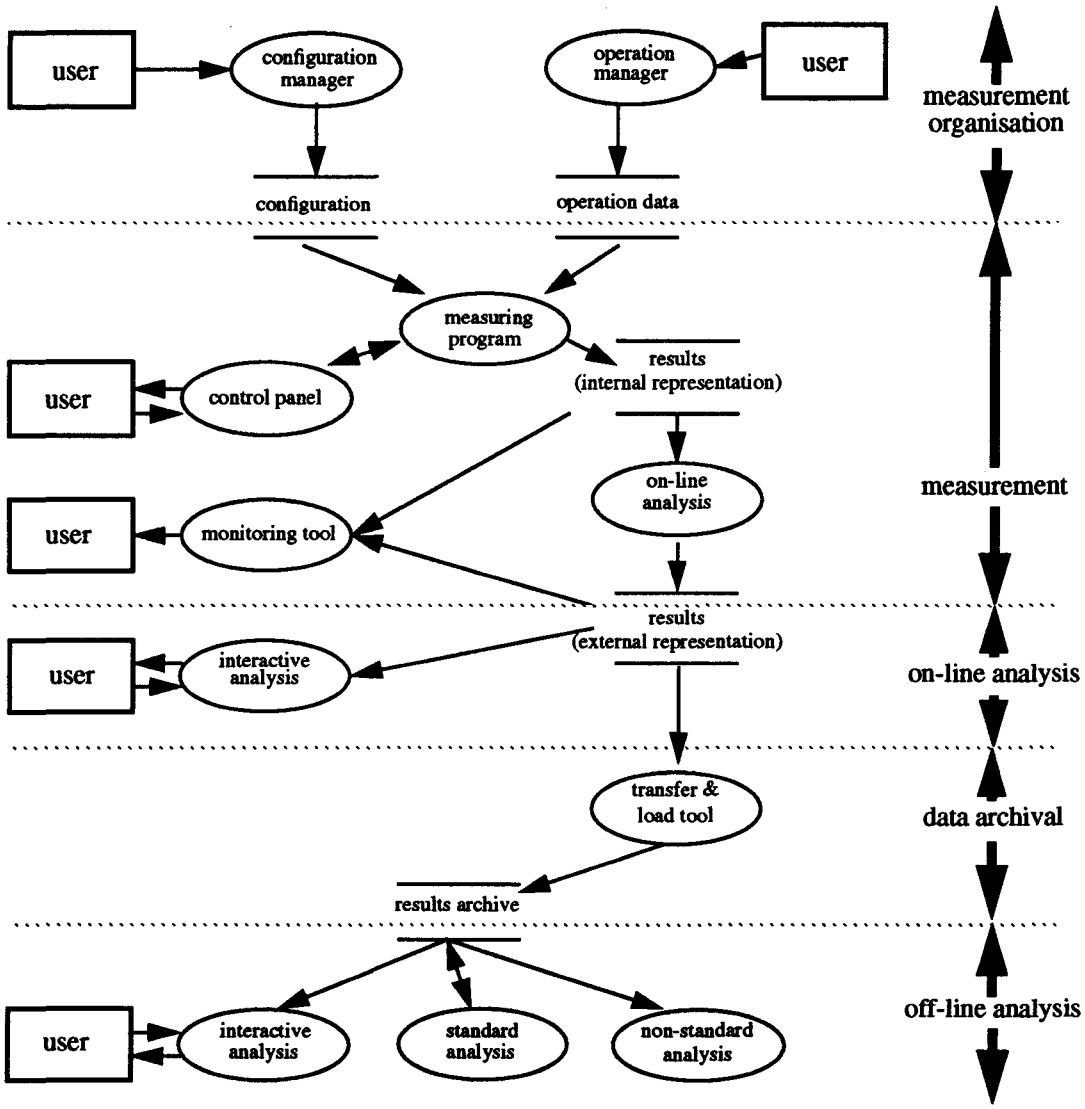

Figure 2. Simplified data flow diagram

The described system is still under development and it will be achieving its final ve sion gradually. The methodology applied to development of the system is based on both tl classical software engineering approach called waterfall lifecycle, and on prototyping. Tl classical software development methodology emphasizes through identification of softwa development phases (requirements analysis, system design, implementation, testing, oper tion and maintenance), whereas prototyping methodology manifests itself in the fact that tl development process modifies the specification as the project progresses. The users are pr vided with prototype systems to allow them to check their ideas and acquire practical me surement experience.