Multicomputer PFS

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Summary

This Product Functional Specification describes a new GCOS 8 multicomputer system design for an information processing complex with significantly increased availability and capacity which may be locally or geographically distributed. The multicomputer system design is an application of the Distributed Systems Architecture, offering tightly coupled multicomputer systems support and local network capabilities. All multicomputer capabilities described in this PFS apply to GCOS 8 and are candidates for inclusion in other operating systems as the marketing requirements dictate.

The multicomputer system design provides increased availability and extensibility by making multiple computer systems appear to the end user to be a single computing resource. The user visibility of an individual computer within the complex will not be greater than that of an individual processor within a traditional multiprocessor configuration. While the multicomputer complex provides the appearance of a single system, it is actually made up of semi-autonomous computers each with it's own operating system, cooperating at a level which creates the perspective of a unified resource. This provides both hardware and software redundancy, contributing to system availability. The multicomputer complex can be configured so that the availability of the total system will be uninterrupted by any single-point hardware or software failure. The isolation provided by the multicomputer system design will also contribute to availability by limiting the effects of any failure to a portion of the total complex. System isolation also provides enhanced extensibility. Transaction processing and timesharing logon workstations, and a global batch scheduler eliminate the requirement for end user knowledge of the configuration. In addition, an attempt is made to distribute the workload judiciously among the computers in the complex. System transparency is enhanced by sharing resources between computers. The multicomputer system design provides the framework for incorporating functionally dedicated processors into a multicomputer complex. For example, a database machine could be constructed from standard hardware and software products, and incorporated into the complex utilizing the high level data interface and the location independent storage management capabilities currently being specified as part of DSA.

Certain applications (e.g. word processing and graphics stations) require high data transmission rates and many interconnected computers and devices. The multicomputer system design will provide DSA based local network capabilities for processors connnected by a high speed bus (inter-computer connection). For example, word processing stations could store and retrieve documents from a host system's database. The high speed inter-computer connection would facilitate the transfer of documents between stations, as well as between the host computer and the specialized stations. A local network can be configured as part of a geographically distributed network. HIS systems, other than GCOS 8, and other vendor's systems, can be accommodated through a network job entry facility and through a file transfer system.

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1.0 Introduction

Recent industry and Parc trends indicate the necessity of providing locally distributed functional separation of processing, extensible systems, and high availability systems. This fact, along with the realization that Distributed Systems involve more than Networks and Communications, has led to the conclusion that the Distributed Systems Architecture (DSA) should be used to prodive a new multicomputer capability. The current capability known as Shared Mass Storage, which has served in a subset capacity, is recognized as being inadequate for the future. GCOS 8 now has the opportunity to provide this new multicomputer capability to the users, which is governed by the DSA protocol, interface, and administrative specifications.

The market requirements for this new multicomputer capability are contained in "LISD Market Requirements For a Multicomputer Complex" (see document 3.19).

1.1 Definition of Multicomputer

Computer - One or more processors sharing main memory along with associated I/O and peripheral subsystems.

Computer system - An information processing system consisting of a single computer and operating system supporting application programs and databases.

Multicomputer system - An information processing system consisting of two or more interconnected computer systems. The operating systems on the various computers cooperate to provide a single end user interface in which the configuration is typically transparent to the end user. The essential characteristics of a multicomputer system are:

- The multicomputer system appears to the end user to be a single computer system.

- The computers are typically located within a limited area. Normally this is a single building or building complex.

- The quick exchange of information among computers is critical and is typically performed via high speed connections.

1.2 Objectives

The following objectives have been established for the multicomputer system design to meet the requirements described in "LISD Market Requirements For a Multicomputer Complex" (see document 3.19).

- The multicomputer system design must increase the availability of the total computing system. This does not necessarily mean that the reliability of any single component will increase, but the availability as viewed by the total end user population must substantially increase over that of a single independent computer system.

- The multicomputer system design must increase computing power through the interconnection of multiple computers. This does not mean that the computing power seen by an individual end user will increase, but that the computing capacity viewed by the total end user population can be substantially increased over that of a single independent computing system.

- The multicomputer system design must ease the migration of GCOS 8 users to new releases of GCOS 8 and to (installation of) new computers. It is envisioned that the interfaces defined will be standardized and that each system of a multicomputer complex can be individually and incrementally updated from one operating system and software release to another.

- The multicomputer system design must provide an evolution to locally distributed functional capabilities (e.g. specialized processors).

- The multicomputer system design must provide a single uniform user interface to the total computing complex. That is, the user interface must be independent of the multicomputer configuration and the location at which hardware and software services are performed.

- The multicomputer system design must support the interconnection of other HIS and non-HIS computer systems in a single multicomputer complex. The objective is for GCOS 8 to support Network Job Entry, File Transfer, and cooperating user applications for such systems.

2.0 Business Strategy

Successful establishment of Honeywell as the leader in multicomputer technology is not only desirable for PARC protection, but it provides a vehicle for penetration of competitor's markets. It also furthers the adoption of DSA as an industry standard and reaffirms our leadership in Distributed Processing.

The multicomputer system design described in this PFS provides:

- Increased power for customers whose requirements exceed the capacity of our largest tightly coupled multi-processor systems.

- Availability approaching utility grade service for customers whose business depends on non-interruptable operation of the computer complex and fast response.

- Non-HIS host connections for special purpose machines (database, array processors, etc.) or to permit the penetration of non-HIS customers in a highly efficient, coexistent environment.

- Ease of migration to new Honeywell machines and operating systems for customers who cannot risk major hardware or software changes in a production environment.

- Allows additional customer flexibility in the manner in which he can take advantage of the decreasing cost of proccessing power while retaining the advantages of centralized operation.

3.0 Applicable Documents

3.01 - DSA Reference Book - Volume 1 (General Description)

3.02 - DSE/DSA Product Set 1 PFS-58053238

3.03 - Unified Network Control Processor PFS RX-006

3.04 - Unified Network Application/Satellite Processor PFS-39848

3.05 - Unified File Transfer PFS-58020563

3.06 - Programmatic Interface to Presentation Control, November 30, 1979

3.07 - Programmatic Interface to Message Management, Rev. 4, July 11, 1979

3.08 - DSA Link Protocol, DSA-51

3.09 - DSA Network Protocol, DSA-52

3.10 - DSA Transport Multiplex Protocol, DSA-53

3.11 - DSA Connection Protocol, DSA-54

3.12 - DSA Dialog Protocol, DSA-55

3.13 - DSA Presentation Control Protocol, DSA-56

3.14 - L66 - UNCP (Common) Exchange Interface, DSA-57

3.15 - DSA Network Batch Protocol, DSA-60

3.16 - Remote File Access Protocol, DSA-61

3.17 - Remote File Access Protocol Logical File Transfer Subset, DSA-62

3.18 - DSA Network Control and Administration, DSA-70

3.19 - LISD Market Requirements for a Multicomputer Complex, LISD P & PM, Dec. 10, 1979

3.20 - ADP Hypervisor Software EPS-58061027, R. Carlisle, Nov. 12, 1979

3.21 - Systems Description: Hyperchannel Network Adapters, Network Systems Corporation, Publication no. A01-0000-02, Rev. 2, Jan 1978

4.0 Development Strategy

The development strategy for the multicomputer system design is to divide the multicomputer capability into a series of development phases (or steps) which can be implemented over a period of several years. The subset to be implemented for each phase will be implemented using the design specifications for the full multicomputer capability.

The advantages of the phased development are:

- A phased development reduces the implementation risks by reducing the number of new functions in each release.

- A phased development plan permits a short term release of a subset of the multicomputer architecture. This will permit early user visibility and feedback. The knowledge gained from this exposure will improve later phases.

- A phased development plan permits a short term release of a shared mass store equivalent subset of the multicomputer capability to meet the marketing requirement defined in "LISD Market Requirements For a Multicomputer Complex" (see doc. 3.19).

4.1 Phase 1 Development

The primary purpose of Phase 1 is to provide a solid foundation on which the complete multicomputer functionality can be built. This phase has four major goals:

- Establishment of the multicomputer system conventions.
- Implementation of the kernel functions of the multicomputer capability.
- Implementation of a functional replacement for shared mass storage.
- Provide a customer release of the multicomputer capability to satisfy market requirements specified in document 3.19.

Phase 1 must meet the following requirements:

- Establish the conventions and standards for subsequent multicomputer development. These will be based on the appropriate DSA standards.

  + Establish the multicomputer configuration definition language which includes:

* Definition of the computers in a complex.
* Definition of the locations of system workstations.
* Definition of peripheral devices and communications connections.

+ Establish the multicomputer operator language.
+ Establish the mailbox naming conventions for both network and multicomputer configurations.
+ Establish the default mailbox names for both system and user workstations.
+ Establish the conventions for all system workstations.

- Provide the basic system functions (kernel) required for the full multicomputer development.

  + Implement the complete DSA Session Control Programmatic Interface.
  + Implement functions necessary to create and initiate system workstations.
  + Implement recovery functions for system workstations.
  + Implement startup and restart functions for multicomputer configurations.
  + Implement functions for user and system processes to be standard workstations. That is:

    * Administration of default mailbox names.
    * Creation of deault mailboxes at process initiation.
    * Loading and initialization of shared code (such as session control) early in startup so that it can be used by system workstations.

  + Modify system processes to be system workstations and to use Session Control Programmatic Interfaces for interprocess communications. These system processes include Scheduler, PALC, GEOT, GEIN, POPM, TSS, and others.

- Implement functional replacement for shared mass storage which must include support for:

  + Multicomputer shared disk drives and packs.
  + Multicomputer shared disk files with access control at the file level.
  + Multicomputer shared input (local and remote).
  + Multicomputer shared output (local and remote).

- Implement Common Exchange Interface (CXI) support for the HIS Inter System Link (ISL).

4.2 Phase 2 Development

The primary purpose of Phase 2 is to provide the capability to run multiple system releases concurrently in a multicomputer complex, provide enhanced resource management of shared resources and provide enhanced availability.

Phase 2 must meet the following requirements:

- Implement multicomputer functions to the point where multiple operating system releases can run concurrently.

- Implement enhanced resource management of shared resources to support:

  + Multiple computer connectability (shared physical connection) tape drives, and unit record equipment.
  + Shared and exclusive allocation of disk packs at the volume set level.
  + Exclusive allocation of multiple computer connected tape drives and unit record equipment.
  + Data integrity control at the control interval level for disk files as specified by the DSA I/O architecture.
- Implement enhanced availabiltiy and recovery functions which support:

  + User planned recovery of user workstations when a computer fails.
  + Integrated processing of journals at the multicomputer complex level.

- Implement the multicomputer operator functions which provides a single operator interface to control the multicomputer complex.

4.3 Phase 3 Development

The primary purpose of Phase 3 is to achieve increased configuration independence.

Phase 3 should meet the following requirements:

- Shared physical connection of disk devices is no longer a functional requirement. At this phase the use of shared physical connections is only required to meet specific availability and performance requirements.

- Shared logical connection of all relevent devices will be supported (i.e. a computer can access device independent of where it is configured in the multicomputer complex).

- Enhanced resource manager and scheduler which support:

    + Scheduling based on resource requirements.
    + Resource allocation and scheduling based on global resource utilization.
    + Resource allocation and scheduling based on shared logical connection of devices.

- Enhanced Media Management which provides coordination of media at the multicomputer level.

4.4 Phase 4 Development

The primary purpose of Phase 4 is to support multiple different operating systems running concurrently and to support specialized processors.

Phase 4 should meet the following requirements:

- Support running multiple operating systems concurrently through coexistence based on the DSA Network Job Entry and File Transfer facilities. The following operating systems will be supported based on specific marketing requirements:

    + GCOS 8
    + CP-6
    + Multics
    + Level-64 (not to be done by LISD)
    + Level-6 (not to be done by LISD)

- Support for specialized processors such as:

    + COBOL machine
    + Fortran machine
    + etc.

- Support a database machine through a non-procedural interface that is much higher than the record-at-a-time interface. This interface is currently being added to the DSA specification.

5.0 Hardware Configuration

The market requirements for the multicomputer system design call for a wide range of possible configurations to satisfy the variations in customer applications. Further, it is expected that the range of multicomputer configurations will reflect evolutionary changes taking place in the computer industry. Therefore, the hardware support for multicomputer must be designed and implemented in the most open-ended and flexible manner possible. This includes:

- The number and type of computers which can be configured in a multicomputer complex.

- The number and type of peripheral devices and their topology within the multicomputer complex.

- The ability to configure all hardware redundantly for maximum availability.

5.1 Computers

The multicomputer system design supports the interconnection of computers of many different sizes and types. This includes:

- single processor computers
- tightly coupled multiprocessor computers
- functionally specialized processors
  (e.g., database machine)
- All GCOS 8 compatible computers
  (e.g., ELS, DPS-E, ADP, CR66 etc.).
- Other HIS computers
  (e.g., L68, L64, L6 etc.).
- non-HIS computers

5.2 Inter-computer Connection

The multicomputer system design requires that each host computer in a multicomputer complex be able to communicate with all other host computers in the complex (See section 6). Since the DSA Session Layer standard does not include message switching in the host computer, the inter-computer connection must allow each host computer in the complex to communicate with every other host computer in the complex without being routed through an intermediate host. The physical characteristics of this connection (multidrop, point-to-point, the distance between computers, the number of computers and the speed of the connection) shall be limited only by the cost-effective technologies available. There may be different implementations of this inter-computer connection to meet the requirements of different multicomputer configurations (number of computers, availability and performance requirements, database size and usage, etc.).

- The minimum inter-computer connection implementation must have the following characteristics:

  + It must be compatible with the DSA Common Exchange Interface (CXI).
  + It must be high speed (>= 5 megabytes/sec.).
  + It must be capable of connecting up to four computers in a multicomputer complex.
  + It must be capable of connecting multiple HIS computer types.
  + It must be capable of distributing the computers over a relatively long distance (>= 70 meters).
  + It must be capable of connecting multiple parallel data paths for increased performance and availability.

- The maximum inter-computer connection implemented must have the following characteristics (these characteristic are similar to the NSC Hyperchannel; see document 3.21):

  + It must be compatible with the DSA Common Exchange Interface (CXI).
  + It must be high speed (>= 5 megabytes/sec.).
  + It must be capable of connecting at least 256 computers in a multicomputer complex.
  + It must be capable of connecting multiple computer types, including non-Honeywell mainframes.
  + It must be capable of distributing the computers over a relatively long distance (>= 1700 meters).
  + It must be capable of connecting multiple parallel data paths for increased performance and availability.

5.3 Peripherals

The peripheral configuration supported by the multicomputer system design must be flexible and extensible to meet the varying requirements of individual installations. These requirements include the following:

- Functional capability (see section 6.5)

- Avaiability (see section 6.8)

- Performance (see section 7.0)

Three basic types of peripheral connections are required to support these requirements. These connections are not the only alternatives available nor is a multicomputer configuration limited to a single type of connection. In fact, the types of peripheral connections used in a configuration form an extremely important consideration bearing on the availability and performance of the complex.

The three types of physical connections are:

- Connection of devices to a single computer (non-shared physical connection).

- Connection of devices to two or more computers (shared physical connection).

- Connection of devices to the inter-computer connection via an adaptor (shared physical connection).

5.3.1 Single Computer Connection (Non-Shared Physical Connection)

Figure 5.3.1 illustrates non-shared physical connection of devices to a single computer in a multicomputer complex. The difference between cases A, B, and C is the level of availabilty and performance provided through hardware redundancy.

The non-shared physical connection of peripherals has one major disadvantage which will limit its usage in some installations. Devices connected in this manner make the system susceptible to single point failures. If a computer fails, all of the devices connected only to that computer are lost from the entire complex. Further, a computer without shared physically connected devices limits the recovery of system work stations in that computer.

5.3.2 Multiple Computer Connection (Shared Physical Connection)

Figure 5.3.2 illustrates shared physical connection of devices to two or more computers in a multicomputer complex. The difference between cases A and B is the level of availability and performance provided through hardware and software redundancy.

The primary advantage of the shared physical connection is availability. Figure 5.3.2 case B provides complete protection from a single point failure. If one of these computers fails all of the work of that computer can be performed by the other computer (possibly with performance degradation). This includes the recovery of system workstations.

A second advantage of the shared physical connection is performance. If an installation has a single large database which cannot be divided into resource partitions, a single computer may not be sufficient to handle the load. This type of connection provides the neccessary additional power at the cost of some additional inter-computer connection traffic for resource management.

5.3.3 Inter-computer Connection (Shared Physical Connection)

Figure 5.3.3 illustrates the shared physical connection of devices to the inter-computer connection. This is accomplished through the use of an adaptor for the specific device type. This adaptor may vary from non-existent to a very complex function depending on the inter-computer connection implementation and the specific device. The difference between cases A, B and C is the level of availability and performance provided through hardware redundancy. Support for this type of connection is dependent upon the existence of market requirements.

The disadvantages of the physical connection of devices to the inter-computer connection are:

- There are limitations on the capacity of the inter-computer connection, based on cost and technology, which may limit the useful applications.

- There are architectual problems with controlling physical access to such devices by multiple operating system. This is complicated when a foreign host is configured in a multicomputer system.

The advantages of the physical connection of devices to the inter-computer connection are:

- All devices are equally accessable by all computers in the multicomputer complex. Therefore, this provides the maximum possible multicomputer availability.

- Since usage of these devices never requires two operating systems, this type of connection incurs the least overhead for non-local use of devices.

Figure 5.3.1
PHYSICAL CONNECTION OF DEVICES TO A SINGLE COMPUTER

```
                   INTER-COMPUTER CONNECTION
==========================================================================
       |                   |                              |
       |                   |                              |
|-----------|       |-----------|                  |-----------|
|           |       |           |                  |           |
|   HOST    |       |   HOST    |                  |   HOST    |
|           |       |           |                  |           |
|-----------|       |-----------|                  |-----------|
      |                |     |                       |       |
      |                |     |                       |       |
|-----------|       |-----------|           |-----------| |-----------|
|CONTROLLER |       |CONTROLLER |           |CONTROLLER | |CONTROLLER |
|-----------|       |-----------|           |-----------| |-----------|
      |      D            |      D                |             |    D
      |---X  E            |---X  E                |-------X-----|    E
      |      V            |      V                |             |    V
      |---X  I            |---X  I                |-------X-----|    I
      |      C            |      C                |             |    C
      |---X  E            |---X  E                |-------X-----|    E
      |      S            |      S                |             |    S
     (A)                 (B)                           (C)
```

Figure 5.3.2
CONNECTION OF DEVICES TO MULTIPLE COMPUTERS

```
                   INTER-COMPUTER CONNECTION
==========================================================================
       |                 |                   |                 |
       |                 |                   |                 |
|-----------|     |-----------|     |-----------|     |-----------|
|           |     |           |     |           |     |           |
|   HOST    |     |   HOST    |     |   HOST    |     |   HOST    |
|           |     |           |     |           |     |           |
|-----------|     |-----------|     |-----------|     |-----------|
           |         |                     |                 |
           |         |                     |                 |
         |-----------|              |-----------|     |-----------|
         |CONTROLLER |              |CONTROLLER |     |CONTROLLER |
         |-----------|              |-----------|     |-----------|
               |      D                    |                 |    D
               |---X  E                    |-------X---------|    E
               |      V                    |                 |    V
               |---X  I                    |-------X---------|    I
               |      C                    |                 |    C
               |---X  E                    |-------X---------|    E
               |      S                    |                 |    S
              (A)                                 (B)
```

Figure 5.3.3
CONNECTION OF DEVICES TO INTER-COMPUTER CONNECTION

```
                      INTER-COMPUTER CONNECTION
  ============================================================
        |            |            |             |            |
        |            |            |             |            |
    |--------|   |--------|   |--------|   |--------|   |--------|
    |ADAPTOR|    |ADAPTOR|    |ADAPTOR|    |ADAPTOR|    |ADAPTOR|
    |--------|   |--------|   |--------|   |--------|   |--------|
        |             |          |              |            |
        |             |          |              |            |
 |-----------|     |-----------|     |-----------|    |-----------|
 |CONTROLLER |     |CONTROLLER |     |CONTROLLER |    |CONTROLLER |
 |-----------|     |-----------|     |-----------|    |-----------|
        |       D          |       D         |                 |    D
        |---X   E          |---X   E         |--------X------- |    E
        |       V          |       V         |                 |    V
        |---X   I          |---X   I         |--------X------- |    I
        |       C          |       C         |                 |    C
        |---X   E          |---X   E         |--------X------- |    E
        |       S          |       S         |                 |    S
       (A)               (B)                         (C)
```

6.0 Software

The realization of the full multicomputer capability requires new designs which depart from traditional operating system designs. These designs will involve:

- Use of DSA concepts and interfaces in implementing the multicomputer capability to provide product evolutionary compatibility and inter product compatibility.

- Redesigning system components (such as scheduler, resource manager, etc.) to be system workstations and to use global algorithms in addition to local algorithms.

- Restructure system startup into steps with each step using functions provided by previous steps. For example, the Session Layer must be initialized early in startup so that System Work Stations can be initialized and communicate during startup.

- Enhancements to availability and recovery concepts are required. The complexity and topology of the multicomputer configuration will require automation of operations traditionally left to the operator.

6.1 Architecture

The multicomputer system design is a specific DSA product set which implements the maximum level of cooperation between computer systems in a DSA network. The level of cooperation is intended to provide end-user visibility equivalent to that of a single computer system.

The communications facility interconnecting computers in the multicomputer system design is based on the DSA definition of a primary network. In order to distinguish the communications facilities interconnecting the computers in a multicomputer complex from the communications facilities through which a multicomputer complex may communicate with other computers or other multicomputer complexes, the multicomputer interconnection is defined as the "multicomputer primary network". The multicomputer primary network may be a totally independent communications network (see Figure 6.1.1) or a portion of a larger communications network (see Figure 6.1.2).

The organization of system functions in the multicomputer system design is based on the DSA concept of cooperating workstations. Three workstation classes are defined for multicomputer based on the configuration attributes of the workstation (i.e., the systems in a multicomputer complex in which an occurrence of the workstation may be executed). These classes are:

- Class 1 Workstations - A workstation which may have any number of occurrences in any number of the systems in a multicomputer complex. Application workstations are typical of this class.

- Class 2 Workstations - A workstation which must have one and only one occurrence in each system within a multicomputer complex.

- Class 3 Workstations - A workstation which must have one and only one active occurrence within a multicomputer complex. There may be one or more inactive occurrences within a multicomputer complex one of which would become active in case of a failure of the currently active occurrence.

It should be noted that class 3 workstations implies a hierarchical relationship between workstations. While this may appear inconsistent with the concept of distributed processing, the feasibility of implementing a totally peer oriented organization requires further study. Thus, for a first implementation a hierarchical structure must be considered.

In the detailed design phase each system function performed in a multicomputer complex will be analyzed and grouped into workstations of one the these three classes. A conceptual overview of the relationship between workstations in a multicomputer complex is illustrated in figures 6.1.3 and 6.1.4. For this illustration the following workstations, their function and class, are defined:

- Multicomputer Administration Workstation (MCADM) - A class 3 workstation which is responsible for administration of the multicomputer complex. Its functions include startup, availability, recovery, and configuration.

- Scheduler/Resource Manager Workstation (SCH/RM) - A class 3 workstation which is responsible for the scheduling of all work, the allocation of all resources, and integrity control for the multi-computer complex.

- Operator Workstation (OPR) - A class 3 workstation responsible for handling the operator interface for the multicomputer complex.

- Multicomputer Availability Workstation (MCAVL) - A class 2 workstation which is responsible for coordinating the system in which it resides with the Multicomputer Administration Workstation. Its functions include local system startup, availability, and recovery.

- Initiation Workstation (INIT) - A class 2 workstation which is responsible for initiating workstations and processes in the system in which it resides. This is achieved through cooperation with the Schedule/Resource Manager Workstation.

- System Input Workstation (SYSIN) - A class 1 workstation responsible for reading batch job input and interfacing with the Scheduler/Resource Manager Workstation.

- System Output Workstation (SYSOUT) - A class 1 workstation responsible for dispersing batch job output. This is achieved through cooperation with the Scheduler/Resource Manager Workstation.

Figure 6.1.1
INDEPENDENT MULTI-COMPUTER PRIMARY NETWORK

```
              MULTI-COMPUTER PRIMARY NETWORK
        ==================================
           |          |          |          |
           |          |          |          |
           |          |          |          |
           |          |          |          |
     |----------||----------||----------||----------|
     |          ||          ||          ||          |
     |   HOST   ||   HOST   ||   HOST   ||   HOST   |
     |          ||          ||          ||          |
     |----------||----------||----------||----------|
           |          |          |          |
           |          |          |          |
           |          |          |          |
           |          |          |          |
```

PRIMARY NETWORK

Figure 6.1.2
SUBSET MULTI-COMPUTER PRIMARY NETWORK

PRIMARY NETWORK

```
     MULTI-COMPUTER PRIMARY NETWORK
    ====================================================================
    |              |              |              |                  |
    |              |              |              |                  |
    |              |              |              |                  |
    |              |              |              |                  |
|----------||----------||----------||----------|      |----------|
|          ||          ||          ||          |      |          |
|   HOST   ||   HOST   ||   HOST   ||   HOST   |      |   HOST   |
|          ||          ||          ||          |      |          |
|----------||----------||----------||----------|      |----------|

     MULTI-COMPUTER COMPLEX
```

Figure 6.1.3
SOFTWARE OVERVIEW NOTATION

```
.            .      Class 1 Workstation


..           .      Class 2 Workstation


..          ..      Class 3 Workstation


 --------
         /           SESSION INTERFACE
        ---------


 --------------      PROCESS AND WORKSTATION INITIATION
```

> ARROW = directed arc/edge

- Undirected arcs/edges imply peer relationships between workstations.

- Directed arcs/edges imply dependent/dominance relationships, i.e., the workstation at the base of the "arrow" is the dominant and the workstation at the head of the "arrow" is the dependent.

Figure 6.1.4
SOFTWARE OVERVIEW

.. MCADM .. .. OPR ..

..SCH/RM ..

.. MCAVL . .. INIT .

. SYSIN . . SYSOUT .

6.2 Operating Systems

The software implementations within the multicomputer system design will permit individual computers within a multicomputer complex to be updated to a new release without having to update the entire complex and without shutting the complex down. This will be accomplished by defining the inter-computer protocols for the total multicomputer capability before the initial implementation so that they will remain stable from software release to software release. However, evolutionary changes in the multicomputer requirements may from time to time require changes in the basic multicomputer design. When this happens incompatibilities between software releases may occur which will require upgrading the software on the entire complex.

6.2.1 GCOS 8

The multicomputer system design supports running multiple releases of GCOS 8 concurrently within a single multicomputer complex. However, there may be GCOS 8 changes from release to release which affect the user or operator interface. Depending on the specific change the multicomputer configuration may not be totally transparent to the end user or operator. Possible areas of visibility include:

- Operator commands
- Job control language
- User/system execution time interfaces

In order to control such visibility and allow more releases to run concurrently, the following functions are required:

- There will be optional JCL commands to specify which release of GCOS 8 is required. If not specified, the site specified default release for the complex is used (the default can be "any release").

- The multicomputer system design will build on the Distributed Maintenance Service (DMS) Software Environment Database facility to identify compatiblity between software components. Thus, it will automatically identify which software releases are compatible with a users application and schedule the application on the appropriate computer in the multicomputer complex.

6.2.2 GCOS 8 Support of Other Operating Systems

The GCOS 8 implementation will include DSA protocols to support coexistence of GCOS 8 and other operating systems (both HIS and non-HIS) within the multicomputer complex. This coexistence will be based on the DSA Network Batch Protocol (see doc. 3.15), the DSA Remote File Access Protocol (see doc. 3.16 and 3.17), and system administration protocols. Conformance to these protocols by the "foreign" system will be required for connection in a multicomputer complex.

The administrative protocols supported by GCOS 8 are:

- Operator message protocol for system operator input and output.

- GCOS 8 will maintain the status of all activities in the multicomputer system. There will be a protocol for activity status update and inquiry.

- Startup and recovery protocol to coordinate system startup and recovery.

- Availability protocol for the exchange of system status information.

- Accounting protocol for exchange of accounting records.

- allocation of peripheral devices to non GCOS 8 operating systems for exclusive use.

The functions based on the DSA Network Batch Protocol and DSA Remote File Access Protocol include:

- JCL commands to specify the operating system on which activities are to be executed.

- transfer of jobs between operating systems.

- transfer of output between operating systems.

- transfer of files between operating systems.

- access to GCOS 8 files and databases through Session Control Programmatic Interfaces to a GCOS 8 foreign system access control workstations.

These protocols are similar to those used between GCOS 8 operating systems; However, due to architectural differences between GCOS 8 and other operating systems the following limitations can be expected.

- The set of functions which GCOS 8 supports for non-HIS systems will be less than for other HIS systems.

- These systems may not be able to fully satisfy the multicomputer objective for end user transparency.

- These systems may not be able to fully satisfy the multicomputer objectives for system availability and recovery.

6.2.2.1 Other HIS Operating Systems

It is expected that other HIS operating systems will support these functions for the concurrent execution of GCOS 8 and other HIS operating systems in a multicomputer complex. This includes:

- Multics

- CP-6

- Level-64

- Level-6

The multicomputer functions supported by each of these operating systems will be specified in a separate PFS for each operating system based on the marketing requirements for the system.

6.2.2.2 Non-HIS Operating Systems

Support for non-Honeywell operating systems is limited to the degree to which the user modifies such systems to conform to DSA and multicomputer conventions. Any special functions required in GCOS 8 to support non-HIS operating systems will be specified in a separate PFS for each such system based on the marketing requirements.

6.3 Resource Management

Resource Management consists of a collection of system functions which include:

- Configuration management

- Allocation of peripheral devices

- Media management

- Allocation of files and databases

- Access control to files and databases

- Scheduling of activities

The multicomputer system design requires major enhancements to current resource management in all of these areas. In single computer systems these functions are often ignored or combined. For example, the allocation of a tape drive (device) and the mounting of a tape reel (media) are often a single function.

In the multicomputer environment the distinction between these functions must be well defined and maintained. For example, in the multicomputer environment it must be possible to allocate a tape drive (device) to a computer system which will subsequently allocate that tape drive to an activity and mount a tape reel (media).

The multicomputer system design provides extremely flexible resource management which supports the many new kinds of device types and device usage that will occur. This includes:

- Local Peripherals - Peripherals restricted to use by the computer or computers to which they are physically connected.

- Non Local Peripherals - Peripherals which may be used by computers other than the computer to which they are physically connected.

- Database machine - The implementation of a database physically connected to one or more computers in the complex which provide storage management workstation services to the rest of the complex.

- Storage hierarchy facility - A data access facility characterized by data being transferred between physical storage devices of different speeds and cost, based on the data usage or specific requests.

- Device pool - The overall cost of a multicomputer configuration can be reduced by having a single pool of logically or physically shared devices rather than having to configure sufficient devices at every computer to handle the maximum resource requirement.

In order to help tune the performance of a multicomputer configuration to specific site requirements, Resource

Management supports the concept of a "resource partition".

A resource partition is defined as "a set of physical resources and the set of all activities which use that resource set. Further, these activities do not reference any resource outside of the resource partition." Resource partitions can be defined either statically or dynamically depending on the resource management algorithms used. Various algorithms will be studied before making the final design decission.

The use of resource partitions improves performance by limiting the scope of operations. Thus:

- Limiting access to a set of peripherals to a subset of all computers in a complex (possibly to one computer).

- Reducing inter-computer data traffic

- Limiting concurrency control to the resource partition.

6.3.1 Configuration Management

The market requirements for the multicomputer system design call for a wide range of configurations to satisfy the variations in customer applications. Further, it is expected that multicomputer configurations will reflect evolutionary changes taking place in the computer industry. Therefore, the software design for multicomputer must be open-ended and flexible.

- The number and type of computers which can be configured in a multicomputer complex must not be arbitrarily limited by the software.

- The number and type of peripheral devices and their topology within the multicomputer complex must not be arbitrarily limited by software.

- In order to provide improved availability, the software must allow for the complete redundancy of all hardware and software components.

The multicomputer system design greatly expands the software and hardware view of peripheral devices. Devices which are currently considered as stand alone devices (e.g., plotters, page printers, etc.) will be handled as standard peripheral devices. In addition, evolutionary changes will introduce many new devices. Some of the peripheral devices are:

- disk devices
- tape devices

- unit record devices
- archival storage devices
- plotters
- optical document readers
- voice input/output devices
- page printers

The manner in which these devices can be configured and used is flexible and open-ended so that each site can tailor the configuration to meet its availability, performance, and utilization requirements.

The following device configuration attributes are defined:

- Shared device connection - A device which is physically connected to more than one computer simultaneously.

- Non-shared device connection - A device which is physically connected to only one computer.

- Local device use - The condition in which a device is used by an activity in the computer to which that device is physically connected.

- Non-local device use - The condition in which a device is used by an activity in a computer other than the computer to which that device is physically connected.

- Shared device use - The condition in which a device is used by more than one computer simultaneously. This is independent of shared or non-shared connection and local or non-local use.

- exclusive device use - The condition in which a device is used by only one computer. This is independent of shared or non-shared connection and local or non-local use.

The configuration capabilities supported are:

- The device attributes defined above may be assigned to any peripheral device. Each type of peripheral device will have default values based on the device type and the type of physical connection. However, the site may specify other values through configuration parameters. For example, while the default values for tapes may be local use only, the site may specify non-local use of specific tape drives.

- Any type of peripheral device may be physically connected as either shared or non-shared. Note, different occurrences of a device type can be connected in different ways.

- Devices are assigned local or non-local use attributes based on device type, physical connection, and site specified parameters. The non-local use of devices will result in additional CPU overhead and inter-computer data traffic. This must be considered when evaluating the benefits of assigning the non-local use attribute.

- Hardware and software redundancy is supported for all components necessary to access a peripheral device.

6.3.2 Allocation of Peripheral Devices

The allocation of peripheral devices includes two levels of device allocation. Devices are allocated first to a computer and then to an activity at that computer. The functions supported are:

- Allocation of devices to computers.

  + Any computer in a multicomputer complex may request the resource manager to allocate a device to that computer for shared or exclusive use. The request will be satisfied based on the request, device connections, device type, and device use attributes.

  + A local or non-local device is allocated based on the request, device availibility, and device attributes. Allocation attempts to minimize non-local device use.

- Allocation of devices to activities.

  + Any peripheral device can be allocated to an activity for shared or exclusive use based on the request, the shared and exclusive use attributes of the device, and how the device is allocated to the computer. The valid combinations of computer and activity allocation are:

	Shared activity allocation	Exclusive activity allocation
Shared computer allocation	yes	no
Exclusive computer allocation	yes	yes

6.3.3 Media Management

Media Management is the system component responsible for keeping track of all disk, tape, and other media volumes used on a computer system. Media are managed in terms of volume sets (one or more volumes used as a set). Media Management provides the facilities to support computer operation (resource allocation) and media library operation. This is achieved by a Media Management maintained catalog of volume sets, a pool of unassign volumes, and a number of Media Management interfaces.

- Media Management maintains a global media catalog for the multicomputer complex which may be either distributed or centralized.

- The media may be organized into one or more media libraries. Media Management provides facilities for both temporary and permanent transfer of media between libraries.

- All media (i.e., tape reels, disk packs, etc.) are managed as volume sets consisting of one or more entities.

- All members of a volume set are always assigned to physical drives with equivalent physical connections and device use attributes (i.e., the identical accessibility by computers).

6.3.4 Allocation of Files and Databases

Resource Management provides all of the functions necessary for effective and reliable use of large databases in the multicomputer configuration. These functions include:

- Database partioning
- Replicated files
- User initiated file transfers
- System initiated file transfers based on file use and size.
- Data integrity control to the file, control interval, and field levels for the multicomputer complex.
- File and database location independence.
- File and database data independence.
- Audit trails.
- Before and after journalization.
- Recovery after distruption.

6.3.5 Scheduling

The scheduling of activities in the multicomputer complex is a key component in providing configuration transparency. The end user will only accept transparency if the scheduler provides efficient use of the computer facility. The scheduling of activities and the allocation of resources are done considering both global and local factors. The factors considered include:

- Operating system type and release
- Administrative overrides
- User overrides
- Resources required (including processor type)
- Global resource usage
- Load leveling
- Special processors

6.3.5.1 Batch Scheduling

The multicomputer batch scheduling capabilities will be based on the DSA Network Batch Protocol and the DSA Remote File Access Protocol. The batch scheduling capabilities include:

- The input location, execution location, and output location are all independent of each other unless specified by the user.

- Activities within a job are automatically directed to a computer for execution considering the above factors.

- Activities within a job may execute in separate compatible computers with the same operating system.

- Output is automatically directed to the appropriate location.

6.3.5.2 Timesharing Scheduling

The multicomputer timesharing capabilities will be enhanced to provide the following:

- A timesharing user can request timesharing services on a specific computer in the multicomputer complex.

- A timesharing user can request timesharing as a generic service. The user's session will be scheduled on a computer based on:

    + which computers are executing timesharing
    + the user resource requirements (user profile)
    + the loading on the various computers

In this situation the computer which handles the user session is transparent to the user.

6.3.5.3 Transaction Processing Scheduling

The multicomputer transaction processing facilities will be enhanced to provide the following capabilities:

- A transaction processing user can request transaction processing services on a specific computer in the multicomputer complex.

- A transaction processing user can request transaction processing as a generic service. The user's session will be scheduled on a computer based on:

  + which computers are executing transaction processing
  + the user resource requirements (user profile)
  + the loading on the various computers

In this situation the computer which handles the user session is transparent to the user.

6.4 Files and Databases

The objectives of the Distributed System Architecture and the multicomputer system design are:

- The multicomputer complex appears to the end user to be a single computer system.

- The multicomputer complex configuration is typically transparent to the end user.

- All batch, timesharing, and transaction processing applications have a single end user view of the files and databases which they use.

- Ease of use for the applications programmer.

- Isolation of the user from details of the database design and the steps required to retrieve data. This allows:

  + The database to be changed without requiring application programs to change.

  + Inter-computer database communication between machines of different personalities (e.g., L68, L66, L64, L6, etc.).

The full realization of these capabilities can only be achieved by evolution to the new, highly structured and standardized, DSA data storage and retrieval hierarchy. The DSA storage and retrieval hierarchy consists of the following layers:

- Data independent access
- Data dependent access
- Record and file access
- Storage access
- Device access
- Physical access

The DSA storage and retrieval hierarchy is a long term development. Therefore, a short term solution to the file and database architecture must be provided in multicomputer for the following reasons:

- System components and applications require a duplicate file capability to provide additional availability. In order to provide maximum availability these files must be accessible from multiple computers.

- Current applications must be accommodated in the multicomputer environment.

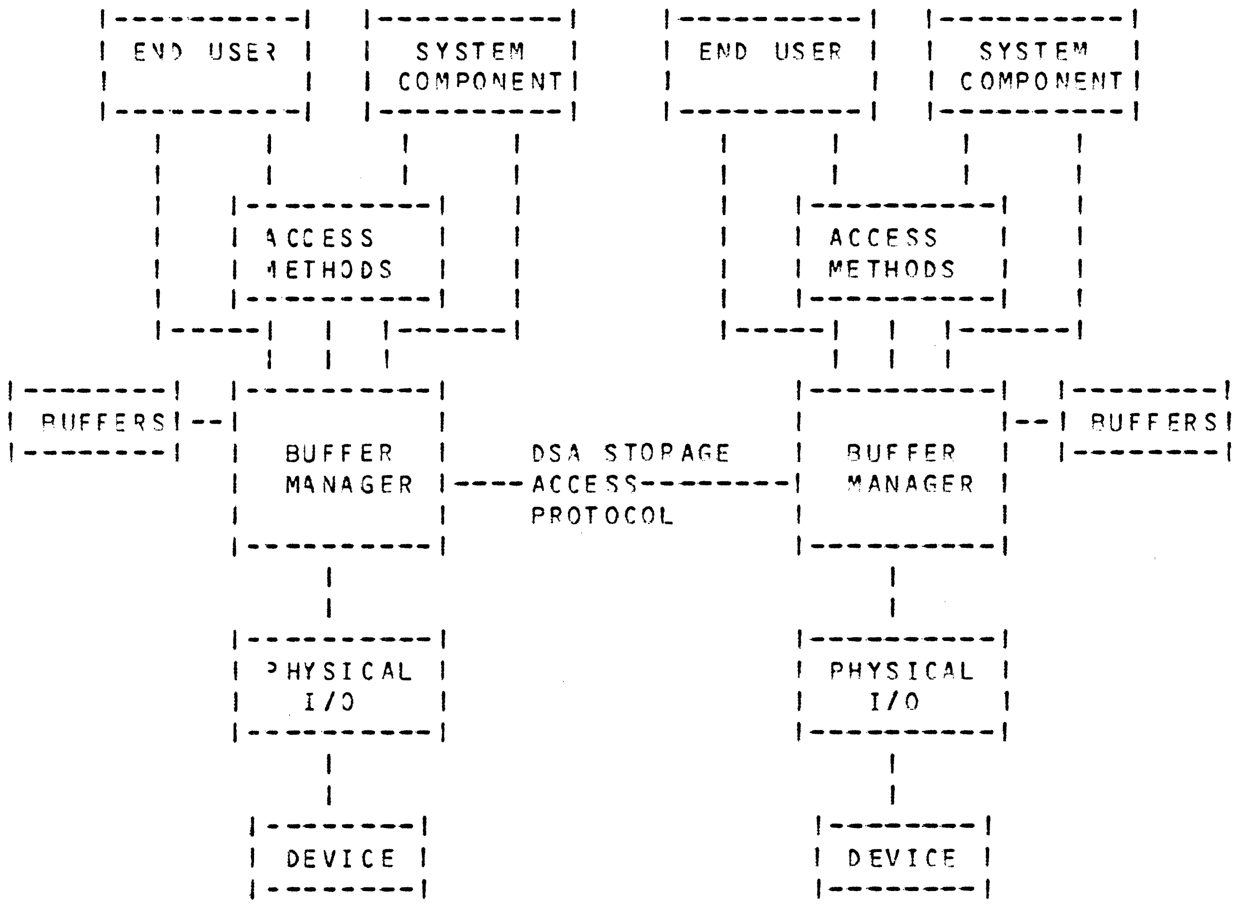
The GCOS 8 Buffer Manager performs functions similar to the storage access layer of the DSA storage and retrieval hierarchy. Therefore, the Buffer Manager will provide the following storage access layer functions (see Figure 6.4.1):

- The Buffer Manager functions as the system-wide space manager for control interval buffers for all files. Its primary function is the balancing of space requirements for "main memory" file buffer space. As such, it works as a software controlled disc buffer attempting to reduce real I/O by maintaining frequently accessed data blocks in main memory.

- The Buffer Manager is responsible for providing a duplicate file capability. When the duplicate file option is specified, Buffer Manager writes every update to the primary file and the duplicate. If there is a failure involving the primary file, Buffer Manager interfacing with File Management automatically switches to the duplicate file for all operations. In addition, Buffer Manager can read from either copy based on device usage.

- The Buffer Manager also provides an inter-computer DSA interface to access, at the control interval level, files located at remote computers.

Figure 6.4.1
BUFFER MANAGER BASED I/O SUBSYSTEM
MULTI-COMPUTER AND NETWORK CONFIGURATIONS



6.5 Operator Interface

The Operator Message Manager must provide functions which allow the multicomputer complex to be managed as a single system. Since the topology of the multi-system complex is significantly different than a single computer, this imposes a number of requirements on the Operator Terminal Manager.

- All operator messages must be assigned to message categories which are based on the type of operator function. These categories should include:

  + tape library requests
  + tape mounting
  + unit record actions
  + general information (job start, end, etc.)
  + job scheduling management
  + configuration management
  + etc.

- It must be possible to specify operator functions (i.e., message categories) for each operator terminal. Note, the functions of several operator terminals may overlap.

- Each operator terminal must be able to restrict its functions by configuration attributes (e.g., all tape mount messages for a specified list of tape drives).

- Support an unlimited number of operator terminals.

- Support operator terminals connected via data communications lines.

6.6 Startup

The manner in which operating system startup occurs must be restructured into a number of steps with each step using functions provided by previous steps. For example, the Session Layer must be initialized early in startup so that System Work Stations can be initialized and communicate during startup.

The concept of a software configuration must be added to startup to support the initiation of specific system workstations according to software configuration parameters. There are a number of system workstations for which occurrences of the workstation do not map one to one with computers in a multicomputer configuration.

The startup procedures used in the multicomputer system must be consistent with the view of a single computing complex. Thus, the startup of any individual computer involves an exchange of configuration and status information with the rest of the complex. The startup of each computer must be done with the cooperation of that portion of the multicomputer complex which is already started. The following functions are required:

- Startup of all computers in a multicomputer complex, except the first computer to be started, must require minimal operator involvement so that consistency of startup parameters across the multicomputer complex is assured.

- In addition to the standard local boot capability, an externally initiated (remote) boot capability must be provided which permits the executing portion of a multicomputer complex to boot and coordinate startup of all other computers in the complex.

- A failing computer must be able to automatically restart with the cooperation of the non-failing portion of the complex.

- It must be possible to startup a multicomputer complex even though one or more of the computers in the complex may be unavailable.

6.7 Availability and Recovery

The availability and recovery aspects of a multicomputer complex must be based on the specific user requirements. The user must consider the following factors in determining his specific configuration:

- The types of applications to be supported. Batch, timesharing, and transaction processing.

- The level of availability that is needed (utility grade, etc.)

- Performance requirements in terms of numbers of users, response time, throughput, etc.

- Overall hardware costs.

The site must be able to configure both the hardware and software to meet its specific needs. The following functions are required for maximum availibility and recovery (These must be subsetable to meet the sites needs):

- The failure of any single entity (computer, channel, device, operator terminal, software component, etc.) in the multicomputer complex must not cause the failure of the whole multicomputer complex. The capabilities required include:

  + Use of duplicate file functions for critical system files.

  + Detection of a computer failure by other computers in the multicomputer complex through inter computer availability protocols.

  + The work of system workstations will either be assumed by a system workstation in another computer or the system workstation will be restarted in another computer from the last checkpoint.

  + The multicomputer configuration will be updated and adjustments made to scheduling parameters.

  + User workstations which use system provided recovery capabilities will be restarted in another computer.

  + Configuration of redundant hardware (IOM, controller, channel, etc.). This includes shared physical connection of devices for optimum performance.

- When any new hardware, including a new computer, is installed it may be added to the multicomputer complex without shutting the complex down and restarting.

Recovery in a multicomputer configuration will be complex. Thus, the system must perform many operations which are currently performed by operators. In situations where operator intervention is required, the system must provide precise and easily understood interfaces. The functions required include:

- In order to reduce the coordination problem associated with recovering from journals, there must be:

  + A single after journal per file (with the capability for multiple copies).
  + A single before journal per process (with the capability for multiple copies).

- Restart of a failed computer in a multicomputer complex must require minimal operator involvement so that restart parameters are consistent with the non-failed members of the multicomputer complex.

6.8 Statistical Data Collection

Statistical data in the multicomputer complex must be consistent with the concept that the configuration is totally transparent to the customer. Therefore, user billing must be independent of the processor and peripheral devices selected by the multicomputer resource manager. For example, CPU seconds alone is not a valid unit of resource usage; CPU seconds must be adjusted by an appropriate CPU speed factor. A second solution would be to have the hardware count memory references.

Statistical data records on this file will contain information which uniquely identifies the resource within the multicomputer configuration. For example, the record for the execution of an activity will identify on which computer the activity executed.

6.9 Distributed Maintenance Services (DMS)

The Distributed Maintenance Services concepts must be extended to include the multicomputer complex. Areas to be extended include:

- The error logging facility in the multicomputer complex must be managed at the complex level. Information on the error log must include unique identifications of all failing components. In multicomputer configurations computers must be handled like any other device.

- Remote maintenance services must be able to access the multicomputer complex as if it were a single system.

- The remote maintenance service must be able to diagnose hardware and software problems within a computer in the multicomputer complex.

- The remote maintenance service must be able to access the error log when any one of the computers within the complex has failed.

6.10 Subexecutives

There is a significant amount of user visible functionality provided by various subexecutives. The transaction processing (ITP) and timesharing (TSS) subexecutives are of particular importance. In order for the multicomputer architecture to truly meet the user requirements, these subexecutives must be extended to encompass the multicomputer architectural objects.

Those areas which must be extended include:

- The subexecutives must be enhanced to interface with the data independent access layer of the data storage and retrieval hierarchy to achieve file and database location independence.

- The subexecutives must be enhanced to optionally provide load leveling capabilities of subexecutive users across the multicomputer complex. This can be done at various times including log in, transaction initiation or periodic rebalancing.

- A computer failure within a multicomputer complex must be transparent to the subexecutive users on other computers and cause minimum disruption to users on the failing computer.

- The multicomputer configuration must be transparent to the subexecutive users.

The functions supported by each of the GCOS 8 subexecutives will be specified in a separate PFS for each Multicomputer release based on the market requirements for that release.

7.0 Multicomputer Performance

The actual performance of any given multicomputer complex will depend heavily on the hardware configuration and software options chosen. The primary factors that will affect performance are:

- The specific availability options chosen.
- The size and distribution of the user database.
- The rate and distribution of database usage.
- The manner in which peripheral devices are configured. The number of devices, whether devices are shared between computers, etc.

In order to achieve optimum performance for each customer, the multicomputer system design must include the tools necessary to accurately measure user performance and provide the information needed for better configuration management. Tools for distributing (partioning) the user database will be particularly important in achieving optimum performance.

8.0 Standards

Software releases for the multicomputer system design conforms to HIS standards applicable to software products as required by Honeywell Policy HIS-8, Product line Unification and Standardization, and Distributed Systems Architecture.

Applicable standards include:

- DSA Reference Book - Volume 1 (General Description)
- HDNA Link Protocol, NT-51
- HDNA Network Protocol, NT-52
- HDNA Transport Multiplex Protocol, NT-53
- DSA Connection Protocol, DSA-54
- DSA Dialog Protocol, DSA-55
- DSA Presentation Control Protocol, DSA-56
- DSA Network Batch Protocol, DSA-60
- Remote File Access Protocol, DSA-61
- Remote File Access Protocol Logical File Transfer Subset, DSA-62

8.1 Design Standards

The Multicomputer design will be a top down design using Wellmade standards. This will result in several important benefits:

- Improved design documentation
- Improved productivity of designers and developers
- Improved product reliability
- Improved product maintainability
- Modularity and reduced intermodule dependence

8.2 Implementation Standards

All implementation will be done in a high level implementation language wherever feasible. This will result in several important benefits:

- Improved productivity of developers
- Improved product reliability
- Improved product maintainability
- Modularity and reduced intermodule dependence
- Standard interfaces

The implementation of the multicomputer system design may result in increased system overhead. In order to prevent any such overhead from becoming intolerable, the following measures will be taken:

- Within DSA implementation standards, every possible measure must be used to prevent unnecessary overhead. These standards may be modified after implementation, if instrumentation shows it is needed.

- The impact of the multicomputer implementation on single computer configurations must be minimized.

- The implementation must include the metering necessary to measure and correct any performance problems that may occur. This should be done in a manner that permits easy removal for production systems (e.g., via macros).

The increased overhead required to support the multicomputer complex will be compensated by the following:

- Overhead must be compensated for by better utilization of resources at the global level.

- Overhead must be compensated for by improved availability of the system. That is, less down time, less time spent recovering from failures, etc.

9.0 Documentation

Documentation must be provided for all the prospective users of the the multicomputer system. The level of detail ranges from concept documents for prospects and end-users through detailed reference manuals necessary to start and operate a Multicomputer Complex.

While initial documentation may of necessity be conventional hard copy, full cognizance should be taken of the advantages of on-line documentation, either via terminal display or using microfiche readers and the like. The need for documentation mobility within a multicomputer system will be at least as great as the need for application or database mobility. This need will impact both the document distribution costs to deliver the documentation to the user and the costs to transfer the documentation within the user system environment. The following sections define the various categories of documentation required.

9.1 End-User Documentation

End users as defined here include casual users of the system, non-computer professionals and interested observers. Documentation required for this class must emphasize the basic concepts employed together with the mechanics of interacting with the system (e.g., sign-on, application activation, file access, communication with another end user). Documentation at this level will not describe implementation or detailed language options. On-line documentation will emphasize a "first aid" capabilty, usually in response to a "help" command. Help must be provided in both training (for first time users) and diagnostic (for unexpected conditions) mode.

- A Multicomputer Concepts and Facilities Manual is required and must be available at the time of announcement of the first release. This document describes both the system design and how the multicomputer capabilities can be used. The document should indicate the kinds of multicomputer complexes that can be configured and how they would be used to support a customer's business needs.

9.2 Application Development Documentation

Application development is primarily concerned with the implementation of new procedures. Documentation required for this class of user must include reference documentation on the various procedure languages supported as well as instructions for linking new procedures into the existing application structure. Among the most important aspects of this integration phase are:

- How to establish a communication session in a multicomputer system.

- How to send and receive messages within a communication session.

- How to interface to the database facility.

- How to interact with other tasks and programs.

9.3 Multicomputer Administration and Control Documentation

The multicomputer administrator controls the entire complex, hence this area demands the richest and most varied documentaton. Basically, six categories of documentation are required:

- Complex configuration and startup

- Database distribution and definition

- Catalog and Media management

- Access control and security

- Operation of the complex (including monitoring and tuning)

- Configuration management (reconfiguration)

Within each of these categories, two classes of documentation are required: The formalism for accomplishing the objective and the assistance in making the decisions themselves. Here again an on-line capability is highly desirable because of the opportunities for linking decision considerations with on-line system performance monitoring tools.

10.0 Glossary (For DSA definitions see the DSA Reference Book - Appendix A , DSA Terminology)

- Activity - An activity is the basic unit of work which is scheduled. Some examples of activities include:

  + A job step (batch)
  + A session (timesharing)
  + A transaction (transaction processing)

- Archival storage device - A mass storage device intended for infrequently accessed files. Typically such devices offer low cost, high capacity storage at the expense of accessibility. Due to the access time characteristics of these devices, files are often staged to high speed devices during periods of file activity.

- Buffer Management - A software component in GCOS 8, similar to the DSA storage access layer, which functions as a system-wide space manager for data files. Buffer Management functions as a software controlled disk buffer - attempting to reduce real I/O by maintaining frequently accessed data blocks resident in main memory.

- Concurrency Control - See data integrity control.

- Computer system - An information processing system consisting of a single computer and operating system supporting application programs and databases.

- Data dependent access layer - A DSA term.

- Data independence - A DSA term.

- Data independent access layer - A DSA term.

- Data integrity control - A DSA term.

- Data Storage and Retrieval Hierarchy - A DSA term.

- Database - A collection of files of stored records where each file is constructed in accordance with a single storage-oriented data description.

- Database Processor - A functionally dedicated computer responsible for the functions of the storage management workstation.

- Device access layer - A DSA term.

- Disc Cache Buffer - A buffer, transparent to central processor software, which is used to reduce real disc I/O by maintaining frequently accessed data blocks in a dedicated separate memory. The cache would be located close to the disc, possibly in the controller or channel.

- End-User - A DSA term.

- Functionally Distributed - In a functionally distributed system activities are segregated based on their type. A database processor is one example of a functionally specialized processor. Other types of functional specialization include higher level language processors such as COBOL or FORTRAN machines, and special editing or text preparation processors. Specialized hardware, firmware and software systems can be employed in a specialized processor, such as a firmware interpreter in a directly executable higher level language processor, or it can simply involve the functional dedication of conventional systems. For example, a database machine can be configured from standard hardware and software products.

- Inter-Computer Connection - A direct physical link between each computer in a multicomputer complex and every other computer in the complex.

- Layer - A DSA term.

- Multicomputer Complex - A Multicomputer Complex consists of two or more inter-connected computer systems and sufficient software to coordinate resources and processing activities at the multicomputer level. The complex typically will be locally distributed and will present a single end user view of the system.

- Physical access layer - A DSA term.

- Record and file access layer - A DSA term.

- Session Control Programmatic Interface - A DSA term.

- Session Layer - A DSA term.

- Shared Logical Connection - With a shared logical connection multiple hosts can access a single device. This device might be physically connected to only one computer, or may be physically shared by multiple computers. If physically connected to only one computer, that computer will access the device for other hosts in the complex.

- Shared Physical Connection - A shared physical connection requires direct physical paths between an I/O device and multiple hosts. This does not imply that the device in part or in whole will be used simultaneously by more than one host.

- Storage Access Layer - A DSA term.

- Storage Management Workstation - A DSA term.

- System Work Stations - System workstations are workstations which support system functions. The user visibility of these workstations is equivalent to that of conventional operating system processes. System workstations in the multicomputer environment, will provide functions including subsystem managers, availability/recovery functions, and scheduling.