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# AN APPROACH TO A REAL-TIME DISTRIBUTION SYSTEM

Frank P. Kittle, Jr.
McDonnell Douglas
16055 Space Center Blvd.
Houston, TX 77062

Eddie J. Paddock
McDonnell Douglas
16055 Space Center Blvd.
Houston, TX 77062

Tony Pocklington
McDonnell Douglas
16055 Space Center Blvd.
Houston, TX 77062

Lui Wang
NASA - JSC
FM72
Houston, TX 77058

## ABSTRACT

The requirements of a real-time data distribution system are to provide fast, reliable delivery of data from source to destination with little or no impact to the data source. In this particular case, the data sources are inside an operational environment, the Mission Control Center (MCC), and any workstation receiving data directly from the operational computer must conform to the software standards of the MCC. In order to supply data to development workstations outside of the MCC, it is necessary to use gateway computers that prevent unauthorized data transfer back to the operational computers.

Many software programs produced on the development workstations are targeted for real-time operation. Therefore, these programs must migrate from the development workstation to the operational workstation. It is yet another requirement for the Data Distribution System to ensure smooth transition of the data interfaces for the application developers. A standard data interface model has already been set up for the operational environment, so the interface between the distribution system and the application software was developed to match that model as closely as possible. The system as a whole therefore allows the rapid development of real-time applications without impacting the data sources.

## INTRODUCTION

In this real-time distribution system, the recipients are development programs supported by the Mission Planning and Analysis Division (MPAD). The data sources are controlled in an operational environment which is located in the MCC. The programs under development are real-time applications such as artificial intelligence expert systems. These applications require access to real-time data streams for development and testing phases. They are also targeted for real-time operational workstations inside of the MCC, so all data interfaces to the distribution system must provide for a smooth transition between these two environments.

Data is transferred to operational workstations throughout the MCC by means of Local Area Networks (LANs). Any workstation receiving data through these LANs must conform to the software standards and procedures of the MCC. It is therefore necessary to use Gateways as a common medium for supplying data to the development workstations outside of the MCC. These Gateway workstations adhere to the MCC standards and procedures and most importantly prevent unauthorized data transfers back to internal MCC systems, such as the Mission Operations Computer (MOC).

## GATEWAYS

In the MPAD data distribution system, there are two operational Gateway machines receiving data from two separate LANs in the MCC (see Figure 1). The MITS (MOD-IPS-TACAN System) Gateway provides for trajectory data, and the CAS (Calibrated Ancillary System) Gateway provides for telemetry data. These Gateways transfer data through a common LAN to designated development workstations. This through-put connectivity is handled with User Datagram Protocol (UDP) sockets.

The UDP protocol provides a procedure for application programs to send data packets to other programs with a minimum of protocol mechanism. The protocol is transaction oriented, and delivery and duplicate protection are not guaranteed. This means that bad or missing data packets are not re-transmitted as with the Transmission Control Protocol (TCP). In the Gateway scenario, this re-transmission is not desirable due to the high data flow requirements imposed on the Gateway machines. The UDP socket connection also allows the flexibility of a multi-socket to single-socket connection which is used in the Gateway (MITS and CAS) to development workstation network interface. In this interface, each Gateway has a

separate "sending" socket that transfers data to a single "receiving" socket at the development workstation. Hence, the UDP protocol is ideally suited for the MPAD data distribution system.

Using Gateways provides the development users with real-time operational data streams while isolating their applications from the strict operational procedures enforced by the MCC. All applications running on an MCC operational workstation must be "flight certified" for each shuttle flight. Flight certification includes rigid configuration management and extensive integration testing for each software release, with all certified software being frozen 45 days prior to the launch date. The Gateway software is a flight certified application running on an operational workstation, whose job is to transfer data to workstations outside the MCC while not allowing access to the MCC operational systems. Since the certified gateways do not allow access from the development workstation back to the MCC, they relieve the development user from the certification requirements while providing him with the benefit of real-time data streams.

## DEVELOPMENT WORKSTATIONS

The MPAD development workstations are UNIX platforms that provide application programs with a software interface to the real-time operational data sources. This interface can be described by dividing it into two software components: the Network Interface Driver (NID) and the Application Interface Layer (AIL) (see Figure 2). The NID interprets UDP data packets from the LAN and then routes the packets through a shared memory buffer pool system to message queues which are designated for each data source driver in the AIL. The routing destination is defined by the Data Source Routing Table. This table is configurable by programs running in the AIL. This allows for dynamic start-up and shutdown of real-time data sources on the development workstation.

The message queues mentioned above allow for a quick passage of shared memory buffer pointers from the NID to the AIL. Each message queue has a corresponding data source driver. These drivers are responsible for translating data types that originate from their respective sources to a common Real-Time Interface (RTIF) format. After translation, the driver transfers the data to another shared memory area and releases the passed buffer. This shared memory area is surrounded by an RTIF layer which, through a set of function calls, allows applications to connect to real-time data sources. The RTIF is governed by an Interface Agreement (IA) document that was developed by a working group for the MCC environment. This IA provides for the software commonality that allows for a smooth transition when the application migrates from the development environment to operational workstations inside the MCC.

## OPERATIONAL WORKSTATIONS

The MCC operational workstations are also UNIX platforms which have operational LAN connections. These workstations have strict configuration management and LAN access procedures which are controlled by a Workstation Executive (WEX) software package (see Figure 3). All operational applications run under WEX, and connect to real-time data sources through interfaces provided by the executive's operational software. These interfaces, such as its RTIF, are software libraries with the same syntax and functionality as those used on the development workstations. Since these RTIF software libraries adhere to the same IA, applications can be ported to the operational environment with little effort. Porting requires transferring the application source, re-compiling and then linking in the operational RTIF library. Therefore, by using the RTIF, user applications see no difference in the data interface between development and operational machines.

## INTERFACE SOFTWARE

All applications and interface software described in this distribution system are written in the C programming language on UNIX operating systems. The application interface software uses multi-processing with a heavy emphasis on Inter-process Communication Software provided by UNIX. The workstations described in this configuration are UNIX platforms from a wide selection of vendors. Portability of applications between these workstations and generic interfaces that support all data sources were the key driving forces, and were considered in all software design phases.

## CONCLUSION

In summary, this approach to a real-time data distribution system provides development users outside of the MCC with an interface to MCC real-time data sources. In addition, the data interface was developed with a flexible and portable software design. This design allows for the smooth transition of new real-time applications to the MCC operational environment.

# MCC Working Environment Hardware Diagram

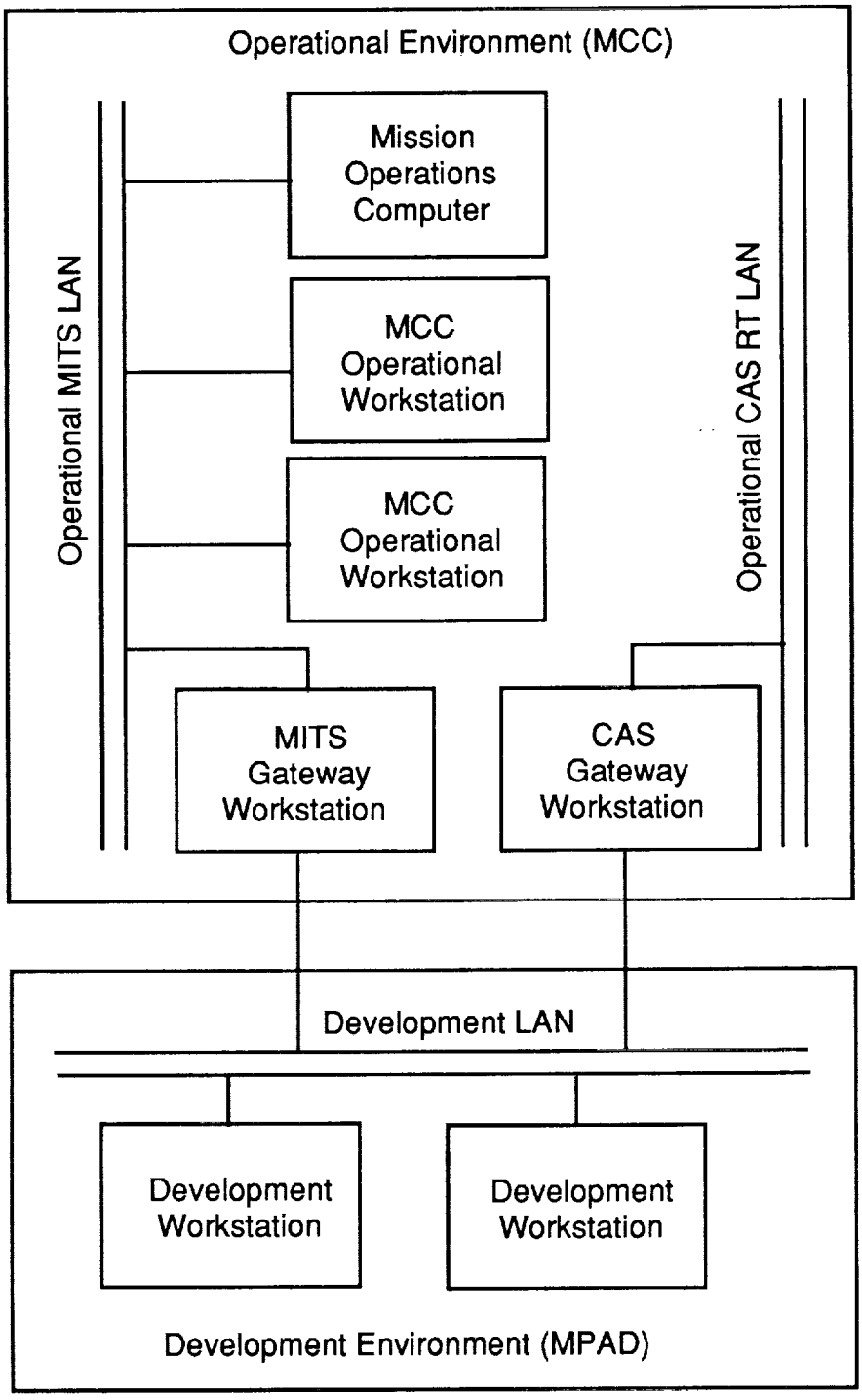


Figure 1.

# Development Workstation Software Diagram

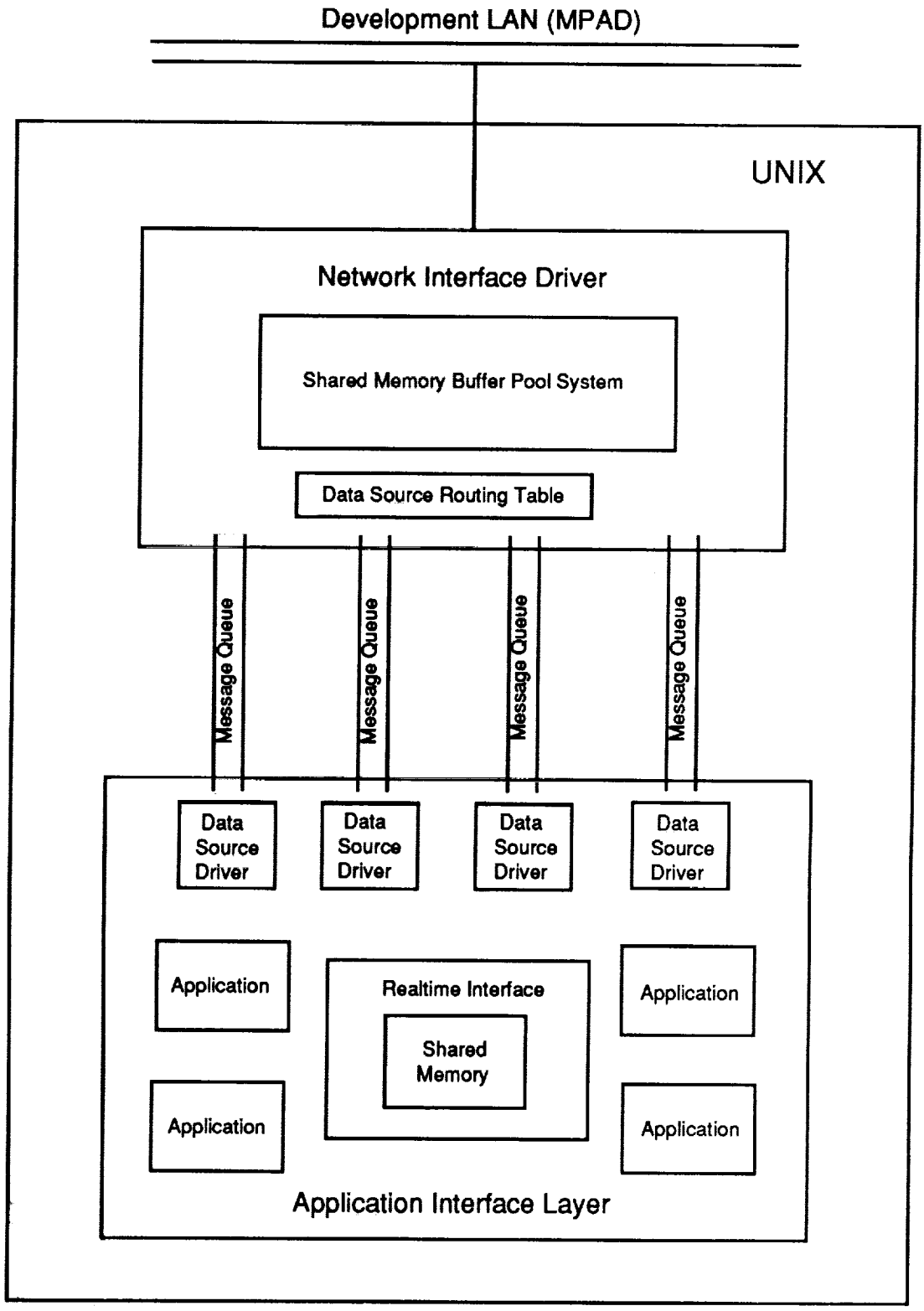


Figure 2.

# MCC Operational Workstation Software Diagram

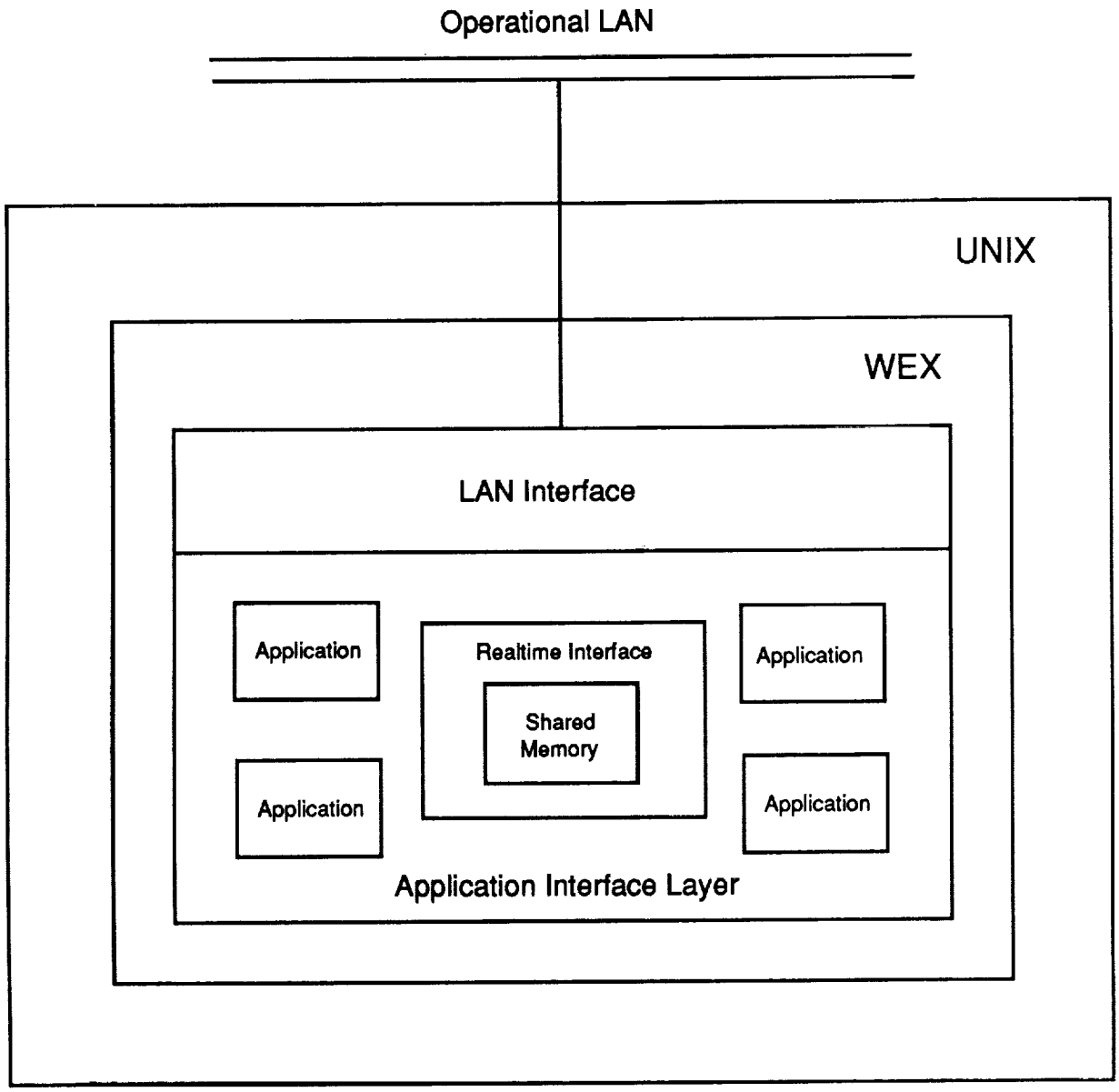


Figure 3.