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AUTOMATED MAP MAINTENANCE

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STATUS OF AUTOMATED MAP MAINTENANCE

As of today, the Texas State Department of Highways and Transportation has limited automated procedures for map maintenance. The primary effort in automated mapping has been to develop procedures for digital capture of map features, plotting and conversion of digital data from our existing TEAMS format to the new TRIMS/Intergraph format.

REPLACES THE MANUAL MAP CREATION PROCESS

Mr. Frank Cooper's "Computer Aided Cartography Position Paper" noted that computer assisted cartography had been initially developed to simply replace the manual map making process with the creation of digital maps that can produce hardcopy products. The disadvantages to this approach that Mr. Cooper described are evident. However, the priorities given to automation of engineering design and drafting functions have not allowed this approach to be significantly altered. Mr. Cooper also notes that an organization's priorities typically present a problem in the automation of a cartography operation.

LIMITED AUTOMATED PROCEDURES FOR MAP MAINTENANCE

Any automated procedures that are now being used by the Texas SDHPT for map maintenance are some adaptation of a procedure developed for base map creation. This has not yet presented a serious data integrity problem because there has been limited availability of digital data for users outside of the central cartography unit.

LIMITED SPECIAL MAP PRODUCTION BY USERS

Special map production outside of the central cartography unit has been accomplished by copying a file or sending a tape to another office and then depending on a CADD operator's individual skills for further enhancements. With the limited availability of digital data, there has not been a lot of emphasis on developing automated procedures for special map production.

COMPLETION OF DISTRICT DATABASE

However, now that most of the District and State Map database has been created and a significant amount of the County and Urban Map database has been created, this situation could rapidly change. Many users outside of our centralized cartography unit are now wanting access to the District

database for various planning and map production operations. Mr. Cooper notes that this is when the typical GIST-C project becomes more dependent on the map maintenance subsystem.

MAP CREATION AT OTHER OFFICES

In addition, other offices are wanting to participate in the creation and maintenance of these databases. Mr. Cooper implies that the creation and maintenance of the mapping databases should be the function the central cartography unit. However, it appears that this will not always be the case in Texas, due to the existing workload on our central cartography unit. The predicted schedule for completing the County and Urban Map database has caused a few of our district offices to inquire about digitizing the counties and urban areas in their district.

SIZE OF THE GRAPHICS NETWORK

The size and distributed nature of our graphics computer network also provides incentives to automate map maintenance procedures. Our existing VAX/Intergraph network is composed of our four computers at the Automation Division in Austin, three computers at other divisions offices in Austin, and one or more computers at each of our 24 district offices, all interconnected via Ethernet. Approximately 200 graphics workstations are now connected to the network and 102 additional new workstations and 65 micro-computer workstations will be operational by the end of the year. Another similar procurement is scheduled for fiscal year 1988.

MANY POTENTIAL USERS

Most of the map maintenance activities will involve very few workstations outside of the central cartography section in Austin. However, many of the workstations throughout the state will require access to the databases for map production.

DISTRIBUTION OF THE DATABASE

This will require the applicable District database to be stored on each district computer and the complete District (Statewide) database to be stored on the central and division computers. It will also require the applicable portions of the Urban and County database to be accessable. Limited disk space will probably not allow all urban areas or counties for a district to be stored at one time.

REASONS FOR AUTOMATED MAP MAINTENANCE

In summary, the conditions mentioned above indicate that the automation of map maintenance procedures will become a necessity in the near future. These conditions are summarized below:

1. The completion of significant portions of the mapping databases.

2. The growing demand for special map production.

3. The creation and maintenance of portions of the mapping databases at offices other than the central cartography unit.

4. The requirement to distribute the mapping databases to a large number of computers in the network.

5. The requirement to have different data on each computer in the network.

SOME AUTOMATED PROCEDURES ARE REQUIRED

Without some type of automated procedures it appears that it will be almost impossible to ensure that the contents of the mapping databases distributed throughout the network are kept current and valid. It should also be noted, that automating all required procedures for maintaining these database may not be completely practical or cost efficient at this point in the SDHPT's implementation of computer assisted cartography. However, it is obvious that some automated procedures plus standarized methods will have to be implemented if the databases are to be distributed throughout the state.

AUTOMATED MAP MAINTENANCE IS OVERLOOKED

Mr. Cooper noted that maintenance appears to be the most overlooked element in an automated cartography system. The future data integrity problems that Mr. Cooper mentions can probably not be avoided if a well-planned map maintenance subsystem is not implemented. A system like the the "Map Maintenance Subsystem" presented in Mr. Cooper's position paper appears to be a logical solution.

OBJECTIVE OF MAP MAINTENANCE SUBSYSTEM

The objective of the Map Maintenance Subsystem is to maintain the integrity of the cartographic database or masterfile. Mr. Cooper described many of the functions that a map maintenance system should provide. The following listincludes many of the functions that Mr. Cooper

described. The list also includes several other functions that appear to be important. It should be noted that this list of functions is relative to the maintenance needs in the Texas SDHPT's automated cartography operation. Our existing mapping databases primarily consist of the graphics database component of the GIST-C described in Mr. Cooper's paper.

FUNCTIONS DESIRED

1. The system should provide the ability to extract a maintenance work file from the cartographic masterfile. The extraction process should allow data to be extracted by feature I.D., groups of features or geographic boundary (quad, county, district, etc.). All further update activities should make use of this work file.

2. The system should create an audit trail or some other mechanism that can be used to differentiate between the original data and the data that is added, revised or deleted.

3. The system should provide the ability to create plots or displays that allow the viewing of the updated map or a combination of the updates and the original data.

4. The system should protect against unauthorized write access to the cartographic master file by personnel other than those authorized by the cartography section.

5. The system should protect against multiple updates to the same feature or area by locking (change to read only) those features extracted from the cartographic master file.

6. The system should create status information relative to ongoing maintenance. Users that attempt to access data undergoing updates should be advised of the update status.

7. The system should provide a method to merge the resulting maintenance work file with the cartographic master file.

8. The system should provide archiving, backup and recovery procedures.

9. The system should provide the ability to maintain the masterfile on multiple computers within the organization's computer network. This should provide the ability to maintain a portion of the masterfile as well as the entire masterfile.

10. The system should allow a cartographer at a remote site to perform creation and update activities on a portion of the masterfile. The system should not allow the cartographer at a remote site to perform the final update procedure. This should still be a function of the central cartography unit.

EXAMPLE OF DISTRIBUTED MAP MAINTENANCE SYSTEM

Figure 1 represents the context diagram for a Distributed Map Maintenance System that performs many of these tasks. This diagram includes a Central Map Maintenance Subsystem and a Regional Map Maintenance Subsystem. This is represented in this manner in order to indicate that different functions need to occur at the central cartography computer and a regional or remote computer. The Central Map Maintenance Subsystem would be used to perform all maintenance activities by the central cartography unit. The Regional Map Maintenance Subsystem would only perform those activities that ensure the appropriate portions of the regional masterfile were identical to the central masterfile.

EXAMPLE WITH REGIONAL CARTOGRAPHER

Figure 2 represents a similar system that would allow a cartographer at a regional site to perform many of the map maintenance activities. In this diagram the cartographer extracts the work file and performs the digital update functions. However, the central cartography unit will approve all updates and will then activate the final update procedures at both the central and regional sites. Figure 3 was included to define the edited manuscript that is input to both of the above diagrams.

CONCLUSION

In conclusion, many decisions have to be made within the Texas SDHPT relative to the automation of map maintenance procedures. We are hoping that this conference will provide valuable information in making these decisions.

DISTRIBUTED MAP MAINTENANCE SYSTEM

WITH CENTRAL CARTOGRAPHER

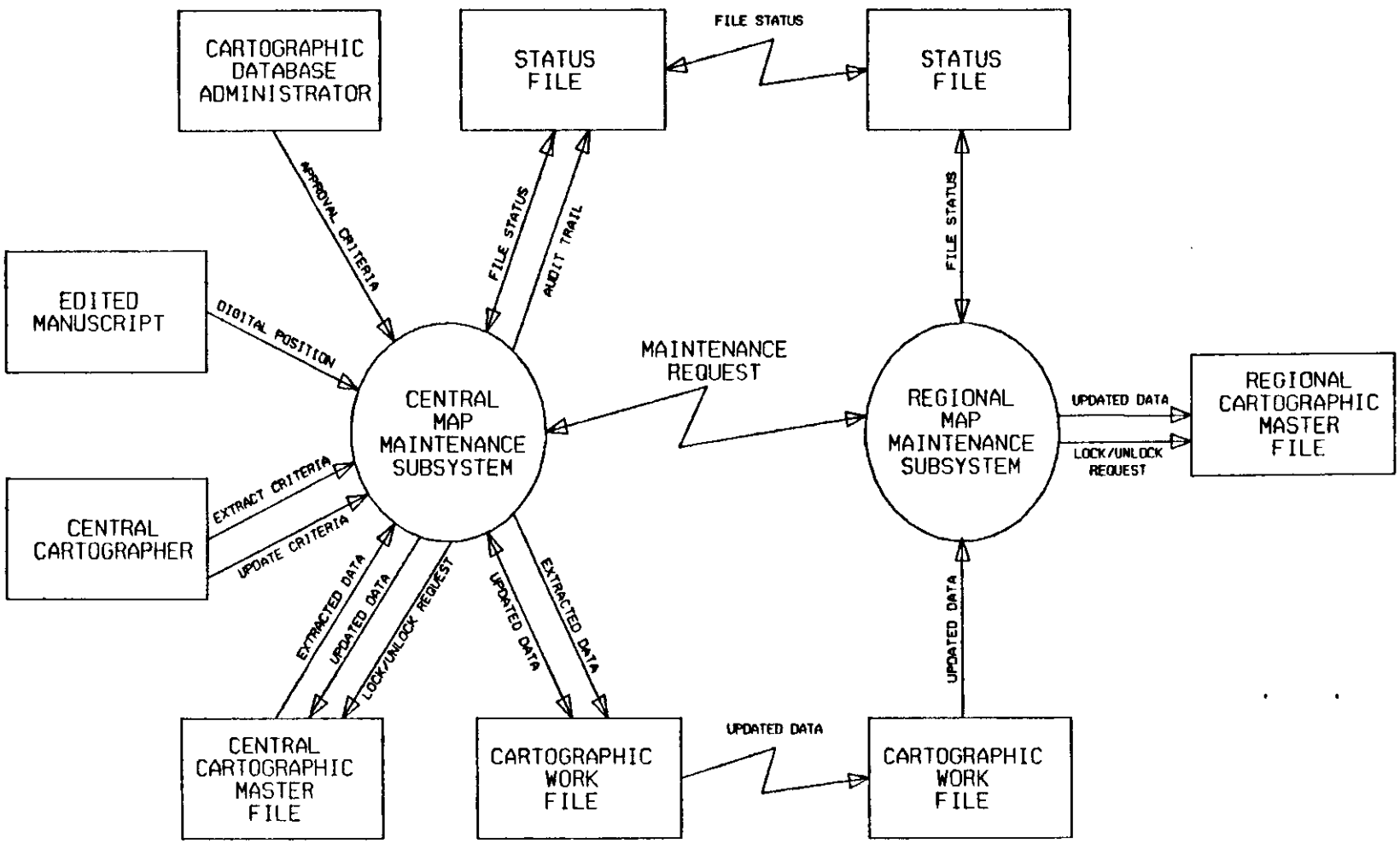

FIGURE 1

DISTRIBUTED MAP MAINTENANCE SYSTEM

WITH REGIONAL CARTOGRAPHER

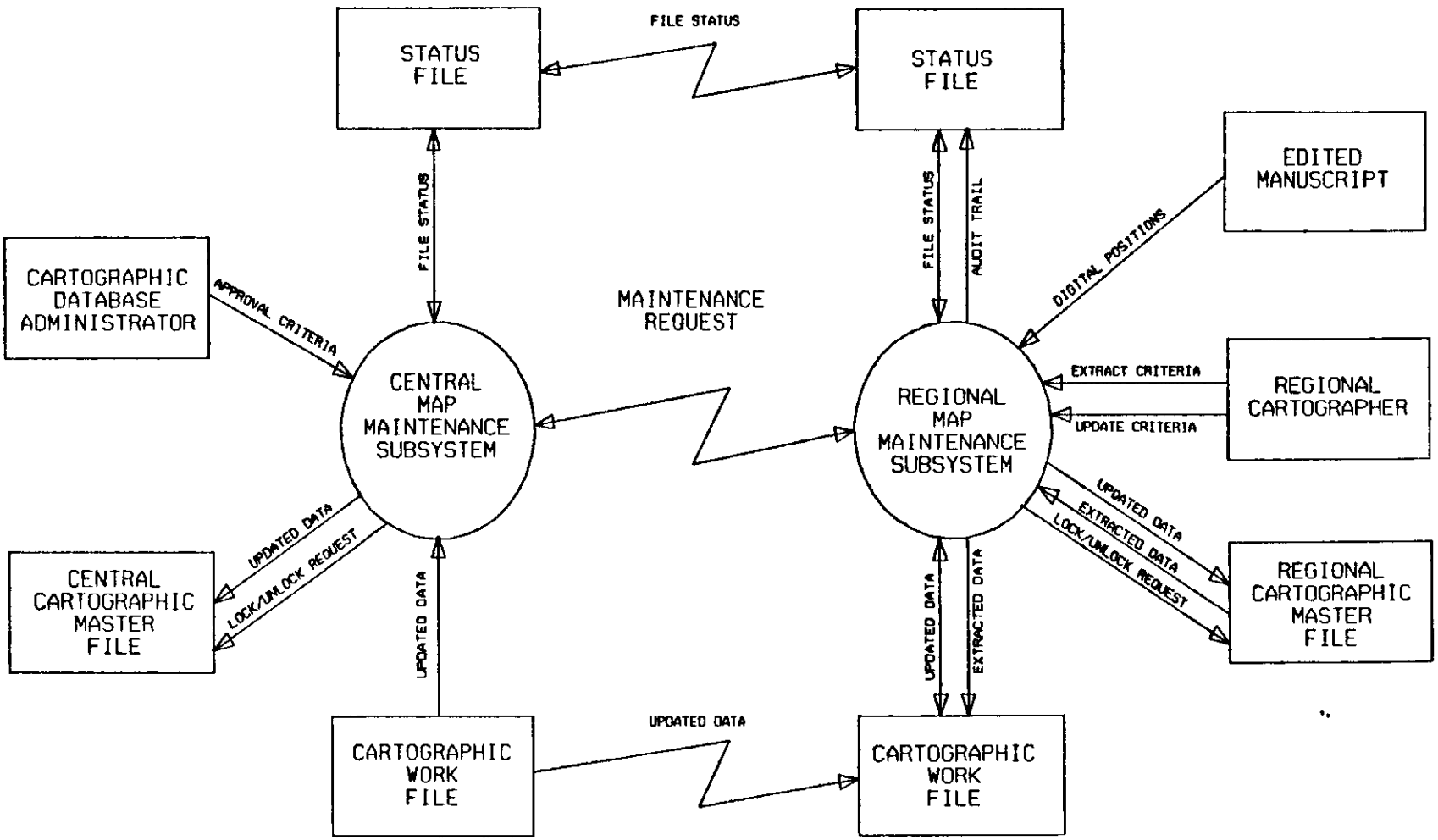

FIGURE 2

MANUSCRIPT PREPARATION

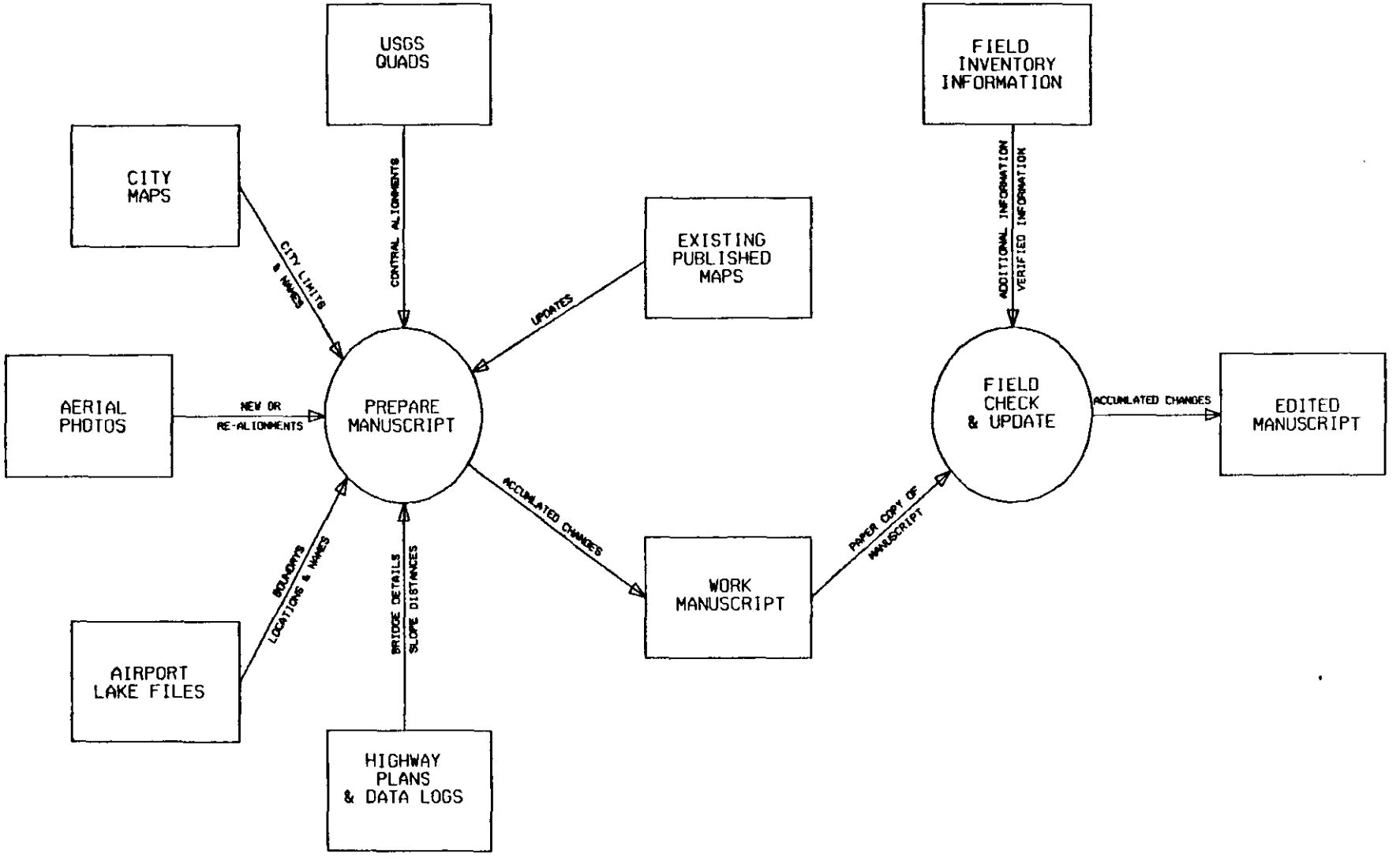

FIGURE 3