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Implementation and Database Issues Involved in Enhanced 9-1-1 Emergency Services and Rural Addressing Systems

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Introduction

Some of the key problems in developing rural addressing systems and a statewide enhanced 9-1-1 system revolve around coordination between the different local governments, state agencies, and telephone companies involved. All three have important roles to play in providing enhanced 9-1-1 service, each with different administrative and information resources to offer. The three sections of this document focus on a different aspect of this problem.

Section I identifies strategic options for implementing E 9-1-1. Phone companies and the government agencies providing E 9-1-1 have different service boundaries and different types of available information. This creates the need for different strategic options, depending on the relative sizes and capabilities of government agencies and phone companies, and state and local agencies to provide E 9-1-1.

Section II outlines the procedure for developing a database for E 9-1-1. It is a step by step handbook detailing the data needed and the process for bringing it together. The handbook is meant to be used as a guide in the case study development of an E 9-1-1 system in an Oregon county. Information gained in the case study will be used to refine the handbook, so that it can be used as a guide for the development of E 9-1-1 in other counties.

Section III includes three short pamphlets, each describing in layman's terms some of the issues discussed in the first two sections. These pamphlets are intended to be educational in nature, and it is suggested that they be copied and disseminated among those needing an introduction to the issue.

The aspect of E 9-1-1 of major concern in this report is the development of a database by which the street address of a caller to an emergency dispatch system is linked to the appropriate Emergency Service Zone (ESZ). The Master Street Address Guide (MSAG) provides the linkage of address and ESZ.

The conversion of street addresses to ESZs is only part of the emergency dispatching process. Consequently, MSAG development must be accompanied by the development of street intersection files, route and milepoint referencing, and street and roadway networks for calculation of minimum paths for computer-aided-dispatching. Digital street and roadway networks with address ranges enable the derivation of all of the above capabilities. The U.S. Bureau of the Census TIGER (Topologically Integrated Geographic Encoding Referencing) line files provide a valuable resource by which to develop these multi-purpose digital street networks and to provide MSAGs to companies and to Public Safety Answering Points(PSAPs), intersection files, route and milepoint files, and networks for dispatching.

Section I

Strategic Options for Implementing Enhanced 9-1-1

Introduction

The purpose of this paper is to explore the transition from the 9-1-1 single number emergency service request system to an enhanced single number system. An enhanced system is one that displays the address of the telephone which is being used to report an emergency and uses that address to identify the correct unit for dispatch. Though the technology has been available for some time now, surprisingly few enhanced systems have been fully installed. Telephone company franchise and jurisdictional boundaries rarely coincide, making it difficult to achieve cooperation in bringing together governments and competitive telephone companies. Outlined below is an attempt to structure this problem in a broad context, which can be used to develop statewide policies, standards, and procedures.

The State's Role in Enhanced 9-1-1 Emergency Number Planning and Implementation

The Oregon Emergency Management Division has successfully implemented legislation which mandated and funded (through a state tax on telephone service), a basic 9-1-1 system. Anyone in the state of Oregon who needs emergency assistance such as an ambulance, the fire department, or police service need only call the easily remembered number 9-1-1 and they will be connected to a Public Safety Answering Point (PSAP). The PSAP will then route the call to the appropriate response agency.

While the 9-1-1 system is a vast improvement over the old system, where every agency had a different 7 digit telephone number and precious time was wasted finding the right number to call, the technology has advanced beyond the basic 9-1-1 system. Some problems with the 9-1-1 system are, a PSAP operator must get the calling party to answer a series of questions about the nature of the emergency, and the location, then the phone call is transferred, which usually requires the caller to answer the same questions over again. In some cases, the originating caller must be switched (or re-routed) as many as three times before getting the appropriate agency dispatcher. While this is clearly faster than the older way, the perception of delay is greater in the already stressed mind of the person making a call for emergency assistance.

Another problem that has always plagued dispatchers is the overwrought caller who is excited or stressed and cannot clearly provide address or location information. The 9-1-1 system has more clearly highlighted this problem, since "9-1-1" is much simpler to remember and use, more calls are being made by individuals who are unable to complete the complex operation of requesting emergency assistance. Children, for example, are taught that if there is a problem to call 9-1-1. But once connected, the operation becomes much more complex and they have not usually been taught or prepared for the remaining tasks, which is to answer the questions. Another problem is the individual who in mid-call becomes incapacitated, such as a heart attack victim. In the past, if the line connection had not been interrupted, the call could have been traced through the older mechanical phone switching equipment, which was a time consuming job. With today's modern telephone

switching equipment, the job of back tracing can be immediate. More recent advances in switching equipment will enable the display of the number of the originating call.

Reasons for Developing a Statewide Approach to Implementing Enhanced 9-1-1

- faster and more accurate dispatching of appropriate emergency response teams to emergency situations
- consistent levels of emergency service protection for all residents of the state
- assurance of complete coverage for all areas and locations within the state
- ability to dispatch to all locations, whether described by address, intersection, road name, milepoint or coordinate
- cost efficiency and uniformity of costs for dispatching and related services
- improved reporting of ancillary information regarding crime, emergency needs and unsafe highway and road conditions
- better coordination with state mapping issues and the ability to work with a standardized state base map

The Geographical Nature of Enhanced 9-1-1

Boundaries of telephone company franchise areas and jurisdictions of emergency service providers rarely coincide, yet calls have to be routed from telephone companies to the appropriate PSAPs. In some cases, PSAPs may accept calls for several telephone companies. To illustrate the basic steps of an enhanced system, two models are presented. Figure 1, the "Single telephone company serving multiple PSAPs," shows a telephone company dominated system. This kind of system is most likely to occur in heavily urbanized areas and is characterized by concentration of people served by a single telephone franchise with many jurisdictions providing emergency services. Since many of the deployment decisions regarding police beats, ambulances on standby, and fire equipment are a function of the number of households, the emergency service zones will be relatively small. Figure 1 shows the basic flow when a 9-1-1 call is made. The switching equipment[1] at the phone company automatically identifies the number of the originating telephone line (ANI). That phone number is then used in a query of the customer data files (CDF) to match a customer record. The address of the customer is then put into memory, and the street address is matched to a data file called the Master Street Address Guide (MSAG). The street name is found and the address is matched to one of several ranges for that street. Once the appropriate range is identified, the correct PSAP is identified. The call is then routed to the correct PSAP with the address and the Emergency Service Zone (ESZ)[2]. Procedures for updating the MSAG are needed to incorporate new streets and

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[1] Not all telephone switching equipment has the ability to provide immediate back tracing, this is a feature of the newer modern equipment.

[2]The actual internal data processing involved in making the above matches can happen in a variety of ways, and each phone company may have a routine which it favors. The three basic ways of doing it are: 1) the MSAG method described in the text, 2) actually encoding the PSAP/ESZ identifiers directly onto each customer record, 3) creating a new separate data base, (like the MSAG) in which the phone number, address, PSAP, and ESZ are the only fields. Each of these three methods involve tradeoffs in the amount of

changes in emergency service boundaries. As shown here, the phone company would have to deal with the individual PSAPs, and would be responsible for identifying inconsistencies and contacting the appropriate PSAPs should an error be discovered.

The other model, Figure 2, the "Single PSAP served by multiple telephone companies," shows a PSAP dominated system, and is most likely to occur in a rural setting. In this situation, a large county with small cities is likely to have large ESZs and several small telephone companies. In this case, it is conceivable that the PSAP might obtain the customer data files, or at least the relevant portions of the CDF and build their own data base of addresses to phone numbers. Here, the flow of an emergency request would be: the telephone company's switching equipment determines the telephone number of the originating line, and then routes the phone number and the call directly to the PSAP. Using the MSAG, the PSAP determines the ESZ and dispatches the appropriate response teams, or routes the call to the right dispatching agency. In this model, the most significant updating procedure involves cooperation in obtaining the CDF from the individual telephone companies. Some phone companies are reluctant to share that information. It is also important to note that the volatility of the CDF is much higher than the volatility of the ESZ data files. That is to say, the CDF file changes significantly each day, while the ESZ data files are more likely to change less frequently.

The two models, Figure 1 and Figure 2, can be thought of as the extremes of a continuum between telephone dominated systems and PSAP dominated systems. Probably nowhere in the State of Oregon are the telephone company boundaries and the jurisdictional boundaries of the counties and cities so clear cut as to allow either model without some modification to accommodate aberrations. Figure 3 shows the geographical relationships of the counties and telephone companies. As can be seen, there will be many variations of the above two models throughout the state.

One solution to the problem of coordinating and rationalizing these relationships throughout the state might be that the Emergency Management Division provide a coordination center. The Emergency Services Coordination Center (ESCC) could provide many critical services as a liaison between regional governments and the telephone companies, and at the same time enable a closer tie to traffic safety. By being between the telephone companies and the local agencies as shown in Figure 4, the state could insure more uniform costs of telephone services based on actual tasks and processing required for an enhanced 9-1-1 system, and assure uniform response standards throughout the state.

The basic responsibilities of the ESCC would be to build a statewide base map of ESZs. The ESCC could build MSAGs from street and road center line maps or use the new TIGER line file and link the ODOT route and mile point data with the TIGER links. This step would provide the basis for cross-street indexing. The development of cross street indexes would not only aid in the dispatching of response vehicles to traffic accidents, it is a feature of almost all CAD systems which greatly aids in geo-positioning of all incidents (with or without graphics). This topic is discussed in greater detail in "E 9-1-1 Implementation Issues" (an accompanying report). With this base map, the ESCC would then determine, with the help of local jurisdictions, the ESZs throughout the state, thereby resolving conflicts and closing gaps. Should ESZ boundaries need to be adjusted within a jurisdiction, the appropriate agency would notify the state prior to the effective date of change.

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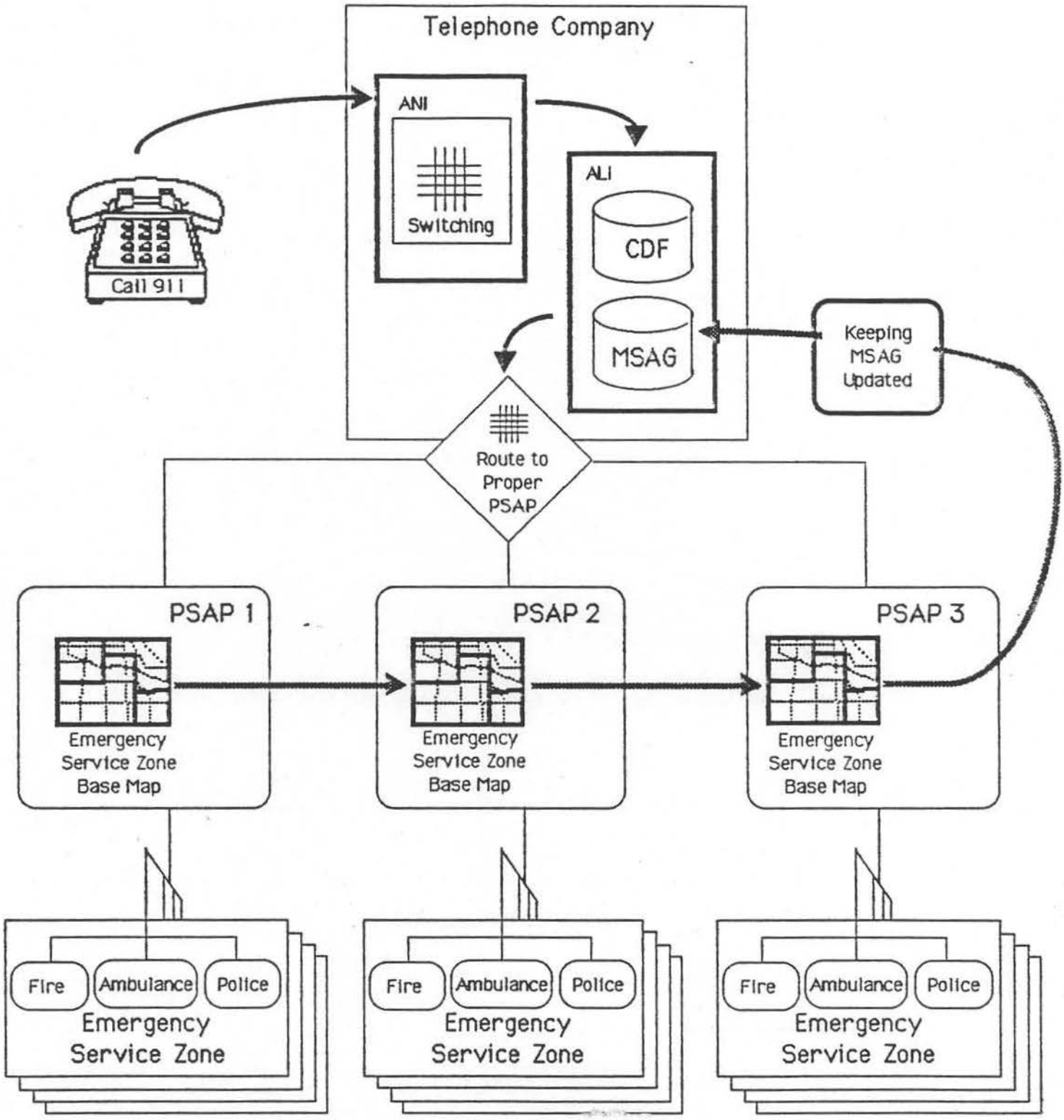
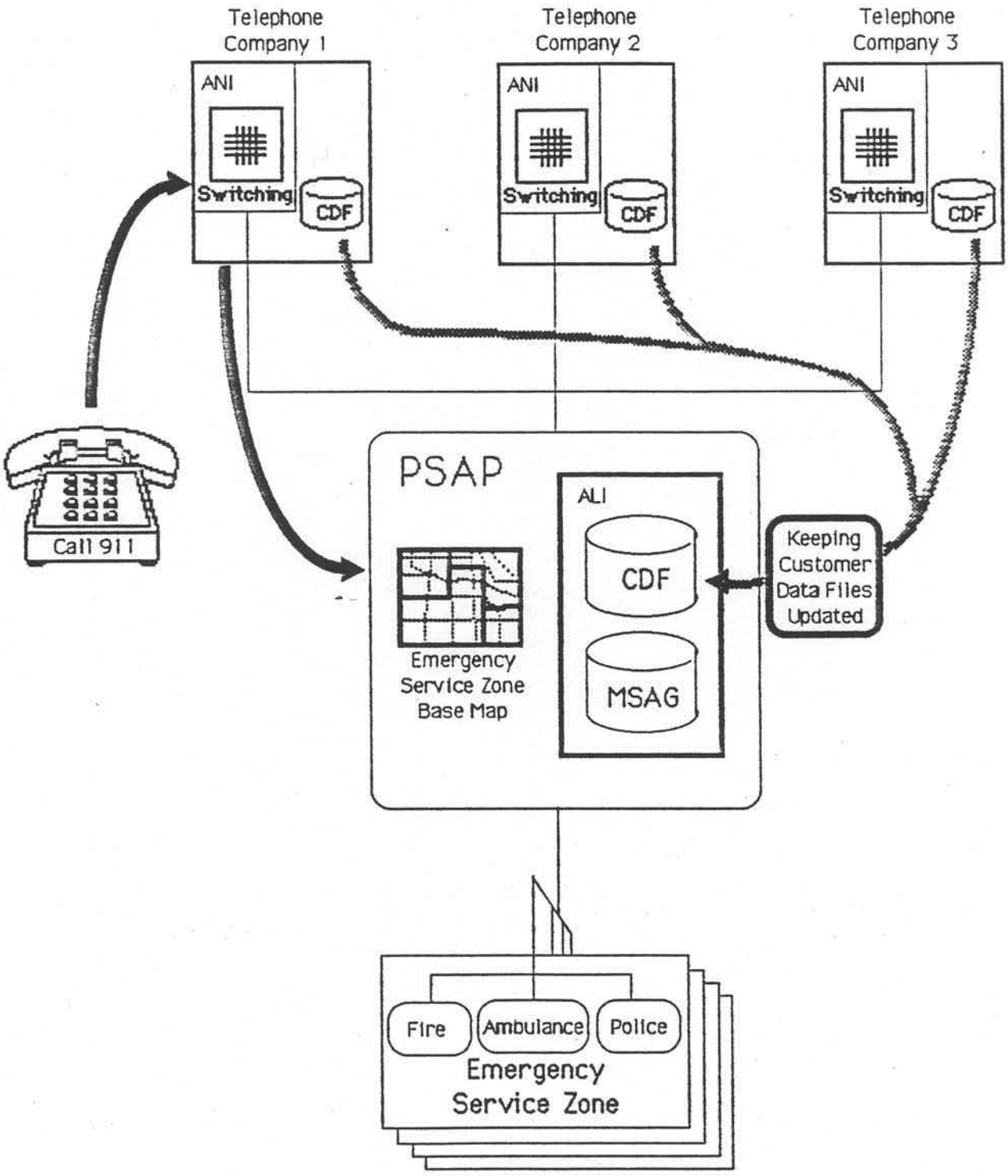
programming, query time and updating maintenance involved, and will undoubtedly be decided in-house by each phone company or data processing site.



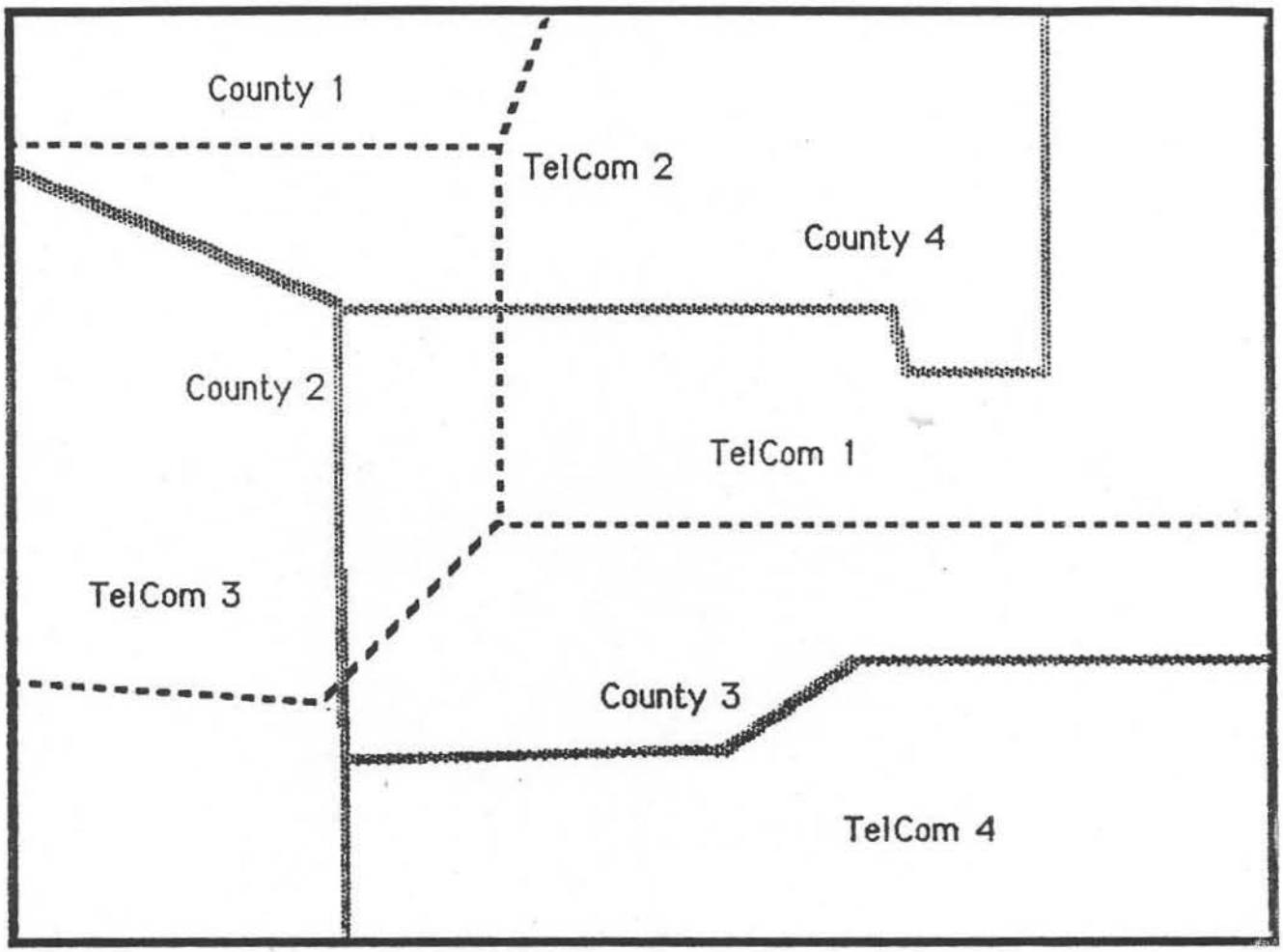
Single telephone company serving multiple PSAPs

Figure 1



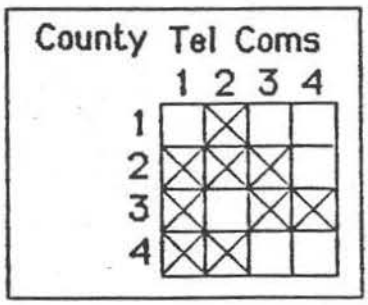
Single PSAP served by multiple telephone companies

Figure 2



----- County Boundaries
~~~~~ Tel Coms

County to Tel Coms



The Geographical Relationship of
Counties to Telephone Companies

Figure 3
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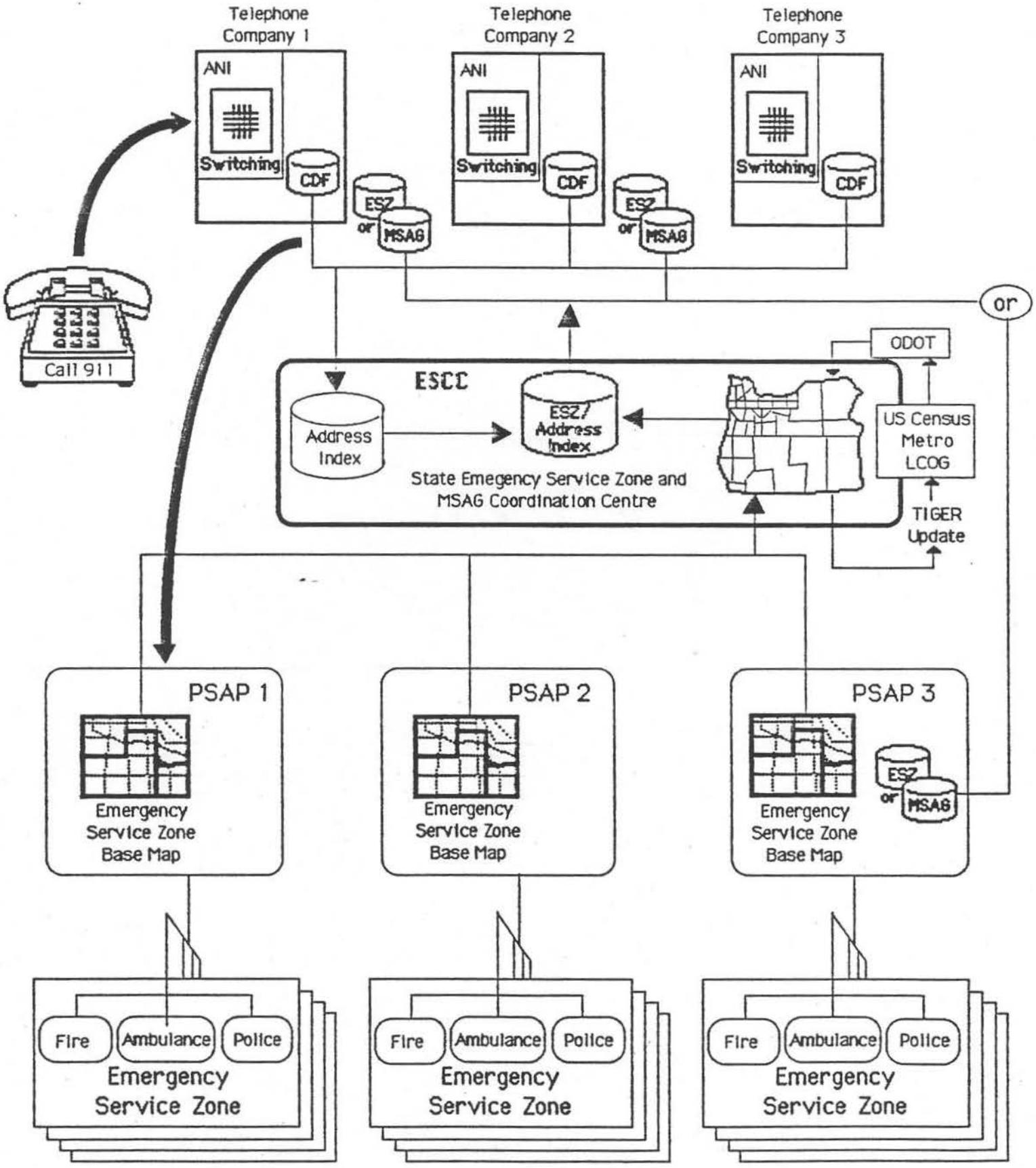

State Center for Coordination of Emergency Service Zones and Address Index

Figure 4

The Center could then provide telephone companies with the correct ESZ for each address in their CDF, or a MSAG derived from the TIGER files, depending on the method used internally by a particular telephone company. Alternatively, for the telephone companies that do not want to be that involved in on-line querying of CDF files and would just like to route calls directly to PSAPs, the ESCC could compile the address/phone number index, or MSAG for the PSAPs. The advantage of the state providing this service is that legislation relieving phone companies of confidentiality conflicts would make the state the single agency to which phone companies would be obliged to provide information. It would then be the state's responsibility to guard against undue intrusion in giving PSAPs access to the phone number/address index.

Issues and Policies Involved in Development of ESCC

The development of a state sponsored coordination center would involve a different approach to the state role in the development of E 9-1-1 than was the case in the development of 9-1-1 systems. Therefore a number of issues will arise in proposing this solution. These issues will fall into at least three categories:

- Data Base, i.e., Quality, Extendability, Updating Responsibilities, and Multi-purpose; Multi-agency uses
- Roles of Telephone Companies, PSAPs and State Agencies
- Funding

Database

For the purpose of this discussion "the database" refers to the geographic framework (topology) for identifying the jurisdiction boundaries, ESZs, streets, and address ranges. Much of the work for building the basic geographic framework put together has been done. The TIGER line files created by the U.S. Census Bureau for the 1990 decennial organizes the State of Oregon into separate data files, one for each county, and in a topological structure. However, more work will be needed to make these files useful for E 9-1-1.

Counties will need to plan and implement rural addressing systems. Address registers should be compiled and coordinated with county property tax records. Both of these steps need to be done, with common methodology and procedures, in all counties throughout the state. The eventual goal is to tag every parcel with a valid address and/or a GPIN (Geographic Position Identification Number). Once this system is implemented, then data flows will be needed to assure that new parcels and topology created by new subdivisions, parcel assemblages, and new improvements are recorded. Right-of-way, permits, title transfers notifications that affect the overall topology or transportation network need to be posted to the "base map," or "the database".

It is important to stress that it is in the interest of the enhanced 9-1-1 system to have this database used by as many agencies so that it will be accurate. Accuracy is a reflection of usage. Therefore, though the ESCC's first priority is to provide good MSAGs, ESZ/Address indexes, and Cross Street Index Files, it should endeavor to build as large a constituency as possible by providing a common resource for various users of geocoded address data.

Roles

Many telephone companies have existing procedures, software, and equipment to offer E 9-1-1. Other phone companies may not have this technology. Similarly, many counties have well established procedures to build a database for E 9-1-1. Others do not. The benefit of the ESCC would be to provide MSAGs to phone companies and updates to MSAGs. Conversely, the counties or PSAPs that need information from a variety of telephone companies would look to the ESCC for assistance.

The state has a major role to play in developing a database for E 9-1-1. Principally, it needs to provide a broad perspective and promote a consistent approach and method to E 9-1-1 database development. A consistent database of high quality is needed. In addition, the database must be capable of extension to support new applications and other users. Computer-aided dispatching is an example of new applications that require not only addresses and ESZs, but street intersections, route and milepoints, and networks for minimum path routing. Other users, such as assessors and building inspectors will find the databases of use for their geocoding problems, and may help in updating the database.

The Traffic Safety Commission has a special stake in seeing the E 9-1-1 database development. First, they see the need for rural addressing to increase the efficiency of response to emergencies. Second, they see the need for a network-based E 9-1-1 database to provide for dispatch to non-address locations of addresses, i.e., street intersections and route and milepoints. Finally, a network-based E 9-1-1 database will facilitate the collection and analysis of traffic accident data, and the relationship of that data to characteristics of the road and traffic at the location and in the vicinity of the accident.

Funding

A different approach is needed for the funding of the ESCC. Assuming the responsibilities of the ESCC would be to:

- Develop standards for geo-based data base using TIGER (this includes rural addressing systems in all counties).
- Develop updating and data flow procedures.
- Develop reporting and file creation programs and routines (MSAG, ESZ indexes, Address Registers).
- Develop telecommunication interfacing standards.

To carry out these responsibilities, the ESCC would need computer resources and staff to develop data processing procedures. These efforts would need to be set up as an on-going system. Therefore, funding will need a stable base. The 9-1-1 portion of the telephone tax goes for the most part to PSAPs. In future legislation, the Emergency Management Division may need to pursue a different approach to funding E 9-1-1 in Oregon.

Section II

Procedure Handbook for Developing an E 9-1-1 Database

Goals and Objectives of this Study

The purpose of this study is to provide the Office of State Emergency Planning and the Office of Traffic Safety with a methodology for developing a logical system of geographic referencing within the State of Oregon. This study, designed as a two phase project, will provide a "manual" for county officials which will describe in detail tested methods for building a database for "enhanced 9-1-1" emergency dispatching. Basic 9-1-1 emergency systems rely on the caller to provide the address, while enhanced 9-1-1 systems provide the dispatcher with the address and response unit. The first phase of this study is a description of the methodology that would be used to produce such a manual. The second phase is designed to test the methodology by working on a pilot project in a county using the methods and tools as described in the first phase. To attempt to produce such a manual without the experience of actual field conditions would be inappropriate.

Scope:
The central premise of the approach presented in this study is that the State of Oregon should provide a common methodology for building a database for enhanced 9-1-1 dispatching, which includes a systematic process for changing rural route and box number systems, where they still exist, to street or highway number systems. It is also an assumption that the system will involve computerization of address and street data and in one or more aspects of the process.[1]

It is possible that counties could develop any of a number of logical addressing systems independently. It is also possible that a county could develop an E 9-1-1 system both independent of neighboring counties and divorced from an addressing system. However, these issues are related, and great efficiencies can be achieved for each county while providing the state and other jurisdictions, agencies, and private interests with expanded opportunities in the use of geo-based information. We recommend developing a topological referencing system for each county within a consistent topological referencing system for the State of Oregon.

It is not in the scope of this study, or the resulting manual, to provide the county with all the steps involved in actually implementing an addressing system as these steps involve social and political solutions, for example, the actual names of streets, the cost of street signs, and the public relations needed to get people to use new street names and numbers.

Organization of Section:
This section is organized to explain the process of building a database for E 9-1-1 and the associated process of instituting a rural addressing system. First, we provide a description of the terms and methods. We identify the need for a pilot project to provide additional detail for the outline of the procedural manual.

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[1] Developing an addressing system does not necessarily involve the use of computers. However, much of the address assignment process can in fact be automated, and creating address databases can help streamline the process, as well as guarding against duplication. Even smaller personal computers can greatly aid in developing an address system. Enhanced 911 is not even possible without the use of computers.

Definitions:
Topology is the mathematical science of two dimensional graphs. The line work of a map can be described topologically. The three basic units of topology are nodes (points), links (lines), and areas. On a street map for example, nodes are the intersections, lines are street segments between intersections, and blocks are the areas on either side of streets. This type of data organization for maps has many advantages for finding relative locations on computer maps. More importantly, for counties that may not have computer mapping or even much experience with computers, a topologically organized street file will provide a list of all street segments, and is invaluable for double checking the completeness of a county's street network.

Building a topological mapping base for a county is big job and requires some familiarity with computer mapping technology. A good staring point will exist for counties in the State of Oregon, and throughout the country. The U.S. Bureau of the Census has already developed such a map and data structure for the country. This system is known as the TIGER (Topologically Integrated Geographic Encoding and Referencing). It is a topological map based on the U.S. Geological Survey maps of all counties in the continental United States.

Traditionally, an E 9-1-1 system depends on having *"Master Street Address Guides"* (MSAGs) for routing emergency phone calls (with the address of the telephone being used to make the call) to the appropriate *"Public Safety Answering Point"* (PSAP), a process known as *selective routing*. To use the MSAG, the telephone company (or PSAP) needs to obtain the address of the phone being used to make the emergency call. This is a two step process, first the *"Automatic Number Identification"* (ANI) operation is done. This technology is part of the switching equipment used by telephone exchanges. The second process is *"Automatic Location Identification"* (ALI). This is done by matching the phone number obtained from ANI with the number in the *"Customer Data Files"*[1]. The MSAG then uses this address to determine which PSAP should receive the call. The call is routed to the appropriate PSAP, and at the same time, data lines (computer connection) inform the PSAP operator of the phone number, address and *"Emergency Service Zone"* (EZS) of the originating emergency call.

Central to the method we propose is the development of *"Cross Street Index"* (CSI). A CSI would list every street segment, (i.e. Oak Street between 3rd Ave, and 4th Ave; Oak Street between 4th Ave and 5th Ave) and the address range beginning at the first intersection and ending at the second intersection (on the right side of the street and on the left side of the street). A CSI is a topological street network file similar to the US Bureau of the Census" *Topologically Integrated Geographic Encoding Referencing"*(TIGER) system. The CSI can be derived from TIGER and will aid in the development and maintenance of the MSAG, as well as provide counties and the State of Oregon with a tool for rational address assignment, and other districting or collating tasks based on geography.

The Methodology:
The remainder of this section describes the steps that each jurisdiction will need to follow in the development of rural addressing and implementation of a database for E 9-1-1. These methods utilize the TIGER file as a resource, particularly the topology, which provides error checking to ensure a quality product. There will be a difference in the scale of some

1 The term "Customer Data File" is used here to describe some form of database maintained by the telephone company which enables them to know which phone number is assigned to which customer. The internal organization of data and computer systems will vary greatly from one telephone company to another. Each phone company will have differing names and acronyms for data files, information systems and departments.

of this work depending on the degree of urbanization of a particular area. For highly urbanized counties, though the volume of data (number of street segments) is greater, more of the work may have been previously accomplished by the U.S. Bureau of the Census in the creation of the DIME files (the predecessor of TIGER, done for the urbanized areas of the U.S). The 1990 TIGER Line file will provide the link and node structure of the entire U.S. as displayed on 1:100,000 USGS maps. However, the address range may be missing in many rural areas that use U.S. Postal route and box addressing systems.

A Cross Street Index of the Road Network:

A "Cross Street Index" (CSI) is essentially a subset of the TIGER Line files though there are a few differences[1]. The CSI would be a listing of all street segments, with name of street or feature at the start (from node) and name of street or feature at the end (to node), the address ranges for left and right sides, and the distance of the link. Other information may be useful as attributes of the link, i.e., the distance of the "to node" from the origin of the street (the practicality and necessity of some attributes would be determined through the hands on experience of a pilot study). The CSI is then used to build an MSAG. The CSI will enable dispatching to street intersections and mile points along roads. Building a MSAG from the CSI would be an easy computer routine, whereas it would not be possible to build an CSI from an MSAG.

In addition to building the MSAG, a CSI has other uses. Recently an ambulance company, which servers portions of two counties, purchased a new Computer Aided Dispatching (CAD) system. Dispatching involves more than obtaining the address, and deciding which response vehicle to send. The time differential from an emergency call to arrival of help at the scene, which vehicles are deployed, where and what they are doing, are but a few of the many details dispatchers must track. CAD systems help with these kind of details.

One of the features of the new CAD was automatic address location, non-graphically. The system gives the dispatcher the two nearest intersections. The ambulance company was able to load the CSI developed by one county (derived from the DIME file) into its new system. Providing intersection data, as well as addresses may save time in response to emergencies. To say 1912 SE 42nd Ave is between Clay and Lincoln Streets may help an ambulance crew get to a house faster than just giving the address (particularly since 42nd is discontinuous).

The street information from another county that has an MSAG and E 9-1-1 cannot be used by directly by the CAD system. Although the dispatcher need not ask the caller for the address, the CAD system is only able to verify the street exists and provide one or more map reference numbers (in this case a page number from the Thomas Brother Map of Metropolitan Portland). The CAD system cannot determine the nearest intersections nor near by landmarks.

The TIGER system would provide a high quality data source for the building of a CSI which would then be used to derive an MSAG. However, a rural addressing system is needed to fill in the gaps outside of urbanized areas in the state. This would be needed by both an MSAG and a CSI. The TIGER file will identify the streets and roads where this additional effort will be needed.

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[1]The differences have more to do with customizing the information needed for dispatchers, and eliminating the more extensive information which the Census Bureau includes for using specifically with census information.

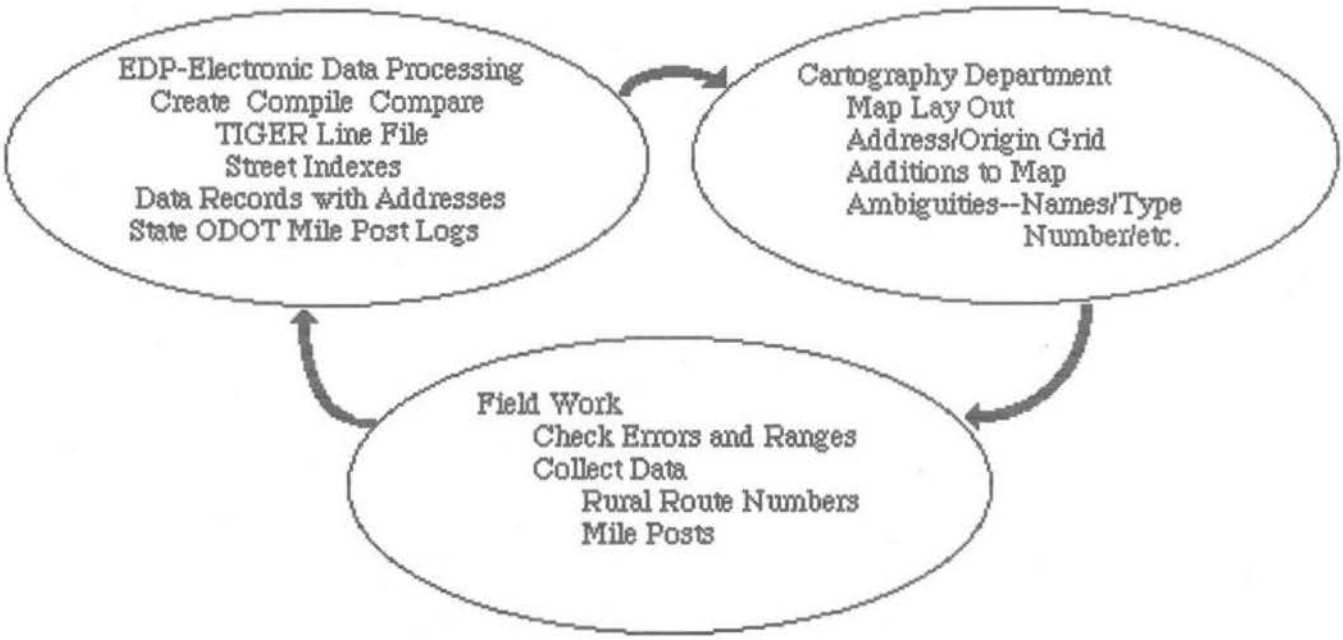

FIGURE 5

The Pilot Study:
The specifics of the process of developing an addressing and geo-based system for counties will depend on the character of the organization and personnel in the various counties. Figure 5 shows the environments in which an addressing project would need to operate. The process will and should make allowances for individual cases. The best methodologies for any process are those that have gained the experience of actual field testing. That is equally true in this case. A pilot study would provide the hands on involvement with the real world problems encountered, and allow a more detailed description of the steps needed to bring such a project to fruition.

A pilot project would involve finding a county that is ready to look at the way to implement a E 9-1-1 system, and is ready to go ahead on converting all route and box number addresses in the county to a street address system. The pilot project would consist of:

- Producing a plot of the TIGER Line file and comparing it to local maps and mailing address source files for completeness.
- Deciding on a point of origin for a street address numbering system[1] and entering street address ranges to the TIGER Line records which do not have the address range.
- Enter route and milepost data to the TIGER Line records to facilitate routing emergency response to traffic accidents.
- Drawing ESZs on the plot to ensure complete coverage of all areas of the jurisdiction. Creating a file with correspondence between street segments and ESZs.

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[1] Usually a lower left origin for rural counties or the center of the principal city in counties that have a major city. Multiple origins can be accommodated where they all ready exist.

- Develop the process for digitizing (locating) buildings with route and box numbers for use with E 9-1-1 system prior to full use of any new addressing system.

- Work with local officials to tailor the process for rural addressing to the specific county. The pilot project will identify and document the steps in sufficient detail to enable the county to proceed with the task. These steps would be:

  - Identifying all road segments and assign unique id's where ambiguity exists.[1]
  - Selecting origin for numbering system or work with expanding existing ones.[2]
  - Develop procedures, programs, or algorithms for assigning address ranges to each road segment.
  - Develop procedures, programs, or algorithms for assigning address numbers to existing and new buildings.

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[1] Although it is not within the scope of this report or methodology to get into the often political issues involved in actually assigning street names, we would work with officials on how those assignments could be matched to road segments once names are adopted. Similarly, the issue of signage, both for streets and new house numbers need not bog down the process if the county is not ready for the expense of full implementation. In this case, we would help develop a temporary solution for implementing the E 9-1-1 database where caller and dispatcher need not have a street address number.

[2] This would include fixing boundaries where multiple origins exist and/or developing procedures for changing address when annexations occur.

An outline of the proposed manual:

PART I INITIALIZATION

I. Collection of secondary data

The first step in setting up an addressing and geo-based system will be the gathering of the secondary data that is available for a given county. Important data to collect includes:

1. **The TIGER Line File**
   The manual will describe in detail the TIGER Line files, with a description of the record layout. Information on how to obtain the TIGER Line file will be provided.
2. **The County Street Index (if it exists)**
   A few counties will already have a cross street index. Consequently, this section will describe where to check within county offices to see if one does exist. For example, some dispatching agencies many be using such a system, even if it is not thought of as a "cross street index" or is not computerized.
3. **Other Street Maps of County**
   This section will describe other useful map resources.
4. **The Oregon Department of Transportation's Mile Post Logs**
   This section will describe ODOT mile post logs and how to obtain them in useful formats for further use. Part of the pilot project will include the development of procedures and/or programs to use the ODOT files as input to produce a CSI files with route and milepost data.

II. Comparison and Organization of data

The next step in the development of a geo-based system for addressing and emergency services is to manipulate the secondary data collected to build as complete a list of all streets as possible.

1. **Program to build street index if one does not exist**
   This section would describe how to build a street index if the county does not already have one. There are several possible ways to do this using one or more of the data sources collected in the first section. Here too, the pilot project might produce some programs that could be used to read various data files as input and produce as output street listings. For counties with little or no data processing capabilities, this step would include data entry and verification procedures.
2. **Comparison of TIGER file with street index**
   Having created a street index, the first step would be to check the completeness of both the street index file and the TIGER Line file. This check would also be used to spot other inconsistencies such as spelling, street type and direction prefix and/or suffixes. Listing the inconsistencies would identify problems to be resolved. This section would describe the programs necessary and/or the availability of programs developed during the pilot project.
3. **Mapping of additional streets**
   During the process of looking for inconsistences, any streets that are found to exist, but are not on the TIGER file, should be added. This necessitates determining the approximate x,y, coordinates of the beginning and ending intersections, and where the found street connects to the network.

III. Data Collection and Field Surveys

This step is potentially the most time consuming, and therefore, most expensive part of developing a geo-base addressing system. It is also the hardest to predict before having the pilot project to use as a test. The steps included in this section are:

1. **Field Checking of Map Additions and Resolving Questions**
   The main purpose of field checks will be to resolve questions raised in the office by comparing map sources, the TIGER Line files, and other address data. Checking streets names on the actual sign will many times be the final arbitrator. Also, resolving questions as to where a street segment actually intersects the network (relatively) may only be done in the field. The pilot project will give a better sense as to the frequency of field checks and how to organize them for maximum efficiency.

2. **Registry of Rural Route Numbers to ESZs**
   Counties wishing to move ahead on Enhanced 9-1-1 implementation prior to completion of a rural addressing system will find a need to locate residences on a map that also shows ESZ boundaries. This is labor intensive because each phone number for each rural route customer will have to be mapped to relate to the ESZ boundaries.

3. **Determination of Origin Point for Rural Addressing System and Mile posts for intersections**
   Implement the steps in the ASPO's *Street-Naming and Property-Numbering Systems; Report 332..*

IV. File Creation

1. **Program(s) to assemble "Cross Street Index"**
   This step will include the development of algorithms to use the data from the above described collection efforts to build the final product(s), files that list streets by intersections with address ranges. These file can then be used to create MSAG and other list of addresses within "districts" or areas.

2. **Program(s) to assemble MSAG**
   Development of programs and/or algorithms to produce MSAGs from the CSI files.

Part II Maintenance and Updating

This section of the manual would describe the updating procedures to keep the TIGER and CSI files current as ESZ's, PSAP's and jurisdictional boundaries change. In addition, procedures are needed to add new streets and sub-divisions to the base map. The recording of new addresses as properties are subdivided is also desirable. This section would include descriptions of:

- Updating procedures, including identification of user interface system
- Additions to the street network
- New properties and addresses

For every county, the flow of data, i.e., what permit, applications, deed recordings, etc. are required and where these paper flows are checked, assessed and filed, is slightly different. This section will deal with some of the issues of how the information that passes through city and county offices may be channelled through the updating function of the

new geo-base system. Though the manual will not accurately chart data flows for every county, it can show how to document data flows and identify the classes of data that are needed to update the system.

The manual will also describe how to use this system for address matching, routing, road maintenance, and other applications of address data.

Part III Planning for Dispatching Systems

Since it is anticipated that a number of counties will be preparing these systems for use with enhanced 9-1-1, this section will detail how to use the CSI to create MSAGs and further how the CSI can be used to increase the ability of dispatchers in identify emergency situation where ever they may occur.

This section can also provide some examples and references of the many different CAD systems available both as turnkey units and that can be built modularly and incrementally.

This section will provide:

- An overview of the Dispatching System and Information flows currently, and as effected by the addition of the CAD system.
- A functional model of a graphic mapping system.
- A requirements document with specification for providing a graphic link to the CAD system including vehicle locaters.
- Requirements to include in an RFP for hardware and software to implement graphics system.

Part IV Implementation of E 9-1-1 System

This section will provide examples and references for the implementation of E 9-1-1 systems. The content of this section will depend on the current E 9-1-1 study groups recommendations concerning the future of a statewide E 9-1-1 system.

WHAT IS ENHANCED 9-1-1?

Enhanced 911 is new system for emergency service dispatching. What enhanced 9-1-1 (E 9-1-1 for short) does that regular 9-1-1 systems do not do is display the address of every 9-1-1 caller on the emergency service dispatcher's screen. Even better,the enhanced system displays the Emergency Service Zone (ESZ) the address lies in, so the appropriate emergency vehicles can be sent to the scene (FIG. 1). This is done automatically, without having to query the caller.

FIG. 1-E911 immediately displays a caller's address and emergency service zone on the dispatcher's screen.

WHAT MAKES E 9-1-1 BETTER?

Basic 9-1-1 systems rely on the caller to tell the emergency dispatcher what his or her address is. The dispatcher must then refer to a file or map to determine the appropriate response unit. Individuals who call 9-1-1 are often under a great deal of stress and are sometimes unable to give the operator their addresses. A simple example will illustrate the depth of the problem. Suppose a young child has swallowed a poisonous household chemical and the frantic mother who calls 9-1-1 is too hysterical to relate her address to the dispatcher. In a situation like this, most 9-1-1 systems have the ability to trace calls. Tracing a call takes valuable time, however, time that may make the difference between life and death. What is needed is a way to quickly determine the street address of the caller's phone without having to rely on information given under duress. E 9-1-1 does this. Immediately, the address and ESZ of the caller are displayed on the dispatcher's screen, without having to query the caller.

HOW DOES E 9-1-1 WORK?

The secret behind E 9-1-1 is a computer database which links the phone numbers of homes and businesses with their addresses, and then matches these addresses to sections of streets and ESZs (FIG. 2). Emergency dispatchers at Public Safety Answering Points (PSAPs) dispatch vehicles in several different ESZs, and must determine which one a citizen requiring emergency aid is calling from. Suppose a citizen located at 2520 Oak street calls E 9-1-1. Phone company equipment automatically identifies the number the citizen is calling from. This number is then matched in a Customer Data File (CDF) with the address where the phone is located. Then, in a Master Street Address Guide (MSAG), this address is matched to the section of Oak Street it lies on and to the ESZ it lies in. Because a street in a city or county is likely to cross through several different ESZs, it is important to determine where an address lies on a particular street. It takes just a few seconds for the system to determine the address and ESZ and give this information to the E 9-1-1 dispatcher, assuring swift response time.

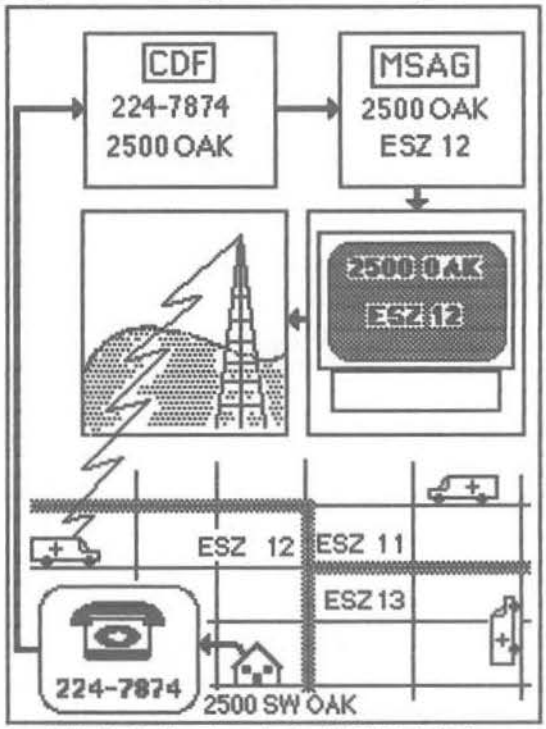

FIG. 2-Caller located at 2500 Oak in ESZ 12 calls E911. Caller's phone # is matched with address in CDF. Address is matched with ESZ in MSAG. Dispatcher receives information from screen and dispatches ambulance in ESZ 12.

SPECIAL SITUATIONS

Like any system, E 9-1-1 is not foolproof. Two problems stand out in particular. First, if a call comes from a large institution that has only one address but many phones, like a hospital or university, knowing the address will not be sufficient in locating the emergency. It is important in situations like this to link more information than just an address to the phone number. Including information like the names of prominent buildings and room numbers will help those responding to the emergency navigate more easily. Second, the location of an emergency and the location of a caller are not always the same. A citizen may call to report the presence of a fire several blocks away that he sees from his home, for example. In this instance the dispatcher must rely on the caller to give clear information. These problems in no way detract from the benefits of E 9-1-1. Caller's for the most part give clear information, but in those instances where they cannot, E 9-1-1 can mean the difference between life and death.

TERMS USED IN E 9-1-1

Customer Data File (CDF)--CDFs are computer files kept by phone companies that match addresses with the addresses where phones are located. They aid phone companies in billing and service.

Emergency Service Zone (ESZ)--ESZs are zones within which particular police, fire and ambulance vehicles are assigned to respond. ESZs are generally made up of portions of fire, police, and ambulance districts, since these vehicles all have unique response areas (FIG. 3). E 9-1-1 automatically determines which ESZ a caller is located in, assuring quick response time.

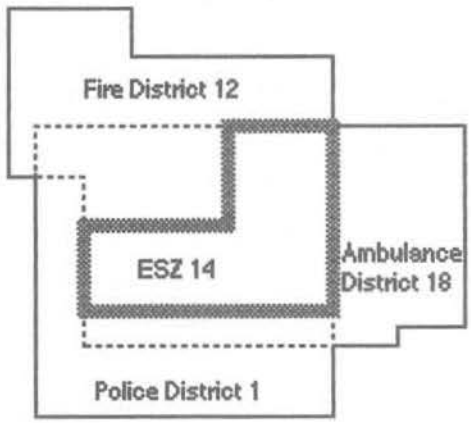

FIG. 3-Emergency service zone (ESZ) boundaries are based on the response zones of fire, police, and ambulance services.

Master Street Address Guide (MSAG) An MSAG is a computer file which includes all the streets in a local street network. Linked to each street in the computer are the address ranges that identify the boundaries of ESZs. These sections of streets are identified by Emergency Service Zones. Because a street often crosses several different ESZs, different stretches of street are assigned to different ESZs.

Public Safety Answering Point (PSAP)--A PSAP is where E 9-1-1 dispatchers are located. Each PSAP is responsible for dispatching police, fire and ambulance vehicles in several different Emergency Service Zones. Because of this, it is important for a dispatcher at a PSAP to know in which ESZ a caller is located.

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ENHANCED 9-1-1 DATABASE ISSUES

DEVELOPING A DATABASE FOR E 9-1-1.

The database function for E 9-1-1 consists of converting an address at which a phone is located to an Emergency Service Zone, which identifies the appropriate emergency unit. There are several requirements in building a database for E 9-1-1:

- accurate conversion of street addresses to ESZ's.
- accurate conversion of street intersection, road name and milepoint to ESZs.
- expandable to computer aided dispatching.
- identification of address ranges downwind of an incident.
- geographic detail should be sufficient for local governments to generate from a single underlying database address directories for other applications, such as voter registration files.
- updates to the database should be the responsibility of the local government.

To satisfy these requirements, a street centerline file with address ranges and mapping coordinates is needed. Such files can be created by coding and digitizing from existing maps. Better yet, existing digital files that are being prepared for the 1990 Census of Population and Housing can be adapted.

USING THE TIGER FILE IN ENHANCED 9-1-1.

The Census Bureau's TIGER file is an excellent base from which to build a Master Street Address Guide (MSAG), a step necessary to implement enhanced 9-1-1. E 9-1-1 systems need to overcome several problems to provide the best service possible. For one, E 9-1-1 requires the coordination of fire, police, and ambulance services. The many different fire districts, police beats, and other response zones in an area make this a difficult task. Secondly, E 9-1-1 requires that address information be highly accurate.. Even a small mistake in the address that flashes on an E 9-1-1 dispatcher's screen can end up sending the wrong vehicle to the wrong address. Using the TIGER file to build the MSAG file can help to overcome these problems.

WHAT IS THE TIGER FILE?

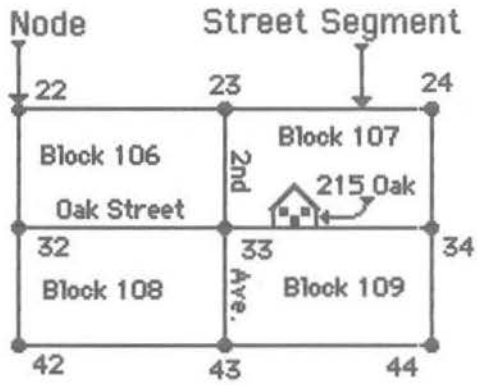
The TIGER file is used by the Census Bureau to manage the complex task of conducting a mail in census. It is the culmination of three decades of experience that began with the development of the precursor to TIGER, the DIME (Dual Independent Map Encoding) file. TIGER is an acronym for Topologically Integrated Geographic Encoding and Referencing file. It is a file that uses topology to encode geographic entities and reference them to one another. Topology is a branch of mathematics which studies how points, lines, and polygons are related. The precursor to DIME, the ACG (Address Coding Guide) did not use topology and could not be edited to insure accurate matching of addresses to areas. The Census Bureau uses the topology of TIGER to relate census tracts and blocks to street segments, in order to tally data from each household to the correct tract and block. Simply knowing the address of each household mailing in the census form is not enough to determine which tract and block the household is located in. An address alone is just a number and name. It is only as it relates to other surrounding addresses, streets and districts that it means something. The TIGER file supplies this meaning by referencing addresses to streets,

blocks, census tracts, or any larger districts, like Emergency Service Zones (ESZs).

HOW DOES THE TIGER FILE WORK?

The TIGER file works by relating each address to specific street segments and blocks (FIG. 1). A street segment is make up of two nodes, and a block is made up of three or more nodes. Each address is referenced in the file to both a street segment and a block face. This is what makes the TIGER file different from other base files that can be used in an E 9-1-1 system. A typical MSAG references addresses to street segments alone.

FIG. 1-The TIGER file consists of nodes, street segments and blocks. Addresses are related to street segments and street segments are bounded by blocks. Here, the address 215 Oak St. is related to block 107 and the street segment defined by nodes 33 and 34. The name of the data structure used to maintain these relationships among the points, lines and areas of the street and block geography is a topological data structure.



THE IMPORTANCE OF BLOCKS.

Blocks allow the TIGER file to be used as a base file by several different agencies. Blocks provide the base out of which larger districts are built. TIGER enables one to convert street addresses to the smallest areal units, blocks, from which a variety of larger areas can be built. This is beneficial to many users of address data, such as providers of E 9-1-1 service, because it allows many agencies to use the same underlying database. Yet, the many users of address data do not utilize the same system of zones. Other users are interested in neighborhoods, voting precincts, school attendance areas or taxing districts. It is unlikely that the borders of ESZs will match these areas, however (FIG.-2). Each organization should not have to develop its own MSAG.

FIG. 2-In TIGER, individual blocks are maintained. This allows derivative files for larger districts. For example, blocks 206 and 207 are contained in the neighborhood NHD 5. Block 206 is contained in ESZ 14 and block 207 is contained in ESZ 15. Maintaining individual block units is the key to deriving multiple district files.

If each derives an MSAG from TIGER, accuracy and economy can be achieved. The flexibility of the TIGER file, its ability to integrate different types of data from different districts, make it useful in E 9-1-1, where coordination between different agencies is often a problem. This issue is particularly important when the MSAG must be updated to reflect new street and boundary changes.

ADDITIONAL BENEFITS OF TIGER. Because of its topological structure, the TIGER file can be used to do complex tasks that other MSAG files cannot. For example, the TIGER file can be used to determine the shortest path between an emergency vehicle and the location of an emergency (FIG. 3). Even more sophisticated analysis is possible. For example, the frequency of emergencies in different parts of a city can be determined and this information can then be used to optimize the boundaries of ESZs. Analysis of this kind is difficult to do with other types of MSAGs, but is relatively easy with TIGER. Also, the x and y coordinates for nodes allow emergency managers to describe areas downwind of incidents, to determine blocks and street segments. Phone warnings can then be issued to those residents.

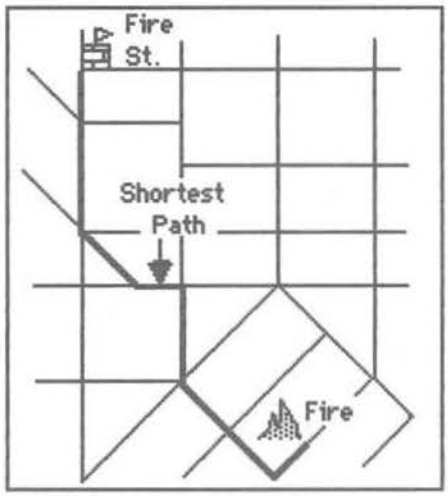


FIG. 3-The TIGER file allows one to do specialized operations, like determining the shortest path between an emergency and a responding emergency vehicle.

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RURAL ADDRESSING SYSTEMS

Adopting a system to address rural areas is an important step in implementing an enhanced 9-1-1 system. Enhanced 9-1-1 (E 9-1-1) relies on a phone link between phone numbers and addresses in a database. In unaddressed rural areas, E 9-1-1 is possible only at a great expense in money and efficiency. It requires the substitution of addresses with other locational identifiers, like landmarks, which are less accurate. The need for E 9-1-1 in isolated areas is as great as the need in heavily populated areas. Imagine forty houses located on a long rural road, and that one of them has called 9-1-1 for help, but before the dispatcher can get more specific directions, the caller collapses, unable to respond. An incident similar to this occurred in Jackson County Oregon, when a man suffering a heart attack was unable to reveal anything other than the name of the road on which he lived. After an interval of 24 minutes paramedics arrived only to find that it was too late. With E 9-1-1, this tragedy might easily have been averted. But to implement E 9-1-1, it is imperative that all residences and businesses be addressed.

OTHER REASONS FOR RURAL ADDRESSING.

Rural addressing is beneficial in many other ways as well. A logical, coherent addressing system is helpful for newcomers and old-timers alike. The efficiency of mail delivery is increased. Private delivery of goods and services is made easier. Businesses, private utilities, and public agencies find it easier to maintain records and provide service. Visitors spend less time in confusing searches for locations. All in all, addressing rural areas provides some benefit to everyone.

PROBLEMS WITH RURAL ADDRESSING.

Despite the benefits of a rural addressing system, there will undoubtedly be some opposition to implementing one. Any new system requires change, and a rural addressing system is no different. With proper planning, however, much of the opposition can be averted. It is best to avoid a situation where businesses and residents are forced to change addresses and then inform clients, creditors, magazines, and others of the change. This problem often occurs when two growing cities share the same rural hinterland. An area may be addressed using one city's system, and at a later date the other city may annex the land and wish to impose its own,. It is best to establish permanent boundaries early on to avoid having to readdress in the future.

FIG. 1-The quadrant system divides a street grid into four sections.

DESIGNING THE SYSTEM

There are several different types of addressing systems, each with pros and cons for suitability under different circumstances. Every system of addressing must accomplish two tasks, street naming and property numbering. Because the layout of streets varies from place to place, different systems are appropriate for different areas. The quadrant system (FIG. 1) is best suited for regions that are dominated by a central town. This system uses a north/south street and east/west street as bases from which addresses increase. It divides a region into four sections, NW, NE, SW, SE, which stretch outward from the center of town.

The Lyman system (FIG. 2) is appropriate for rural regions with no dominating town. It is based on the x-y coordinate system familiar from basic algebra. The Lyman system, like the quadrant, uses two baselines. Streets in the Lyman system are given a number name based on their distance from the baselines. The process of locating ones position in a region using the Lyman system is the same as locating a point on a coordinate graph. The Lyman system, unlike the quadrant system, does not require that a region be divided into four sections (although this is possible). The two baselines can be set at the west and south edges of a jurisdiction, allowing addresses to increase outward from the southwest corner rather than a central point.

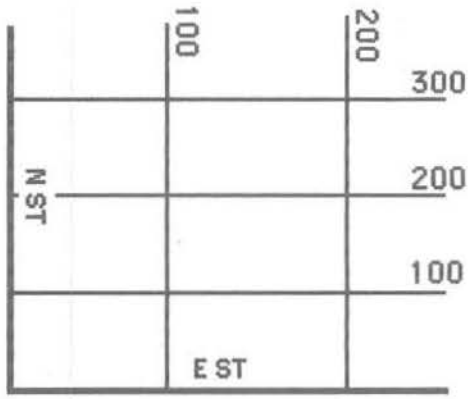

FIG. 2-The Lyman system is based on an x-y coordinate graph.

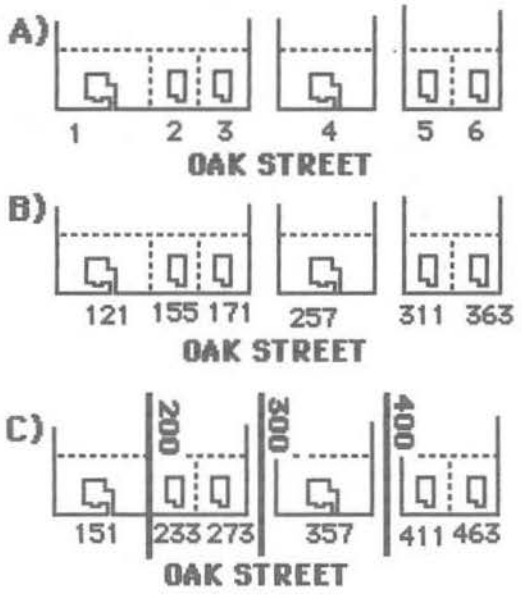

FIG. 3-Three ways of numbering property are:
A) Numbering in increasing numerical order along a street front.
B) Using blocks as a division, with increments of 100 in between.
C) Using equal intervals of 100 and ignoring block divisions.

PROPERTY NUMBERING SYSTEMS.

Three methods exist for determining how the addresses of individual properties increase from a baseline (FIG. 3). The first is to assign numbers in increasing order from a base point, based on existing property divisions. This is not recommended in rural areas where property is likely to be subdivided in the future. The second is to base the addresses on block divisions. In regions where there is a dominant central town with evenly laid out blocks, such a system makes sense. Rural areas with no consistent block layout should use the Equal Interval system. In this system, addresses increase outward from a baseline at an even rate. Property size and block divisions are disregarded. On long rural roads, where property parcels vary greatly in size and intersections are not evenly spaced, the Equal Interval system makes sense.

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