NENA
Technical Information Document
on
Rate Center Consolidation
(TID)

NENA Technical Information Document on Rate Center Consolidation
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Prepared by:
National Emergency Number Association (NENA) Network Technical Committee Chairs

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Acknowledgments:

The National Emergency Number Association (NENA) Network Technical Committee developed this document.

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Tom Hinkelman	AT&T
Tom Breen	BellSouth

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1 Executive Overview

1.1 Purpose and Scope of Document

This document is a guide for E9-1-1 Subject Matter Experts (SMEs) and Regulatory Agencies in determining a rate center consolidation configuration that minimizes the impact of E9-1-1 call delivery in a failure condition. Specifically, this document addresses the impacts of rate center consolidation in an environment served by multiple service providers.

This document is not intended to provide E9-1-1 SMEs or Regulatory Agencies with a definitive mechanism for rate center consolidation, as each geographic area is unique and should be addressed on a case by case basis. Also, this document is not to be construed as NENA's complete endorsement of rate center consolidation as a means of number conservation or intermodal porting.

1.2 Reason for Issue

The reason for issuance of this document is to provide a framework for a more analytical approach to rate center consolidation utilizing urban planning theory.

1.3 Reason for Reissue

NENA reserves the right to modify this document. Upon revision, the reason(s) will be provided in the table below.

Version	Date	Reason For Changes
Original	October 2006	Initial Document

1.4 Recommendation for Standards Development work

This TID does not require any further Standards Development work. It is informational in nature.

1.5 Costs Factors

Not Applicable

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1.6 Acronyms/Abbreviations/Definitions

This is not a glossary! See NENA 00-001 - NENA Master Glossary of 9-1-1 Terminology located on the NENA web site for a complete listing of terms used in NENA documents.

The following Acronyms are used in this document:	
ALI	Automatic Location Identification
ANI	Automatic Number Identification
CAMA	Centralized Automatic Message Accounting
CAS	Call Path Associated Signaling
CBN	Call Back Number
CLEC	Competitive Local Exchange Carrier
CPN	Calling Party Number
E9-1-1	Enhanced 911
ESN	Emergency Service Number
ESRD	Emergency Service Routing Digit
ESRK	Emergency Service Routing Key
ESZ	Emergency Service Zone
FCC	Federal Communications Commission
LEC	Local Exchange Carrier
LNP	Local Number Portability
MF	Multi-Frequency
MSC	Mobile Switching Center
NCAS	Non-Call Path Associated Signaling
NPA	Numbering Plan Area
PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
RCC	Rate Center Consolidation
SCP	Service Control Point
SR	Selective Router
SS7	Signaling System Number 7
WSP	Wireless Service Provider

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1.7 Intellectual Property Rights Policy

1.7.1 General Policy Statement

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2 Technical Description

This NENA Technical Information Document (TID) provides a reference for E9-1-1 SMEs and Regulatory Agencies with respect to the implementation of Rate Center Consolidation (RCC). This document is subject to any network disclosure or configuration documents published by any company that provides interconnection to a SR. This document is intended as a reference to assist in the application of Central Place Theory (CPT) as a methodology for defining a RCC configuration that minimizes the impacts to E9-1-1 call delivery.

3 Rate Center Consolidation and E9-1-1 Impacts

3.1 E9-1-1 Impacts

Rate center consolidation as a methodology for efficient number utilization and conservation, is not recommended by the National Emergency Number Association due to the potential for degradation of E9-1-1 service. The greatest impact is on the default routing arrangements established in the embedded network architecture. However, in some areas of North America state regulatory agencies (i.e. PUC, PSC) have considered rate center consolidation as a viable approach to efficient number utilization. Therefore, it is in the best interest of industry experts to assist in the determination of the scope and magnitude of the consolidation. By employing a more analytical approach to the consolidation, the impact to the embedded E9-1-1 default routing infrastructure can be lessened. The following is a discussion on the impacts of default routing with respect to rate center consolidation.

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3.2 Geographic Scale

Variations in the geographic scale of a rate center consolidation will be one of the determining factors as it relates to the extent of the impact on the existing E9-1-1 default routing architecture. The larger the geographic scale of the consolidation, the greater the impact. Conversely, if the consolidation is limited in scope to rate centers that are physically located within a county boundary the less the impact to the default routing architecture.

3.3 Small Scale Consolidation

For the purposes of this document a small scale rate center consolidation will entail the consolidation of several rate centers that are either wholly within the boundaries of a single county jurisdiction, or with one or two rate centers that overlap into an adjoining county. Generally, these small scale consolidations do not pose as significant problem as it relates to default routing as a large scale consolidation.

Given that the extent of the consolidation may be limited to the jurisdictional boundary of a county, a single default PSAP is a viable option. The county may already have a designated default PSAP for all default routed calls within that county. On the other hand, there may exist two or more designated default PSAPs within the county with each PSAP receiving defaulted routed calls for a specific rate center or rate centers. In this scenario, the objective would be to identify the most appropriate PSAP to designate as the single default PSAP. The concepts discussed in sections 5.5 and 6.0 should be taken under consideration when making that determination.

3.4 Large Scale Consolidation

For the purposes of this document a large scale consolidation will entail the consolidation of multiple rate centers that encompass two or more county jurisdictions. These large scale consolidations are rare but pose the greatest risk to the default routing architecture for a particular E9-1-1 system. The following will illustrate the problems associated with a rate center consolidation of this scope and magnitude.

Figure 1 below is a depiction of a Competitive Local Exchange Carrier (CLEC) providing local dial tone from a single end office serving multiple rate centers. In this scenario the CLEC is serving the geographic areas defined by the rate centers Zone 1, Zone 2, Zone 5, and Zone 11. The designated default PSAPs for these rate centers are PSAP A, PSAP B, and PSAP C. Thus, the CLEC or Telco B has established E9-1-1 trunking to the E9-1-1 network service providers selective routing tandem to accommodate each of the default routes. Rate center consolidation is proposed for the entire geographic area depicted. This will include Zone 18, which defaults to PSAP G. PSAP G is interconnected to a separate E9-1-1 selective router.

The E9-1-1 network service provider in this scenario is also the Incumbent Local Exchange Carrier (ILEC) or Telco A. The selective routing tandems that serve the entire geographic area depicted are not interconnected through inter-tandem trunks. Thus, there is no capability to perform a tandem-to-tandem transfer in the event a E9-1-1 call from Zone 18 is misrouted to PSAP F.

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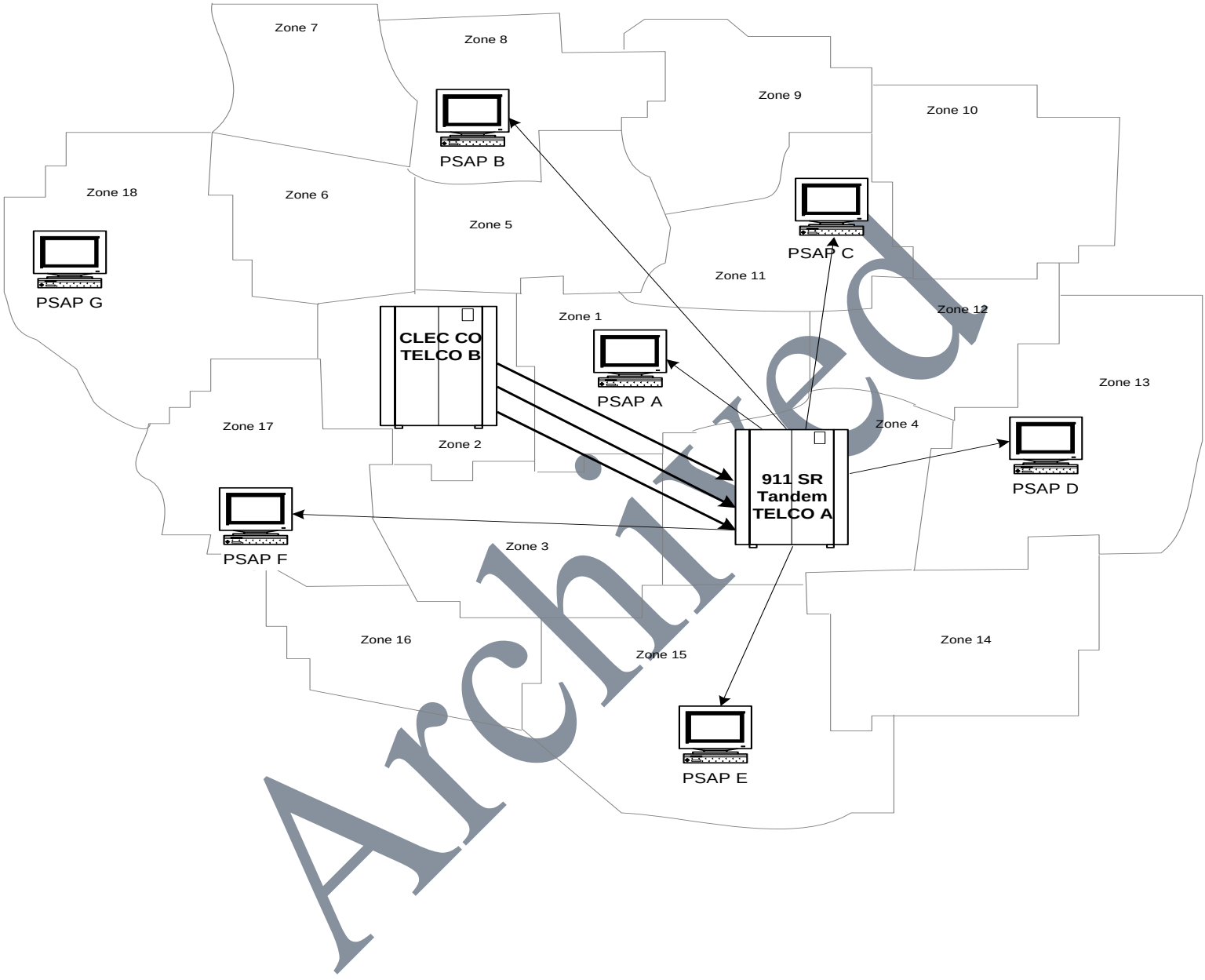
Figure 1



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The following is a table listing the designated default PSAP for each of the rate centers.

Table 1

DEFAULT PSAP	RATE CENTER	DEFAULT PSAP	RATE CENTER
PSAP A	Zone 1	PSAP D	Zone 12
	Zone 2		Zone 13
	Zone 3		
	Zone 4		
PSAP B	Zone 5	PSAP E	Zone 14
	Zone 6		Zone 15
	Zone 7		
	Zone 8		
		PSAP F	Zone 16
PSAP C	Zone 9		Zone 17
	Zone 10		
	Zone 11		
		PSAP G	Zone 18

In this scenario Telco B will have to establish the appropriate E9-1-1 network infrastructure to ensure proper default routing to all designated PSAPs. This will entail provisioning E9-1-1 Trunk Groups (TGs) for PSAP D, PSAP E, PSAP F, and PSAP G. In order to accommodate default routing to PSAP G, the CLEC or Telco B, will have to interconnect to the same selective router as PSAP G (see Figure 2).

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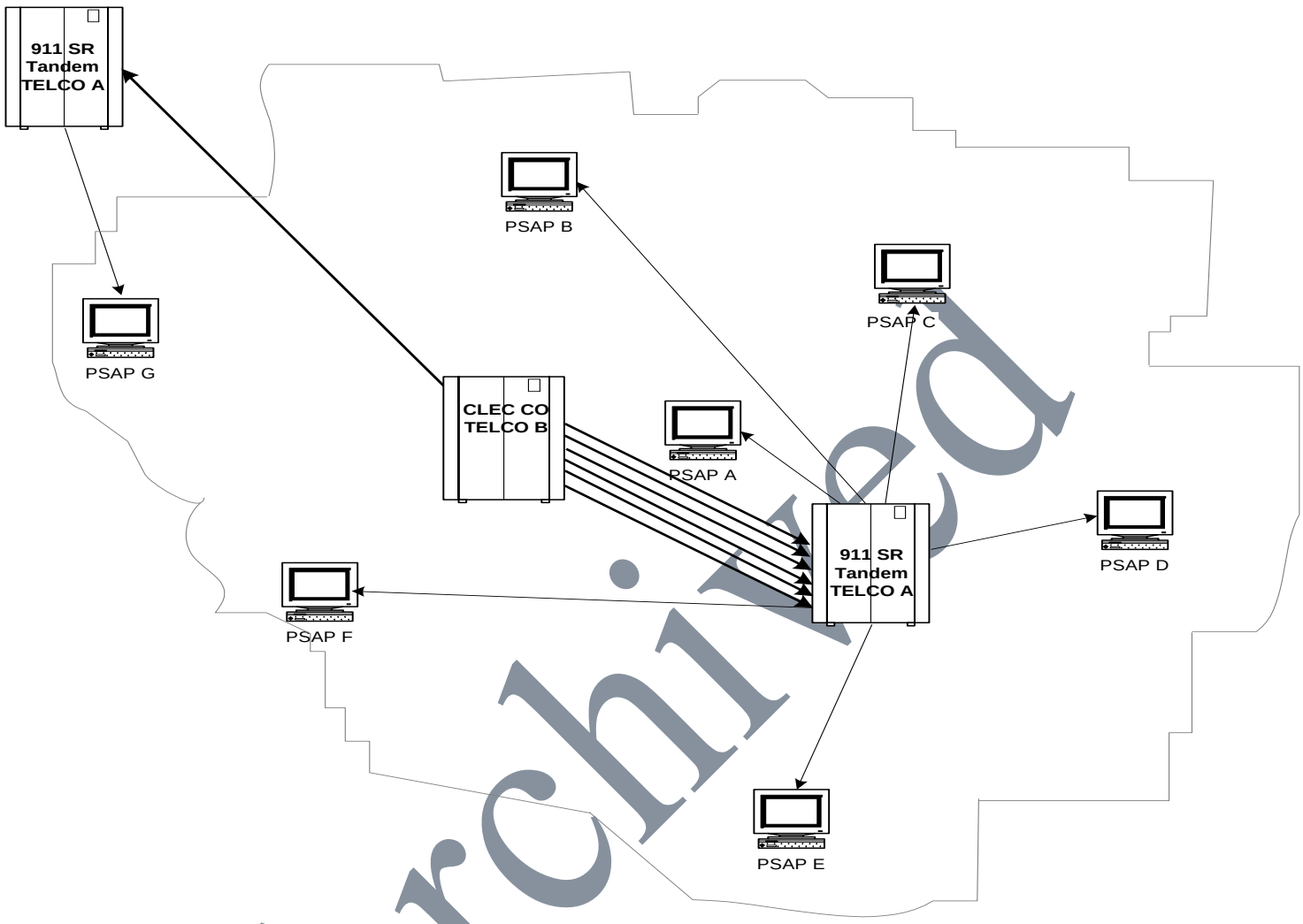
Figure 2



3.5 Screening

The consolidated rate center allows Telco B to assign any of its existing NXXs to a subscriber located within the new rate center geography. To ensure proper route indexing of E9-1-1 calls, screening is required from the CLEC's CO. This is accomplished through Line Class Code (LCC) Screen Indexing (SI) to route calls over the appropriate E9-1-1 TG for default routing purposes. In essence the CLEC builds distinct rate area exchange assignments for each default route such that Zones 1, 2, 3, and 4 constitute a unique rate area exchange.

The use of screening requires manual intervention in the assignment of the rate area on the internal service order. The rate area may be based on either the physical location of the subscriber alone, or the ESN assignment established in the Master Street Address Guide (MSAG) for that location. This introduction of a manual process increases the probability of an incorrect rate area exchange assignment and thus a E9-1-1 call route indexing over the wrong default TG.

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3.6 ANI Failures

This becomes extremely problematic when an ANI failure condition exists. As an example, a subscriber line is provisioned by Telco B with a rate area exchange that will route a call over the E9-1-1 TG assigned a default ESN associated with PSAP B. However, the subscriber is physically located in the area served by PSAP E. If an ANI failure occurs during the process of the subscriber placing a E9-1-1 call, the call will route to PSAP B. The end result is an increase in time to handle the call due to the omission of location information, which delays the proper determination of the appropriate PSAP agency to handle the call. This is further exacerbated by the receiving PSAP's ability to transfer the caller to the appropriate PSAP agency, which ultimately results in increased emergency response time.

3.7 "No Record Found" Condition

The degree of degradation of default routing accuracy may be lessened in magnitude for a "No Record Found" condition, but is still a failure condition. With a NRF a valid ANI is delivered to the selective routing tandem, however an ALI record for the ANI has not been populated in the Automatic Location Identification Database Management System (ALI/DBMS). Thus the selective routing database (SRDB) has not been updated with the TN to ESN relationship that is extracted from the ALI system. As a preemptive measure a TN to ESN relationship within the selective routing database may have been established ahead of time by the SR operator by using a predominant ESN assignment for either an entire 10,000 block of a particular NPA or at the 1,000 block level.

If one uses the assumption that Telco B is porting the majority of their subscribers to their central office, then in all probability the TN to ESN relationship in the SRDB for this subscriber is unchanged. Thus, if the subscriber's ANI is delivered to the E9-1-1 selective router, the call will be routed to the PSAP associated with that NPA-NXX based on a predominant ESN assignment. However, the ALI bid from the PSAP to the ALI database returns a "No Record Fund" with the calling party ANI.

A second scenario in which a NRF condition results in a degradation of the default routing arrangement occurs when Telco B assigns one of their own NPA-NXXs to a subscriber. As an example, the NPA-NXX assigned is initially built in the SRDB with a predominant ESN associated with PSAP A. The subscriber of Telco B is physically located in the geographic default response area of PSAP C. If the subscriber dials 911 prior to an update of the ALI/DBMS, the call will route to PSAP A with an ALI display of "No Record Found." In this scenario emergency response is delayed due to increased time to determine the appropriate agency to handle the call and the omission of location information of the calling party.

4 Porting and Pooling

4.1 Number Porting

Degradation of default routing can also occur when Telco B ports a subscriber to their central office and at the same time the subscriber moves to a different physical location. An example using the rate center consolidation scenario depicted would entail a subscriber who is ported to Telco B with

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an NPA-NXX that has a predominant ESN in the SRDB that defaults to PSAP A. The subscriber moves to a physical location in which the predominant ESN default is PSAP B. If the subscriber dials 911 prior to an update of the ALI/DBMS and the SRDB, the call will route to PSAP A and retrieve the ALI for the physical location of the subscriber prior to the move. The end result is a delay in emergency response as the PSAP agency must determine the proper physical location of the calling party and identify the appropriate PSAP agency to transfer the caller.

4.2 Number Pooling

With the introduction of Number Pooling as an additional conservation measure to minimize NPA-NXX exhaust, its utilization may be problematic in conjunction with RCC. Again using the RCC scenario depicted, a NPA-NXX is pooled at the 1,000 block level with a predominant ESN assignment for the entire 10,000 block established in the SRDB to route to PSAP A. Telco B acquires a 1K block of that NPA-NXX and utilizes the newly acquired numbers to assign to subscribers physically located in the jurisdiction of PSAP B. As with LNP, if the subscriber dials 911 prior to an update of the ALI/DBMS and SRDB, the call will route to PSAP A. The distinction between porting and pooling is that the subscriber number is assigned to the location as opposed to the subscriber moving to that location.

4.3 Intermodal Porting

Intermodal porting entails the porting of an end user number from a wireline carrier to a wireless carrier or wireless to wireline. In this RCC scenario, the Wireless Service Provider (WSP) Mobile Switching Center (MSC) serves the entire consolidated rate center just as the competitive carrier's central office. This requires the WSP to provision the appropriate E9-1-1 trunk interconnections to the E9-1-1 SR in order to assimilate the embedded default PSAP architecture. Unlike the CLEC, the WSP utilizes a network architecture that is integrated into the E9-1-1 system designed primarily on the placement of cell towers. However, screening of routing keys or digits associated with specific cell sites or cell site sectors at the MSC is necessary to ensure E9-1-1 calls from a cellular handset route index over the appropriate E9-1-1 trunk group.

With intermodal porting in a consolidated rate center environment, the impact to default routing of a E9-1-1 call is based on the type of solution utilized by the wireless carrier for wireless E9-1-1 call delivery. The default PSAP assignment within the wireless network is based on the placement of cell sites within a specified Emergency Service Zone (ESZ). In a Callpath Associated Signaling (CAS) or Hybrid – CAS architecture a unique Emergency Service Routing Digit (ESRD) is assigned to each cell site or cell site sector. In a Non-Callpath Associated Signaling (NCAS) architecture an Emergency Service Routing Key (ESRK) is assigned to the number delivered to the MSC from a Service Control Point (SCP) database[1]. A range of ESRKs are assigned by the number of cell sites within an ESZ.

With a wireline to wireless intermodal port in a CAS architecture where a NRF condition exists, the E9-1-1 call will route to the designated PSAP based on the ESN assignment of the ESRD. Similarly,

[1] The use of the terms CAS and NCAS will be consistent with their application in J-STD-034 as it relates to the network architecture and delivery of the call back number.

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in an NCAS architecture the E9-1-1 call will route to the designated PSAP based on the ESN assignment of the range of ESRKs for the cell sites within an ESZ. The degradation of the E9-1-1 call is limited to the delivery of the cell site location data.[2]

An ANI failure from the MSC will utilize the designated default PSAP E9-1-1 trunk group for the cell site(s) or cell site sector(s) based on the location of the caller. In this type of failure condition the degradation of the E9-1-1 call is compounded by the PSAPs inability to receive location information and the Call Back Number (CBN) of the calling party. However, this condition exists regardless if RCC is employed as a numbering conservation measure.

Wireless to wireline porting presents a different set of issues in a consolidated rate center environment. As an example, an end user subscribes to a wireless service and obtained a number rated to a rate center that prior to RCC defaulted to PSAP A. The end user requests the number be ported to a wireline service but has subsequently moved to a physical location that is designated to default to PSAP B. If the end user ports to a wireline carrier that serves the entire consolidated rate center as previously depicted, then all the same default routing conditions apply. On the other hand if the end user subscribes to wireline service from a traditional Incumbent Local Exchange Carrier (ILEC), then the only default routing condition that results in a degradation of service is a NRF condition. This holds true as the end user will receive dial tone from the appropriate ILEC end office that serves the location of the terminating loop. Thus, any ANI failure that may occur will use the E9-1-1 trunks from that end office with a more accurate default PSAP assignment.

5 Central Place Theory

5.1 Background

To lessen the impacts of ANI and ALI default routing in rate center consolidation, a more analytical approach to define the proper configuration of the consolidation is required. One methodology that can be deployed to achieve this goal is the application of an urban planning tool. Urban planners and geographers alike have recognized that the spatial distribution of settlements conform to well defined patterns. The economic development of a region over time dictates this spatial arrangement. The theory behind this concept is Central Place Theory (CPT) developed by Walter Christaller.

Christaller published his theory in 1933 after completing a detailed study of the settlement patterns in southern Germany. First and utmost, Christaller recognized two inherent facts about cities. One, people congregate together in cities to exchange commodities and ideas. And two, cities exist for economic reasons; to facilitate the exchange of goods and services. In the flat landscape of southern Germany Christaller noticed that towns of a certain size were roughly equidistant. By examining and defining the functions of the settlement structure and the size of the hinterland or countryside he found it possible to model the pattern of settlement locations using geometric shapes (usually triangles and hexagons). Thus, Christaller's study lead to a theory concerning the distribution of points around one or more central points with which they have some dependent functional relationship.

[2] This assumes that the port has completed and mixed call back is no longer an issue.

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5.2 Role of the City

Central Place Theory provides a conceptual mechanism for understanding the role of the City as a service center. When viewed as the focus of a region the City becomes a supplier of goods and services to the surrounding countryside. However, the City depends on the inbound cash flow produced by the spending of the regional population to support the compliment of goods and services offered. The key concepts in conjunction with this are:

Threshold: The amount of purchasing power required in a region or the minimum amount of monetary support (sales) necessary for a business to break even on investments.

Range of Goods: The distance a consumer will travel to purchase goods or services.

Lower Order Goods: Goods that are frequently replenished.

Higher Order Goods: Goods and services that are purchased less often and require a sizeable expenditure.

In Central Place Theory there are two assumptions made about human behavior. One, consumers will always purchase from the closest central places that offer a particular good. And two, whenever threshold purchasing power for a good is obtained at a central place, an entrepreneur will offer the good. Whenever demand for a good drops below threshold, the good will no longer be offered. Thus, the greater the number of higher order and lower order goods, the greater the range of goods. Therefore, the greater the centrality of an urban center.

There does exist a positive correlation between population size and the importance of a city as a distribution center. However, two cities of equal population do not necessarily function as equally important central places. Measures such as sales tax receipts, the number of retail and wholesale stores, or employment are more accurate measures of centrality. At the time that Christaller developed his theory, he identified a hierarchical structure of town, village, and then hamlet. A more modern analogy would be city, suburb, and township or village (See Figure 3).

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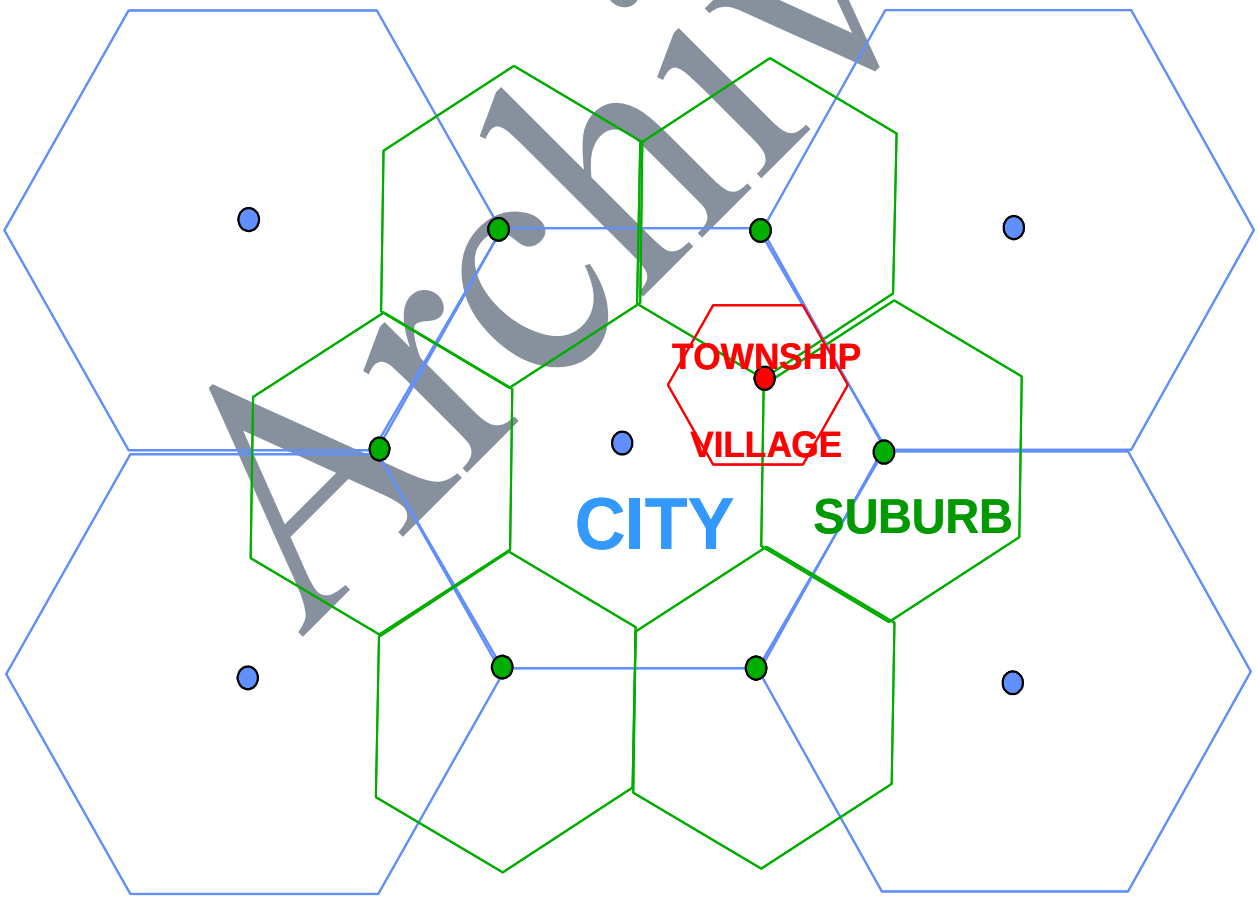
Figure 3



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5.3 Friction of Distance

The one factor that has had the greatest influence on the distribution of urban settlements is the friction of distance. This concept has helped explain to some extent the distribution of urban places that exist today. One illustration of how distance has contributed to the growth and development of urban places is to evaluate it from the standpoint of commuting.

Prior to the advent of mobile forms of transportation, the most common methods of travel were by foot or horse drawn carriage. This greatly limited the distance one was willing to travel to a town or village for either employment or the exchange of goods and services. Generally, the furthest extent of this commute was limited to a distance that was no more than 30 minutes from the urban center. As technological advancements in transportation increased the commuting distances by reducing the overall travel time, the extent of urban development expanded outward from the original urban core. Travel times have continued to increase with commutes in excess of 45 minutes.

5.4 Edge Cities

In recent years, however, there has been a shift from the traditional commute to the urban core or central business district ("CBD") to urban centers on the fringes of metropolitan areas. These new urban centers or "edge cities" have experienced unparalleled growth in the last 20 years. This continued expansion has resulted in once small bedroom communities growing into full-blown urban centers with all the compliments of goods and services found in the traditional CBD. These "edge cities" have increased their zone of influence to draw the residential population for employment and the exchange of goods and services. This drawing power is a direct result of an effort by the regional population to reduce their friction of distance whether it be the daily commute to work or the exchange of goods and services.

5.5 PSAP Zone of Influence

A corollary to this friction of distance can be transferred to a PSAP zone of influence and degree of interaction with surrounding PSAP agencies. This interaction is translated into common capabilities associated with the same E9-1-1 tandem. These capabilities relate to network transfer, ALI transfer, and the ease of speed dial transfer of voice information. As these "edge cities" grow in both population and employment, the PSAPs experience a reciprocal growth in call volume and interaction with other agencies. This is to ensure that all emergency calls are handled accurately and in the most expeditious manner. Therefore, in the scenario depicted, there may exist a PSAP or PSAP agencies that due to their site and situation exhibit a zone of influence or centrality.

For the sake of this discussion we will make several assumptions with respect to the growth and development of this fictitious metropolitan area. First, PSAP A represents the original PSAP agency of the urban core. PSAPs B and C are PSAP agencies for two of the more established suburbs within the metropolitan area. These suburbs have developed from small bedroom communities to central places, and represent the predominant direction of economic development and growth over the past several years. Second, PSAPs D, E and F represent the most recent movement of the

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population to exurbs[3] in an effort to escape the more crowded conditions of the urban core. Recent improvements in the transportation system have allowed this particular segment of the population to move further out from the central business district. Yet, at the same time maintain an acceptable level of travel time with respect to the daily commute to work. In this particular case there is a trade off in travel costs and time for lower housing costs. Also, there exists a recent trend in the movement of retail and employment to these exurbs, as this segment of the economy tends to gravitate to where the population resides. Thus, these exurbs exhibit all the traits of "edge cities."

Based on the assumptions established with respect to the geographic make up of this fictitious region, there exists a high probability that PSAP A has a greater degree of interaction with PSAPs B and C. However PSAP A does have some interaction with PSAPs D and F, but to a lesser extent. On the other hand, PSAPs D and F will in all likelihood exhibit more of a two-way interaction with PSAP E. The interaction will occur from E to F and F to E as well as D to E and E to D. One means to verify this degree of interaction is to evaluate the number of fixed transfers or speed dials and the terminating end location of each. This should provide a mechanism whereby the centrality or zone of influence exhibited by one agency could be evaluated through empirical data. Another source of data is the number of both ANI failures and No Record Found conditions as well as misrouted calls. If one agency historically has a greater number of calls that fall into this category, then in all probability that agency has the capability to properly handle these calls and transfer the caller to the appropriate responding agency.

5.6 Application of CPT

Given the parameters set forth in the preceding discussion the concepts of Central Place Theory can be applied. The first assumption identified the geographic area of PSAP A as the urban core. While the geographic area of PSAPs B and C represent the contiguous growth and development of the larger metropolitan area. When combined, they represent a first order central place which can be delineated as depicted in figure 4.

The second assumption differentiated the geographic coverage of PSAPs D, E, and F as edge cities. These second order central places clearly fall within the next hierarchical level of urban places (see figure 4). With the central place hierarchies defined, a pattern emerges with respect to the rate centers that fall within a particular boundary.

At the first order level, Zones 1 through 10, either in whole or partially lie within the boundary delineated. At the second order level, two separate boundaries are delineated and overlap the first order boundary. Combined they encompass Zones 13 through 17 and overlap into zones 2, 3, and 4. From the results of this analysis, a recommendation can be made to consolidate Zones 1-10 into a single rate center with PSAP A as the default PSAP location for ANI failures. In conjunction with this, Zones 12-17 could be consolidated into a separate rate center with PSAP E defined as the default PSAP for ANI failures (see figure 5). Zone 18 however, would be eliminated from the consolidation plan since it homes to a E9-1-1 control office that is not incorporated into the

[3] The term exurbs is a reference to urban areas that extend out beyond the suburbs to the fringe and encroach on land that was once devoted to agricultural use.

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embedded network of the geographic region. An alternate recommendation is to consolidate Zones 1 through 10 and eliminate the remaining rate centers from consideration (see figure 6).

6 Agency Approval

The final recommendation for this consolidation is dependent upon approval from the PSAP agencies affected. The PSAP agencies should be involved in the process to the extent possible. Their participation and cooperation is strongly encouraged, as the end result will impact their daily operations. Once the analysis of the consolidation geography is complete and evaluated in conjunction with the data on call transfers, an assessment as to the most appropriate agency(ies) for ANI default routing can be made. It is at this time that the respective PSAP agencies should be contacted to discuss the results. Additional information that should be brought to the table is the number of ANI failures and No Record Found conditions as a percentage of total call volume for a given period of time.

Generally, the percentage of ANI failures and NRFs is 0.5 and 1.0 percent respectively. Statistical data from two separate regions within the U.S. are comparable and very closely approximate these percentage values. The data presented on ANI failures and NRFs should assist the PSAP agency affected in their final determination as to whether they are willing to accept these calls. However, it should be noted that the number of NRF conditions might increase for a particular agency depending upon the level of predominant ESN routing. As previously discussed predominant ESN routing may be established at either the 1,000 or 10, 000 block level of an NPA-NXX. At the 10,000 block level there exists a higher probability of an increase in NRF default routing for one PSAP agency in a consolidated rate center environment. At the 1,000 block level the probability is diminished with increased granularity built into the selective routing tables at the E9-1-1 control office.

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Figure 4

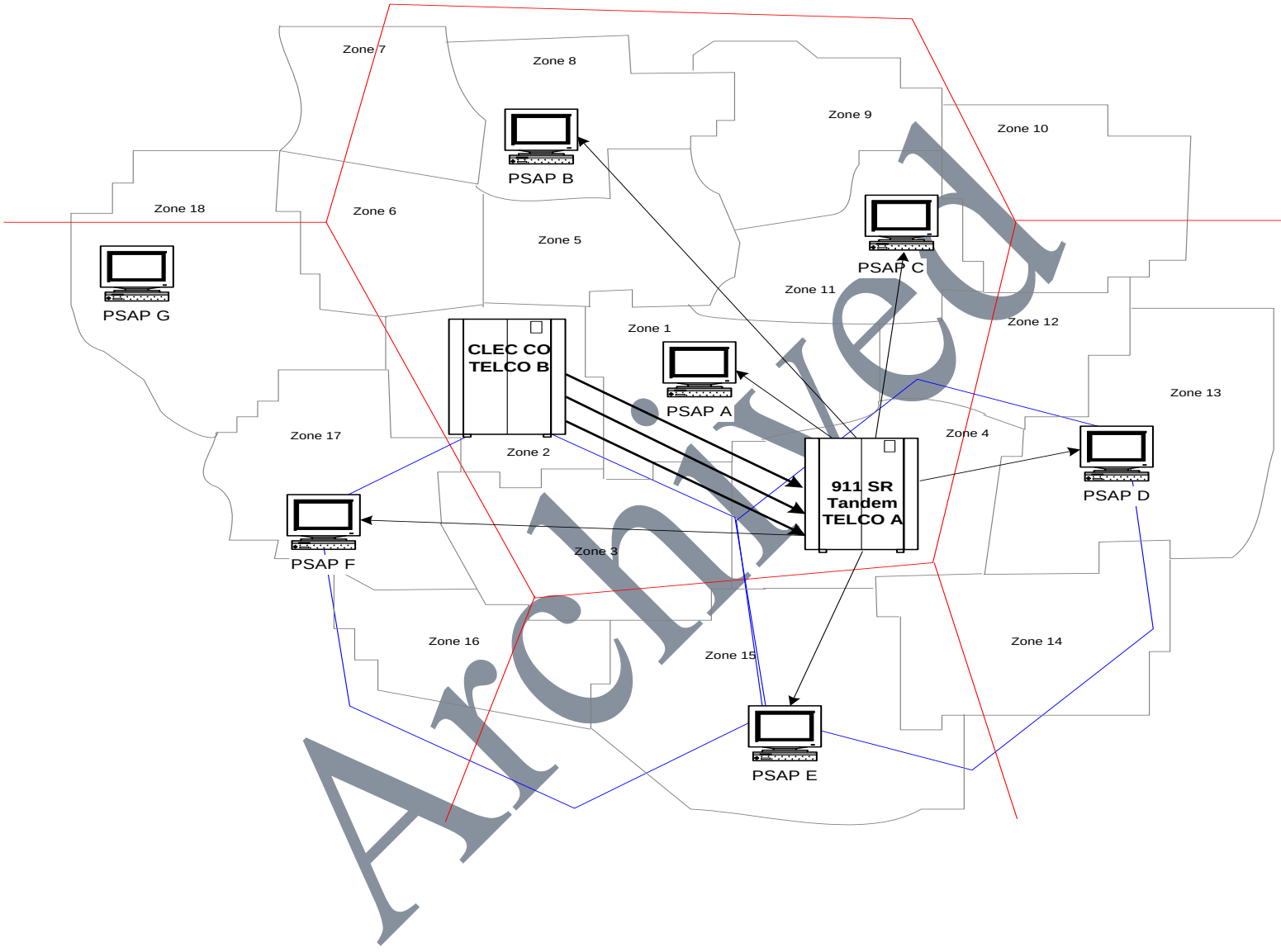

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Figure 5

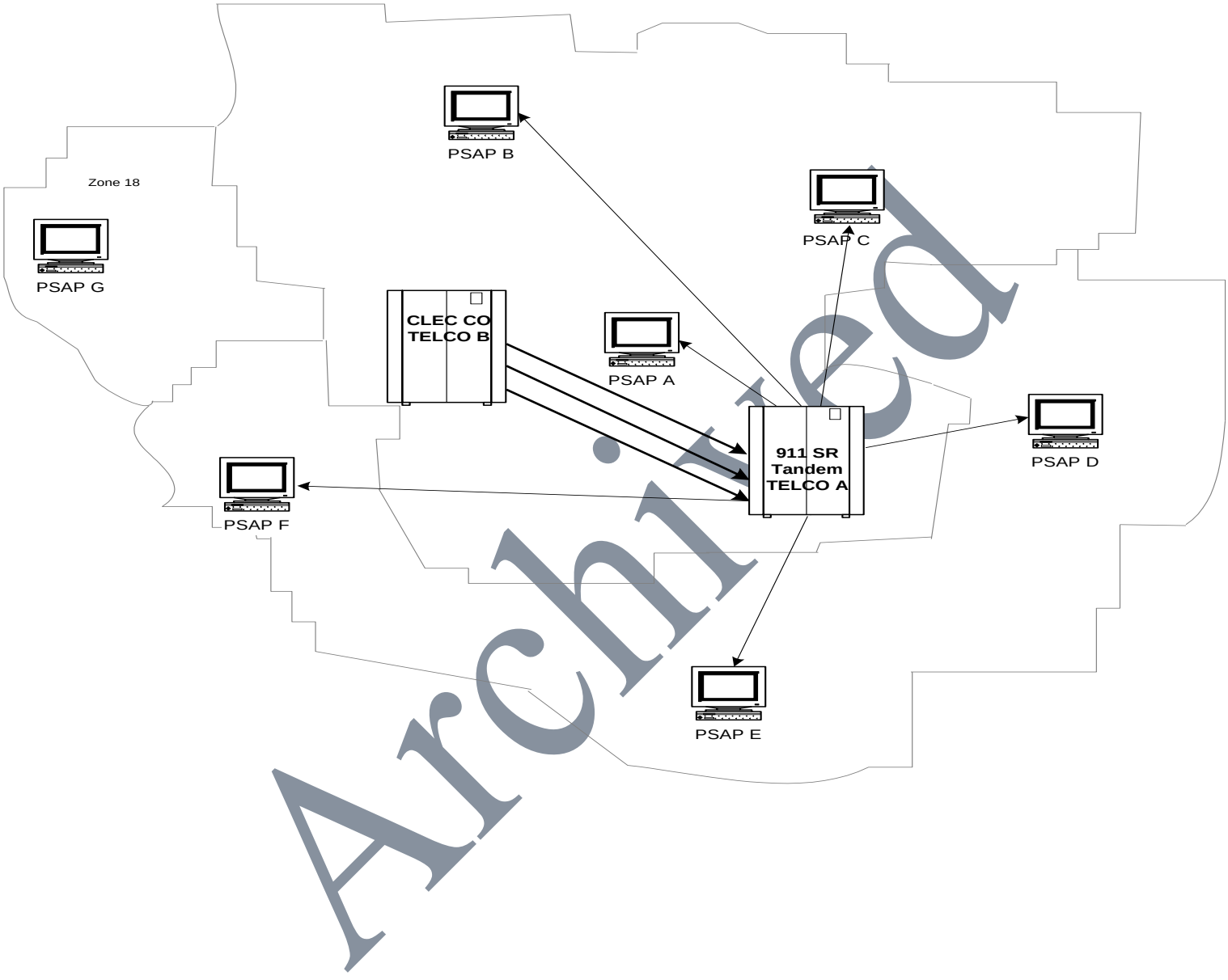

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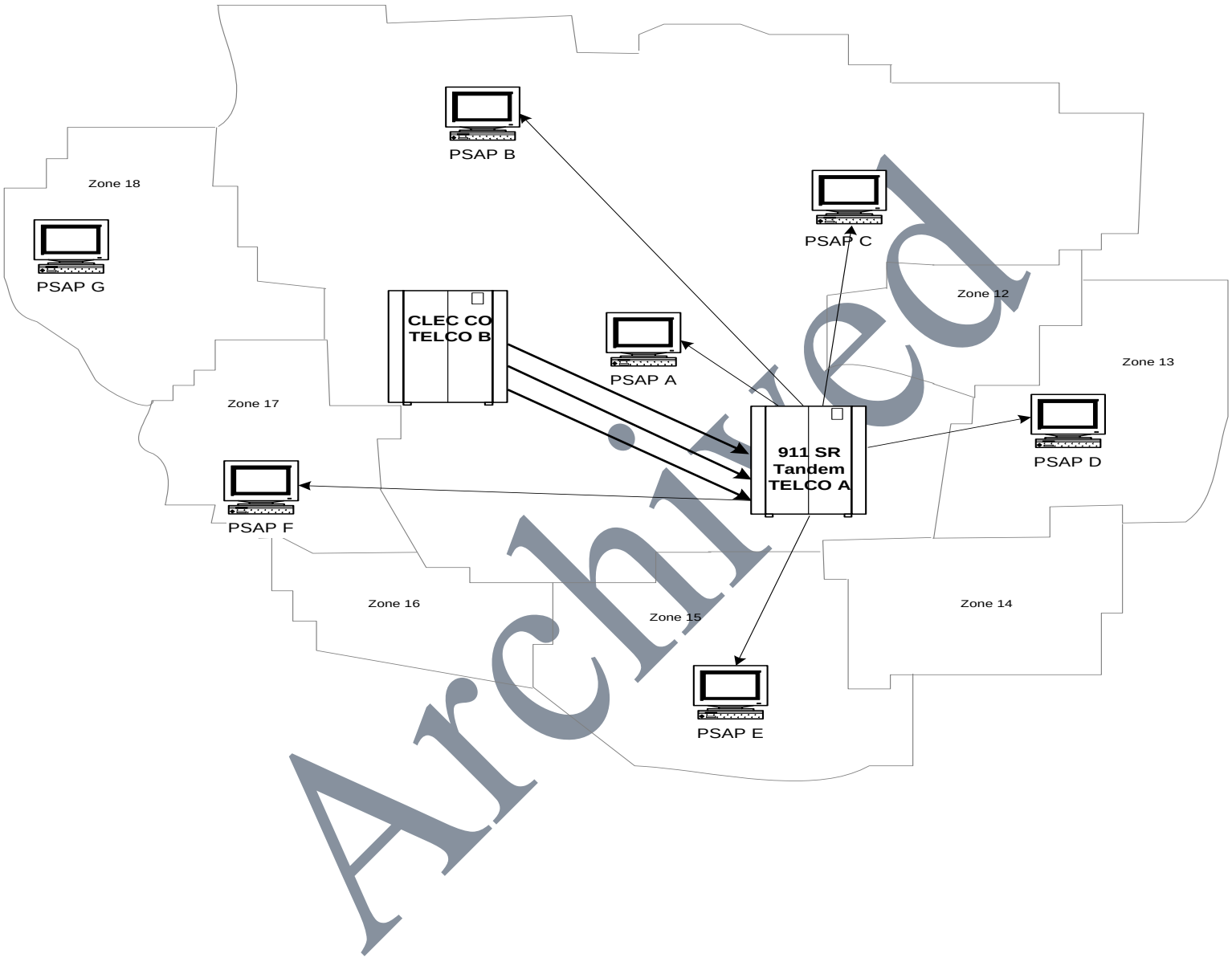
Figure 6



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7 References

N/A

8 Exhibits

N/A