E9-1-1 System Assessment
Executive Summary

for:

The Statewide Network Modernization Project

submitted to:

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Department of Public Safety

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L. Robert Kimball & Associates
Architects and Engineers

EBENSBURG, PENNSYLVANIA CORAOPOLIS, PENNSYLVANIA PITTSBURGH, PENNSYLVANIA HARRISBURG, PENNSYLVANIA PHILADELPHIA, PENNSYLVANIA
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1. EXECUTIVE SUMMARY

L. Robert Kimball & Associates (Kimball) is pleased to provide this comprehensive executive summary of the State of Minnesota enhanced 9-1-1 (E9-1-1) system assessment report. The finer details of the E9-1-1 system assessment report are located in the State of Minnesota Current 9-1-1 Assessment and Next Generation (NG) 9-1-1 Strategy Report also produced by Kimball. Kimball conducted this statewide evaluation of the E9-1-1 system to determine the current state of the overall 9-1-1 network including the public safety answering point (PSAP) customer premises equipment (CPE) equipment. An executive summary for the PSAP gap analysis has also been provided to the Minnesota Department of Public Safety (DPS).

This E9-1-1 system assessment executive summary will include a review of these elements below, pre-approved by the Minnesota DPS:

- Current 9-1-1 network analysis
- Selective routers and automatic location identification (ALI) systems currently available in use in Minnesota
- Recommendation and conclusions

1.1 CURRENT 9-1-1 NETWORK FINDINGS AND ANALYSIS

Kimball found that there is limited ability for PSAPs to transfer 9-1-1 calls with data to other PSAPs, which in today's mobile environment presents a major impediment to public safety. The inability of either 9-1-1 service provider to transfer calls between their networks leads to delays in dispatching an emergency call. Qwest has implemented the capability to transfer 9-1-1 calls between PSAPs homed on different selective routers within their network, while Independent Emergency Services LLC (IES) has limited PSAP transfer capabilities between selective routers in their network.

Equally important is the fact that Minnesota's two service providers have not fully deployed the Network Reliability Council's 1993 recommendations relating to diversity and redundancy of 9-1-1 selective routers. The service providers have implemented these protective measures in the more populated areas, but the cost of network reliability is out of reach for 46 percent of the population.[1] This lack of redundancy renders PSAPs vulnerable to network outages.

IES' CML ECS-1000 selective routers cannot economically provide direct connection to carriers using Signaling System 7 (SS7). The IES network design requires that SS7 supported carriers must use the IES Lucent 5E tandems as gateways to convert the SS7 to integrated services digital network–primary rate interface (ISDN-PRI) so that the CML ECS-1000 can accept it. This configuration creates a single point of failure (SPOF) for wireless carriers in a large population

[1] Refer to Table E-4

area. PSAPs outside of the IES network do not receive automatic location identification (ANI) or emergency services routing key (ESRK) identification on 9-1-1 wireline or wireless call transfers.

Nomadic voice over Internet protocol (VoIP) carriers do not utilize dedicated 9-1-1 but share licensed competitive local exchange carriers' (CLECs') trunks for access to the tandems/selective routers.

One PSAP, Wabasha County, which does not have connectivity to a selective router; the telephone company's end office trunks terminate directly on the PSAP's ANI/ALI controller.

Minnesota's existing 9-1-1 system cannot support text messaging, photographic images, video or native VoIP calls, even though the public uses these technologies in their day-to-day communications and expects to have access to 9-1-1.

1.2 CURRENT SELECTIVE ROUTER FINDINGS AND ANALYSIS

Qwest has five Lucent 5E switches that provide selective routing, call transfer, and centralized automatic message accounting (CAMA) trunking to the PSAPs within its service areas. Qwest has configured four of these switches as primary 9-1-1 tandems/selective routers, and they are located in the cities of Duluth, Fargo, Minneapolis, and Rochester. The fifth, configured as a secondary 9-1-1 tandem/selective router, is located in St. Paul and is paired with the Minneapolis E9-1-1 tandem/selective router. Qwest's tandems deliver 9-1-1 calls to 53 PSAPs throughout Minnesota. Most 9-1-1 calls are delivered to the 19 primary, 4 secondary and 2 Minnesota State Patrol (MSP) PSAPs within the eight-county metropolitan area: Anoka, Carver, Chisago, Dakota, Hennepin, Ramsey, Scott, and Washington. The Metropolitan Emergency Services Board (MESB) supports the 9-1-1 network and ALI database within this eight-county metropolitan area. In addition, Qwest provides E9-1-1 services to 18 primary, 1 secondary and 9 State Police PSAPS in greater Minnesota.

The eight-county metropolitan emergency service area utilizes a dual tandem selective routing configuration. A dual tandem configuration is where the 9-1-1 caller's end office has the ability to send the 9-1-1 call to either of two geographically diverse 9-1-1 tandems. Should load changes, equipment, or a transport facility failure occur at either 9-1-1 tandem, the 9-1-1 call would automatically be routed to the other 9-1-1 tandem for call completion. PSAPs that are served by a dual tandem selective routing configuration are capable of receiving 9-1-1 calls from either tandem. In addition, during periods of high call volume when one tandem is busy, the other tandem is configured to receive and selectively route calls to the appropriate PSAP.

Outside of the metropolitan area, connectivity from Qwest's end offices to the 9-1-1 tandem is a concern due to the lack of redundancy in the current 9-1-1 network provisioning. The PSAPs outside of the metropolitan area served by Qwest in the state of Minnesota are not in a dual 9-1-1 selective router configuration.

IES is a consortium of seven independent telephone companies consisting of Consolidated Telephone Company, Garden Valley Telephone Company, Hutchinson Telephone Company, KM

Telecom f/k/a Kasson & Mantorville Telephone Company (K&M), East Otter Tail Telephone Company, Lakeland Telephone Company, and Paul Bunyan Rural Telephone Company. IES utilizes seven CML ECS-1000 selective routers for E9-1-1 selective routing. The IES selective routers are located in the communities of Turtle River, Brainerd, Erskine, Hutchinson, Kasson, Perham and Ruthton. IES' service is predominantly greater Minnesota, and excludes the MESB area.

The standards for NG9-1-1 have not been fully developed. Draft reports and early engineering efforts have demonstrated that Internet protocol (IP) will be the technology that is required to support NG9-1-1 components.

NG i3 9-1-1 traffic will need to bypass time division multiplexing (TDM) switching components of today, or be converted to and from IP to TDM via gateways to continue to utilize the current TDM technology-based selective routing systems. There will need to be data standards developed for what data the traditional TDM network will deliver with the call and what data will be delivered from centralized ALI databases for those PSAPs not i3 capable.

The future i3 network will deliver with the call, the location information as well as whatever is developed as the initial data standard, whether it be from voice, text, or video transmission.

Qwest and most of the wireless service providers serving the state of Minnesota are currently utilizing selective routers that are central offices switching systems. These systems are based on TDM technology. TDM technology will not natively support i3 NG9-1-1 traffic.

1.3 CURRENT ALI SYSTEMS

IES uses a redundant Datamaster system to host its ALI. 9-1-1 Datamaster Inc., headquartered in Overland Park, Kansas, focuses exclusively on providing and supporting 9-1-1 database solutions. The Datamaster hardware and software are housed in the IES locations of Lakedale Telephone Company in Annandale, Minnesota and Hutchinson Telephone Company in Hutchinson, Minnesota. The TCS and Intrado third-party database service control points are connected to these locations.

Qwest has contracted Intrado for ALI hosting and maintenance. The Qwest ALI network for Minnesota works from two diverse and redundant nodes in Longmont, Colorado; Minneapolis, Minnesota. IES maintains its own database management center for the PSAPs they serve. The IES ALI network is also redundant and physically diverse.

Third-party database providers' (TCS-Xypoint and Intrado) service control points are connected to these IES and Intrado locations.

The current ALI network in Minnesota has been very reliable within the TDM network. Where Qwest has elected to provide ALI from a third-party vendor (Intrado), they have also provided redundancy and diversity within the ALI network and ALI database. IES has also provided redundancy and diversity within their serving areas.

The inability to transfer between serving areas leaves a gap in the provisioning of public safety. Should the ability to physically transfer become a reality, the ALI data will also have to be shared. Wireless shell records and pseudo automatic number identification (P-ANI) steering must be entered into both Qwest and IES database systems to allow the PSAP to query for the ALI data.

The PSAPs store and query the ALI data from redundant and geographically diverse ALI storage locations, with the exception of one Minnesota PSAP that utilizes an "on-site" ALI management solution. The remaining 115 Minnesota PSAPs subscribe to an ALI management service either from Qwest or from IES.

The majority of Minnesota PSAPs access the ALI database(s) over dedicated leased telephone special service circuits that are often called "ALI Links." Each PSAP is supported by two diverse ALI links that are either configured to query both ALI storage systems at the same time or query a primary and, if it fails, then query the backup system. The ALI database management system (DBMS) includes utilities that mirror the data across the geographically diverse storage sites.

Currently, ALI transmits at very low speeds compared to more updated, high-speed solutions. ALI does not transmit at speeds higher than 19.2K in Minnesota, primarily because the current protocol is ASCII.

2. RECOMMENDATIONS AND CONCLUSIONS

During the course of conducting this study, Kimball identified several areas of concern. They are:

- The inability of PSAPs to transfer 9-1-1 calls with ANI/ALI
- Limited network redundancy
- The need to address new technology
- The need to control costs

This section outlines each concern and makes specific recommendations to address them.

2.1 ISSUE–THE INABILITY OF PSAPS TO TRANSFER 9-1-1 CALLS WITH ANI/ALI

The inability to transfer 9-1-1 callers from one PSAP to another PSAP is a critical issue–one that has a major negative impact on the response to an emergency. This limitation can exist if different selective routers, regardless of whether or not the selective routers are supported by the same service provider, serve the two PSAPS. Even if this deficiency were to be resolved by achieving interoperability between the selective routers, the current network design would create a secondary problem with the ALI database(s). For a 9-1-1 call to be selectively routed or transferred between PSAPS, when those PSAPs are served by selective routers that are supported by different 9-1-1 service providers, and when the ALI databases are maintained by different database providers, the ALI record(s) must reside in both databases. Unless ALI is addressed, fully enhanced 9-1-1 calls would still not be delivered to the PSAPS.

Recommendation
Interoperability between all current and future 9-1-1 networks and ALI providers is a necessity. This interoperability must encompass all PSAPs in the State including the State Patrol. If the incumbents or future providers do not provide voluntary and economically viable solutions, the State should consider amending its legislation.

Kimball recommends the State address the ALI database deficiency by issuing a request for proposal (RFP) that includes a solicitation for a single ALI database solution or an ALI steering solution.

Kimball recommends an accelerated migration to a NG9-1-1 network as the most comprehensive and efficient means to help resolve all of these deficiencies.

2.2 ISSUE–LIMITED NETWORK REDUNDANCY

The lack of network redundancy is Kimball's second concern. There are many Single Points of Failure (SPOFs) in the present 9-1-1 network configuration. The metro area utilizes primary and secondary selective routers to ensure network reliability, but greater Minnesota PSAPs generally utilize only single selective routers. The network between the end offices and the selective routers and between the selective routers and the PSAPs are seldom diverse. This increases vulnerability to 9-1-1 service outages.

Recommendation

NG9-1-1 networking solutions would address many of the current networks' limitations. Thus, Kimball strongly recommends that the State continue the planning and preparation necessary to implement an expanded NG9-1-1 solution for the state of Minnesota.

Kimball recommends that the RFP include additional NG9-1-1 network components to address the known limitations caused by non-redundant selective routers and tandems, and expand the required IP connectivity to the PSAPs in a phased implementation approach.

It is Kimball's opinion that an accelerated migration to a NG9-1-1 network would be of assistance in resolving these deficiencies.

2.3 ISSUE-THE NEED TO ADDRESS NEW TECHNOLGOY

PSAPs face new challenges with communications devices that do not use traditional means to access the 9-1-1 system. A new generation of access devices presents a technology challenge to systems originally designed to provide only fixed landline 9-1-1 calls. A network and PSAP originally intended to carry and receive voice and a minimal amount of data now must be made ready to support substantial amounts of data, including pictures, text messaging and video provided by the calling public. The hearing impaired are depending more on text messaging to communicate and are a driving force to implement an IP-enabled, Next Generation 9-1-1 system.

Recommendation

NG9-1-1 networking solutions would lay the framework and network backbone that would allow for text messaging to be transported across the 9-1-1 network. Many of the standards for how text messaging, video and pictures will access the 9-1-1 network still need to be established but it is imperative that an IP network be in place once those standards are developed to allow access to the PSAP from these devices. Thus, Kimball strongly recommends that the State continue the planning and preparation necessary to implement an expanded NG9-1-1 solution for the state of Minnesota.

It is Kimball's opinion that an accelerated migration to a NG9-1-1 network would be of assistance in resolving these deficiencies.

2.4 ISSUE–THE NEED TO CONTROL COSTS

Network cost reduction is the third issue that needs to be addressed. It is apparent that excess trunking exists in many of the end office network designs. This situation results in unnecessary network expenses that are paid by the State. It is Kimball's recommendation for the State to request traffic studies for all end office trunking and evaluate for the grade of service. National Emergency Number Association (NENA) recommends a P.01 grade of service for 9-1-1 trunks. Anything more than that increases costs unnecessarily. Elimination of trunks in some cases and further trunk studies would be required to ensure a P.01 grade of service is maintained. The inter-selective router trunking is also quite costly and should be included in this review process. Here again, an accelerated migration to a NG9-1-1 network would be of assistance in resolving concern by reducing the amount of mileage-based network elements and incorporating an increasing number of bandwidth-rated network elements.

As previously reported, there is currently a cap on the 9-1-1 user fee, but none on expenses.

Recommendation

Kimball recommends the State request traffic studies for all end office trunking to determine whether the 9-1-1 system meets the P.01 grade of service standard. In many cases, we expect trunks can be eliminated; in others, trunks may need to be added to ensure a P.01 grade of service is maintained. Overall, this appears to be an area where costs could be reduced.

In addition, Kimball recommends that inter-selective router trunking be included in this review process.

As we previously recommended, an accelerated migration to a NG9-1-1 network would help reduce these costs by reducing the amount of mileage-based network elements and increasing the number of bandwidth-rated network elements.

Kimball recommends that the State eliminate cost recovery for all carriers for all end office trunking to the selective routers. This policy position, we believe, would be consistent with the Federal Communications Commission's (FCC's) King County wireless ruling and would have an immediate, positive effect in reducing expenses.

If this is not possible, Kimball recommends the State, at a minimum, cap carrier cost recovery.

2.5 RECOMMENDATION FOR THE PATH FORWARD

The State of Minnesota and the Minnesota Department of Public Safety (DPS) are faced with 9-1-1 issues that are similar to those encountered elsewhere across the country. The DPS understands that PSAPs face new challenges with communications devices that do not use traditional means to access the 9-1-1 system. The residents of Minnesota are quickly utilizing new technologies with their computers and wireless devices with the expectation of being able to communicate with today's 9-1-1 systems. A new generation of access devices presents a technology challenge to systems originally designed to provide only fixed landline 9-1-1 calls.

With the seemingly constant advancement of new technologies prevalent in today's 9-1-1 environment, a high degree of readiness must be incorporated into the 9-1-1 emergency call delivery and receipt system. A network and PSAP originally intended to carry and receive voice and a minimal amount of data now must be made ready to support substantial amounts of data, including pictures, text messaging and video provided by the calling public. The hearing impaired are depending more on text messaging to communicate and are a driving force to implement an IP-enabled, Next Generation 9-1-1 system. A new model is required in order to achieve the National Emergency Number Association's (NENA) stated desire of "any device, anytime, anywhere".

Along with the development of new technologies requiring access to Minnesota's current Enhanced 9-1-1 (E9-1-1) system, Minnesota also faces some functionality issues. There are two 9-1-1 system providers in Minnesota, and the inability to transfer a fully-enhanced 9-1-1 call from one service provider's network to the other can cause delays in processing these calls. The State desires an IP-enabled common backbone network that will support call transfers between PSAPs with Automatic Location Identification (ALI). One other area of concern is the single points of failure in portions of the 9-1-1 network. With the increasing number of choices available for network designs, including the option of using the existing State IP network, connectivity to Minnesota PSAPs and the supporting network infrastructure can become more affordable. Design choices can reduce many single points of failure and result in a more user friendly, reliable, robust and flexible E9-1-1 system for the State of Minnesota.

Kimball recommends that the Department of Public Safety implement a new, IP-enabled, Next Generation ready 9-1-1 (NG9-1-1) infrastructure that will better serve the needs of today as well as future NG applications. This solution is required to include, but not be limited to, network transport, PSAP termination interfaces, 9-1-1 trunk support, and selective routing and ALI interfaces. The system must be scalable, affordable, reliable and capable of resolving the limitations of the current system. To facilitate this migration strategy, it is envisioned that this project will be implemented in three major phases however, the DPS is open to alternative migration strategies.

Kimball foresees that it may be more economical to continue to support several of the 9-1-1 services, such as traditional wireline and potential wireless, in the same fashion as today. When connectivity is expanded to the PSAPs it would be possible to migrate one of the redundant ALI links and half of the 9-1-1 trunks to the IP backbone network. As each PSAP concludes their NG migration plan to newer CPE that has IP supportive platforms, the next phase would be to establish full IP network redundancy to the PSAP that would support a full migration. This migration strategy would minimize the duplication of network transportation costs that are foreseen, since any migration plan will require that many components of the older network remain in place until the 9-1-1 services are fully migrated.

These migration strategies will require individual PSAP planning and coordination as the new 9-1-1 infrastructure is implemented in the state of Minnesota with the stated purpose of improving public safety, improving services, and realizing technical and fiscal efficiencies. As Kimball performed its study for Minnesota, it was clear that more than one NG IP solution might be available to support the state. Because several solutions are available, a competitive procurement will ensure the best solution and value for Minnesota's PSAPs and citizens.

The RFP process would allow the State to evaluate the responses and compare the multiple solutions and costs, all of which will be of tremendous benefit to the State in its decision-making process. Once a vendor's solution and price is accepted, the State would then award the selected vendor the contract(s) to proceed with its solution(s). Kimball encourages the State to precede through the RFP stages to more accurately determine the best course of action to achieve the desired results.

2.6 PHASED APPROACH

Fully transitioning from a TDM emergency communication network to a fully redundant IP network is challenged by a number of dependencies, such as the type of PSAP CPE equipment and individual PSAP transition plans.

The individual PSAP transition plans, implementation timelines, and geographic location will also affect that true diversity offered to each PSAP and costs for each PSAP's conversion to a full IP network. Some PSAPs' transition plans might be better supported by retaining the existing analog network and only adding a non-redundant NG network component, until the PSAP CPE is upgraded or replaced. Some PSAPs could benefit more immediately from a fully redundant IP network and totally migrate to IP. The best plan for each PSAP needs to consider the existing level of redundancy, maintenance support, and individual requirements.

Kimball has previously suggested that a network migration solution that would be NG scalable be considered as a first step towards the migration of NG9-1-1. This first phase would establish connectivity between the existing selective routers to support existing call transfer requirements.

2.6.1 Phase 1–Establish Common Backbone

The first phase would include installing TDM to IP converters that are commonly known as gateways. These gateways would be required at each of the current selective routers and tandem locations and would be sized to support the expanding NG traffic requirements as the project progresses to the next phase. These gateways would be the entry or access point to and from the TDM environment to the IP environment. In the first phase, we would establish gateway connectivity and transfer capabilities. This will require the installation of gateways, selective router interface, and establishing a common network backbone and maintenance support. This initial deployment would not be required to be fully redundant, since it would only be utilized for limited 9-1-1 services.

2.6.2 Phase 2–Establish Non-Redundant IP Connectivity

The second phase would be to establish non-redundant connectivity to each of the PSAPs, enlarge the scalable network backbone, and add a minimum of four data center network action points (NAPs). These NAPs would be utilized to support the convergence of one of the two redundant low-speed ALI data links onto the IP network. Depending on the PSAP CPE and ALI services, this data would need to continue in the same ASCII data format or fully converted to IP. This approach would allow for a migration to the IP solution and the convergence would abandon

50 percent of the existing low-speed ALI links. Reducing existing transportation costs to provide this service will be subject to termination liabilities, unbundling of tariff services, and both services will need to be in service until the third phase of the project is completed.

Up to 50 percent of the existing 9-1-1 voice CAMA connections could utilize this first phase of connectivity if it supported the individual PSAP conversion plans.

2.6.3 Phase 3–Establish a Fully Redundant IP Network

The third phase would be to establish a fully redundant network; we are suggesting that the third phase have a staggered timeframe from the first two phases to limit duplication of network expenses for a minimum time period. This phase is actually a replication of Phases 1 and 2, since we will be duplicating and expanding gateways and network components for a fully geographical diverse and redundant network capable of supporting NG9-1-1 applications. The recommendation of this staggered timeline is to limit duplication of expenses, while each PSAP migrates its 9-1-1 data and voice components to the new network. PSAPs should not migrate fully to the IP network until full redundancy is available.

2.7 SUMMARY

Based on the findings of this report, Kimball recommends that the State proceed in developing an RFP for NG9-1-1 networking solutions that can address the current network's interoperability limitations as well as support substantial amounts of data, including text messaging, pictures and video-- in essence a network that can achieve the National Emergency Number Association's (NENA) stated desire of "any device, anytime, anywhere". It is further recommended that the State implement a state-wide NG9-1-1 solution that is managed by one entity that can be held accountable for the entire network. It is foreseen that it may be more economical to continue to support several of the 9-1-1 services such as traditional wireline and potential wireless in the same fashion as today. Kimball recommends that the RFP request that interested parties define how additional NG9-1-1 network components could be utilized to continue to address the known, non-redundant selective routers and tandem limitations and expand the required IP connectivity to the PSAPs in a phased implementation approach. As each PSAP concludes their limited migration plan to the newer IP platform, the next phase would be to establish full IP network redundancy to the PSAP that would support a full migration. This migration strategy would minimize the duplication of network transportation costs that are foreseen, since any migration plan will require that many components of the older network remain in place until the 9-1-1 services are fully migrated. All of these phases will require individual PSAP planning and coordination as the NG9-1-1 infrastructure is implemented in the State with the stated purpose of improving public safety, providing improved services, and realizing technical and fiscal efficiencies.

The RFP process is an announcement of willingness to consider bids for the performance of a specified project or program component and a logical next step in the path towards NG9-1-1. RFPs are often issued when seeking bids for a specified research project. An RFP is a document that solicits a particular solution offered by the respondents to the RFP. The respondent's cost to provide that solution is included in detail in the response. An RFP is announced to multiple companies that will be interested in procuring the project. This allows the State to evaluate the

responses, and compare the multiple solutions and costs. This evaluation process will aid the State in their decision-making process. Once a vendor's solution and price is accepted, the State would then award the selected vendor the contract(s) to proceed with their solution(s).

Based on our findings and the information reported in this report, Minnesota is well positioned to move forward with the recommendation of a IP network solution that will provide connectivity between the existing 9-1-1 selective routers and tandems to resolve the call transferring issue of today. The IP network elements required to provide such a network are available in Minnesota from a variety of sources. Because several solutions are available, an air of competition among RFP respondents and proposing vendors will result, ensuring the best price is provided for the chosen solution.

Due to the fact the one best solution is not known at this time, the State will be provided with a menu of options to choose from as a result of the RFP process. The State will need to determine at what pace they wish to proceed to achieve their goals with the next phase of NG9-1-1. Kimball encourages the State to proceed through the RFP stages to more accurately determine the best course of action to employ to achieve the desired results.

APPENDIX A–ACRONYMS

-A-

ALI	Automatic Location Identification
ANI	Automatic Number Identification

-C-

CAMA	Centralized Automated Message Accounting
CLEC	Competitive local exchange carrier
CPE	Customer Premise Equipment

-D-

DBMS	Database Management System
DPS	Department of Public Safety

-E-

E9-1-1	Enhanced 9-1-1
ESRK	Emergency Services Routing Key

-F-

FCC	Federal Communications Commission

-I-

IES	Independent Emergency Services
IP	Internet Protocol
ISDN-PRI	Integrated Services Digital Network Primary Rate Interface

-M-

MESB	Metropolitan Emergency Services Board
MSP	Minnesota State Patrol

-N-

NAP	Network Action Point
NENA	National Emergency Numbers Association
NG	Next Generation

-P-

P-ANI	Pseudo Automatic Number Identification
PSAP	Public Safety Answering Point

-R-

RFP	Request for Proposals

-S-

SPOF	Single Point of Failure
SS7	Signaling System 7

-T-

TDM	Time Division Multiplexing

-V-

VoIP	Voice over Internet Protocol