
System Level Analysis and Performance Evaluation of Soft Switch Network in PTCL South Region

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ABSTRACT

In this paper, we present a thorough research to analyze the performance of the soft switches of PTCL (Pakistan Telecommunication Company Limited) in south region by taking real values from the operational systems and ratio of fault occurrence in soft switches. The major issues and shortcomings related to hardware of soft switches, network build up and protocols of SS (Soft Switch) are discussed. Performance characteristics of two soft switches (Pak Capital SS Vendor-A and Marston Rd SS Vendor-B) on the basis of key parameters including, System over view, System architecture, Hardware, Network built-up are analyzed. All parameters are compared with PTA (Pakistan Telecommunication Authority) standards and suggestions are provided to remove single point of failure to achieve 24x7 services available for the customers of PTCL. The conclusion drawn out of the research works, and suggestions provided will pave a path to increase the efficiency of soft switches, enrich the operation of the system, reduces the fault occurrence and complete isolation of the MGs/MSAN/MSAGs, improve the availability of the PTCL services to its customers and will enhance the image of the company for its valuable customers.

Key Words: New Generation Network, Soft Switch, Pak capital Soft Switch (Vendor-A), Marston Rd Soft Switch (Vendor-B).

1. INTRODUCTION

Traditionally large organization or government departments used high speed networks to carry voice and data services [1]. At present two independent networks exists in Pakistan Telecommunication; the PSTN (Public Switch Telephone Network) and data network, which provides the voice and data service respectively. Due to two separate networks, maintenance cost is high and convergence of services is very complicated. The optimum solution is the transition from existing network to NGN (Next Generation Network). NGN is a packet supported

network with provision of broadband and features of triple play (Voice +Data +Video) over fixed and mobile line [2-3]. For voice setups SS which is a programmable device that controls the VoIP (Voice Over IP) calls is the dominant device in NGN [4]. Soft Switch facilitates the optimum integration of different protocols within NGN [5]. Soft switch is also responsible for interface setup across the existing telephone network, PSTN, via SG (Signaling Gateways) and MG (Media Gateways) [6]. Many NGN retailers specifically Siemens, Alcatel, ZTE and Huawei are working across the globe, but in

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Pakistan two vendors of soft switches namely as STE (Zhongxing Telecommunication Equipment) and Huawei are more dominant. In this work, we have compared performance of two soft switches (ZTE, Pak Capital SS named as Vendor- A and Huawei, Marston Rd soft switch named as Vendor-B) on the basis of System over view, System Architecture, Hardware, and Network built-up. Results obtained on the basis of these performance parameters have been analyzed according to the benchmark standards provided by the PTA. Finally it has been concluded which system outperforms on the practical data of soft switches, fault occurrence ratio and availability of the systems. Suggestions would be offered to improve the performance of the both soft switches.

The remainder of this paper proceeds as follows. In Section 2, the next generation networks have been described. The hardware and protocol standards of SS are discussed in Section 3. Comparative analysis of the hardware of Vendor-A and Vendor-B SS is given in Section 4, which is followed by the network build-up issues and proposed suggestions for Vendor-A and Vendor-B in Sections 5 and 6. Finally this paper has been concluded and given the future point.

2. EVOLUTION TOWARDS NEXT GENERATION NETWORKS

Currently, existing two independent networks, i.e. PSTN and data networks maintenance cost is high and convergence of services is very complicated. Existing PSTN voice network is a closed network and have monopolized resources. Companies need to trace the latest technologies and so as to efficiently utilize the existing technologies and resources. The optimal solution is smooth transition from existing network to NGN. NGN system architecture falls into four layers as shown in the

Fig. 1 namely Service Layer, Control Layer, Core Transport Layer, and Access Layer [7]. Moreover, the detailed elements of the NGN network including soft switches are presented in Table 1.

3. SOFT SWITCH PROTOCOLS AND HARDWARE SETUPS

Being the core of the next generation network, the control and management of NGN is the primary purpose of SS technology [8]. The separation of calling transfer and the calling control is the principle aim of SS. Call process control, Protocol processing, Resource allocation Media gateway access control, Adhoc Routing, Service Authentication, API (Application Programming Interfaces), Voice services and Multimedia services are the core function that SS normally can perform [9].

3.1 Protocols and Signaling Supported by Vendors-A and Vendors-B Soft Switch

The Protocols supported by Vendor-A and Vendor- B soft switches are given in the Table 2.

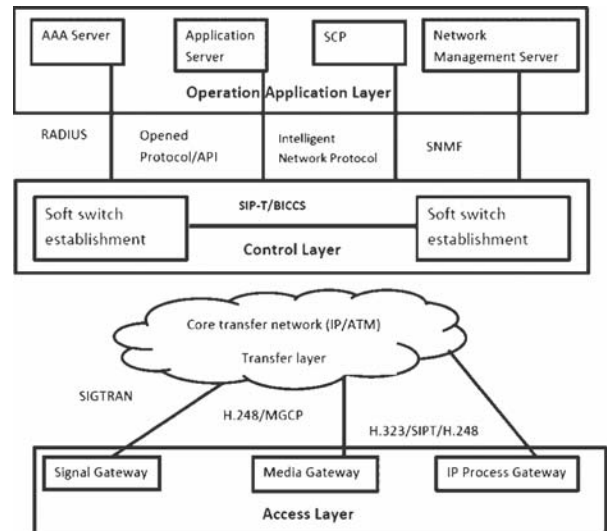


FIG. 1. THE STRUCTURE OF LAYERED NGN NETWORK

3.2 Hardware of Vendor-A Soft Switch

The hardware structure of the Pak Capital soft switch control equipment consists of the background (Operations Support System and Database Server), foreground (real-time processing part), Operation and Maintenance system and SSN (System Switching Network) card that interconnect all the internal modules [10]. The background includes the CDR (Call Detail Reporting) server and the database server. The database server provides the storage of static service data, configured data and user data. Every time when call finishes, CDR information will be transport to the CDR server. The billing center periodically collects the CDR files from the CDR server. The foreground accesses or writes data from or to the background by responsible interfaces. Operation and maintenance system contains terminals which are either connected with Pak Capital SS directly or are connected across the network management network. Fig. 2 illustrates the detailed hardware structure of Vendor-A SS, whereas the specific function of individual hardware module of Vendor-A SS is briefed in Table 3.

3.3 Hardware of Vendor-B Soft Switch

Basic Frame 0, Basic Frame 1, Expansion frame and Media resource frame are the four major hardware components available in Vendor-B SS as shown in Fig. 3.

4. COMPARATIVE ANALYSIS AND PROPOSED SUGGESTIONS

In following section a detailed analysis and proposed suggestions are made on the basis of hardware setup and network diagram issues of Vendor-A and Vendor-B SS.

4.1 Hardware Analysis of Vendor-A and Vendor-B Soft Switch

It was analyzed that Vendor-A SS is more compact as compared to Vendor-B SS. Power redundancy (2+2) in

TABLE 2. PROTOCOLS SUPPORTED BY VENDOR- A AND VENDOR- B SOFT SWITCHES

Protocol Name	Function
MGCP,H.248	Media Gateway Control Protocol
H323, SIP	Call Control Protocol, Service Interface Protocol
SIGTRAN	Signaling Transmission Protocol
SNMP	Simple Network Management Protocol

TABLE 1. ELEMENTS OF THE NGN NETWORK

NGN Network Element	Functionality
Soft Switch	A core NGN network used for call control & processing, Protocol Adaptation, Service Interface Provision, Application System Support.
Signaling Gateway (SG)	Responsible for accomplishing signaling translation from PSTN to IP.
Trunk Gateway/Media Gateway/Universal Media Gateway	Responsible for accomplishing voice translation from PSTN to IP.
Multi-Service Access Gateway	Accessing subscribers.
Multi-Service Access Node	Accessing subscribers.
Integrated Access Device	Accessing subscribers
Broadband Gateway (BGW)	Interconnecting public network and private network
Smart Home Location Register	Responsible for storing subscribers data
Application Server	Responsible to provide Application Programming Interface for different services

Vendor-B SS is for each shelf. Also separate power breakers are used for each two shelves which reduce the power failure chances and limit the power failures. Whereas in Vendor-A SS only two (1+1) power cards are available for the whole system due to which chance of whole system failure is more in Vendor-A SS as compared to Vendor-B SS. Hence, power distribution in Vendor-B SS is better than Vendor-A SS. SPC (System Protocol Card) processes all the protocols of Vendor-A SS whereas in Vendor-B SS FCCU (Fixed Calling Control Unit), BSGI (Broadband Signaling Gateway Interface) and MSGI (Multimedia Signaling Gateway Interface) are used for protocol process. FCCU implements call control, processes protocols, generate and stores bills in its bill pool. BSGI process the

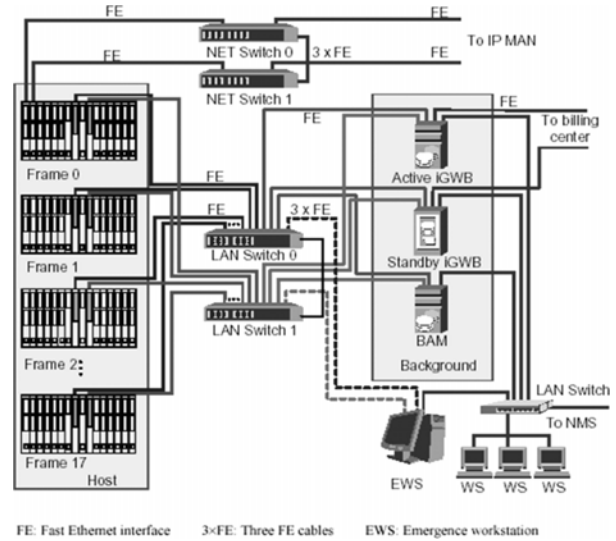


FIG. 3. HARDWARE OF VENDOR- B SOFT SWITCH

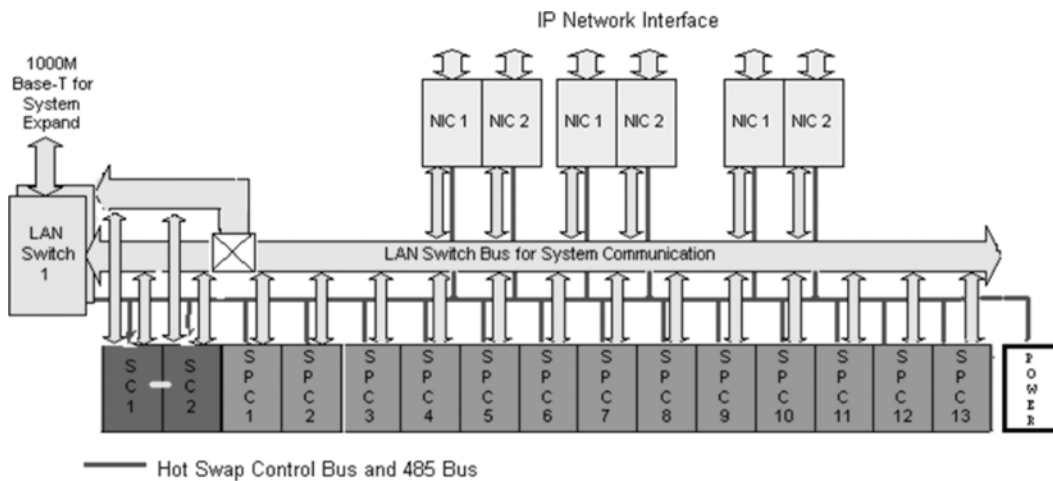


FIG. 2. HARDWARE STRUCTURE OF VENDOR- A SOFT SWITCH

TABLE 3. HARDWARE OF VENDOR-A SOFT SWITCH

Vendor-A Hardware Module	Specific Function
System Control Card	It is responsible for Monitoring and Control of both hardware and software status of other boards in the shelf, File backup (Calling Line Identification script).
System Switching Network	It provides Ethernet switching platform
System Protocol Card	Responsible for protocol and call processing
Network Interface Card	Responsible to distribute the protocol and other packet among System Protocol Cards. Also provides external interface to different gateway devices and internal interface to all kinds of application server, database, authentication server and Operations, Administration and Management (OAM) terminals.
System Switching Network Interface	It is used to interface with billing server and database server
Transportation Interface Card	It is used for environmental alarms.

IP packets. MSGI processes the UDP (User Datagram Protocol), TCP (Transmission Control Protocol), H.323, and SIP (Service Interface Protocol) protocols. SSNI (System Switching Network Interface) is not a redundant in Vendor-A SS whereas HSCI (High-Speed Communications Interface) card in Vendor-B SS is redundant due to which chances for getting billing server and data server out of access at Vendor-A SS are more as compared to Vendor-B SS. Separate alarm cards are available in Vendor-B SS, which makes easy to locate the alarms. In short, hardware redundancy of Vendor-B SS is stronger than hardware of Vendor-A SS.

4.1.1 Proposed Suggestions

The proposed suggestions that may highly be useful for the current situations in mobile network are as under:

- (i) Being the service providing company, the basic motto of PTCL is to make the services available

24x7 hours to customers; hence vendor should provide redundant (1+1) hardware to have uninterrupted service.

- (ii) Vendor-A should provide all service affecting cards redundant for uninterrupted service.

4.2 Network Diagram Issues of Vendor-A and Vendor-B Soft Switch

The typical network diagram of both Vendor-A SS and Vendor-B SS are discussed in this section and on that basis some suggestion have been proposed to improve overall system response and connectivity.

4.2.1 Network Diagram Build up issues of Vendor-A (Pak Capital) Soft Switch

The network issues of the Vendor-A SS are discussed in the following section and its diagram is shown in Fig. 4.

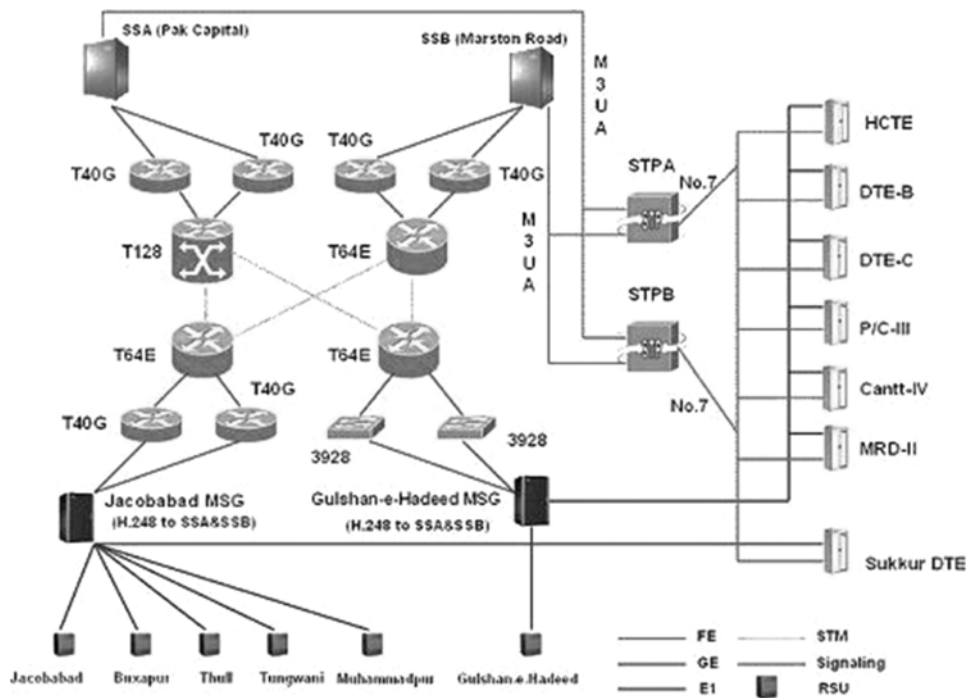


FIG. 4. NETWORK DIAGRAM OF VENDOR-A

4.2.1.1 Pak Capital Soft Switch T-64 Router Installed at Marston Road Site

Currently, T-64E router installed in SS (slave) Marston road site is connected with Jacobabad MSG and G- Hadeed MSG on one NPC (Network Process Card) with P3C card at back. Thus single point failure exists i.e. if the card becomes faulty, both MSG will be failed completely from SS Marston road. Furthermore, no spare of NPCT (P3C) module has been provided by Vendor-A to avoid any emergency situation.

4.2.1.2 Pak Capital Soft Switch T128 Router at Pak Capital

MG Jacobabad and MG-G Hadeed are connected on single NPC card (P3C card) at T-128 router of Pak Capital SS. Thus single point failure exists i.e. if the card becomes faulty then these MGs will be failed completely from SS Pak Capital. Furthermore, no spare of NPC (P3C) module has been provided by Vendor-A to avoid any sort of emergency.

4.2.1.3 Pak Capital Soft Switch T64 Router at Jacobabad

Two routers of Vendor-A (Pak Capital T-128 router and Marston T-64 router) are connected with MG Jacobabad via STMs (Synchronous Transport Modules) and are terminated on one NPC (P3C card at back) of MG Jacobabad T-64 router. Thus single point failure exists i.e. if the card become faulty, MG Jacobabad will be failed completely from Pak Capital soft switch as well as from Marston Rd SS, resulting complete isolation of MG Jacobabad from the system.

4.2.1.4 Pak Capital Soft Switch T-64 Router at G-Hadeed

Two routers of Vendor-A (Pak Capital T-128 router and Marston T-64 router) are connected with MG G-Hadeed

via STMs and are terminated on one NPC (P3C card at back) of MG JG-Hadeed T-64 router. Thus single point failure exists i.e. if the card become faulty, MG Hadeed will be failed completely from Pak Capital SS as well as Marston Rd SS, resulting complete isolation of MG G-Hadeed from the system.

4.2.1.5 The Connectivity of MG Jacobabad via STM by Transmission Team

MG Jacobabad is connected with slave Pak Capital SS at following media position of OFS (Optical Fiber System) long.

Distance Marston Road

OFS Marston road SDH → 454-KRC-12 OL1/1

Jacobabad OFS → 437-JCD- 6 OL1/2

MG Jacobabad is connected with master Pak Capital SS at following media position of OFS long.

Distance Pak Capital

Pak Capital SDH → 421-KRB-15 OL1/1

Jacobabad OFS → 437-JCD-6 OL1/1

From above two positions, it is clear that both STMs are connected on separate OFS Hall at Karachi but both are terminating on same optical line board at Jacobabad OFS. On failure of optical line board at OFS Jacobabad, MG Jacobabad connectivity will fail with both slave and master soft switches of Vendor-A. Furthermore, 3(1+1+1) redundant paths are available for Jacobabad MG with both slave and master SS. All three paths are on ZTE transmission system. On failure of ZTE transmission system, Jacobabad MG will be completely down. Thus one path (out of three paths) should be on Huawei transmission system for redundancy.

4.3 The Connectivity of MG-Hadeed via STM by Transmission

MG-Hadeed is connected with slave Pak Capital SS at following media position of PCM:

Marston Road

ODF PCM Marston road → slot 8 OL1/1

G-Hadeed PCM → Slot 8 OL1/1

MG Hadeed is connected to SS Pak Capital at following media position of PCM Pak Capital:

ODF PCM PC → Slot 17 OL1/1

G-Hadeed PCM → Slot 8 OL1/1

From above two positions, it is clear that both STM's are connected on separate PCM Hall at Karachi but both are terminating on same optical line board at G-Hadeed PCM. On failure of optical line board G-Hadeed MSG connectivity will fail with both slave and master soft switches of Vendor-A. Furthermore, 1+1 redundant paths are available for G-Hadeed MG with both slave and master soft switches. Both paths are on ZTE transmission system. On failure of ZTE transmission system, G-Hadeed MG will be completely down. Thus one path (out of two paths) should be on Huawei transmission system for redundancy.

4.4 Connectivity of STP with T-128 Router of Vendor-A

Currently both STPs (Signaling Transfer Point) are connected on same NPC card at T-128 router of Vendor-A. On failure of this card signaling of all connected MGs will fail which lead to revenue loss.

4.4.1 Proposed Suggestions

Following are given the proposed suggestions according to the analysis done on the basis of above given discussion:

- (i) There should be redundant NPC (P3C) cards in T-64 router and T-128 router of vendor-A to avoid single point of failure, because on failure of NP Card, all MGs connected with SS will be disconnected resulting complete isolation (no dialing) of MGs. Spare (NPC and P3C) cards should be available on the site to immediately replace the card on failure of the card to minimize the outage.
- (ii) Both soft switches of Vendor-A (Master and Slave) should be connected on redundant cards and spared NPCT and P3C cards should be available at MG Jacobabad.
- (iii) Both soft switches should be connected on redundant cards and spared NPC and P3C cards should be available at MG-Hadeed.
- (iv) STMs of master and slave soft switches should be connected on separate line boards by OFS Jacobabad.
- (v) STMs of master and slave soft switches should be connected on separate line boards by PCM G-Hadeed.
- (vi) Both STPs (STP-A and STP-B) should be connected on different NPC cards to avoid complete failure of MGs signaling.
- (vii) SS Pak Capital and MGs must be connected with PIE to avoid single point of failure for the system.

4.4.2 Network Diagram Build up Issues of Vendor-B (Marston Rd) Soft Switch

Fig. 5 represents the network diagram of Marston Rd SS of Vendor-B. The connectivity diagram of SS with core routers is shown in Fig. 6.

Marston Rd SS of Vendor-B is connected with two separate PIE routers at Marston road for redundancy. SS is directly connected via three FE (Fast Ethernet) interface with each PIE router. Both PIE routers are acting as active stand by for

the Marston Rd SS as shown in Fig. 4. HSRP (Hot Standby Router Protocol) is configured between PIE Router-1 and PIE Router-2 via GE interface. When this link fluctuates, PIE Router-2 loses heart beat with PIE Router-1 and assumes

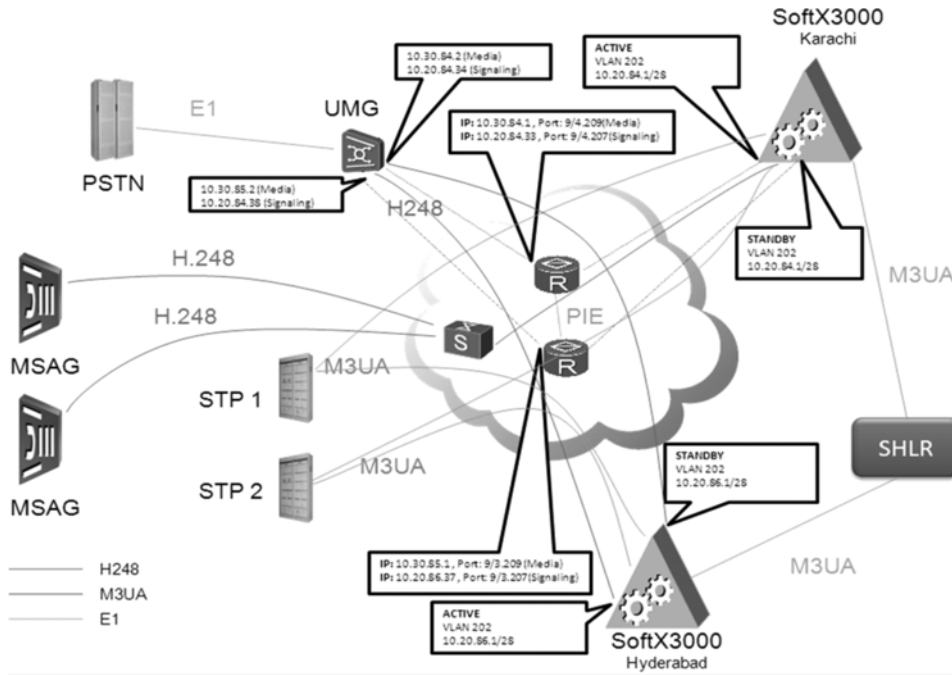


FIG. 5. NETWORK DIAGRAM OF MARSTON RD SOFT SWITCH (VENDOR-B)

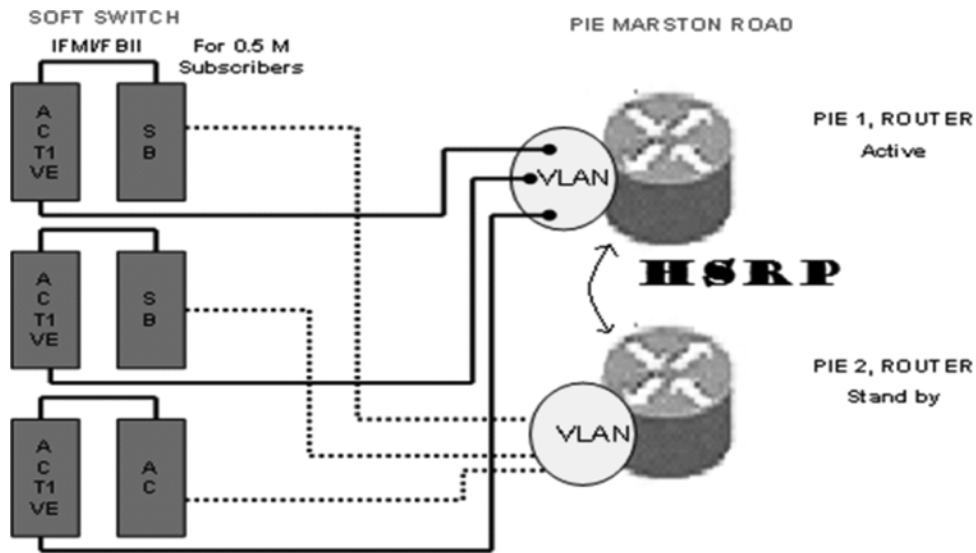


FIG. 6. THE CONNECTIVITY DIAGRAM OF SOFT SWITCH WITH CORE ROUTERS

that PIE Router-1 has failed; so load is shifted to PIE Router-2. At that time SS gets both routers active and traffic of all MSANs and MSAGs get disturbed. Marston Rd SS of Vendor-B is connected with both STPs via PIE cloud through single GE port. On failure of GE port or any issue at PIE, whole system of Marston Rd SS will be without signaling and there would be no dialing except inter office calls.

4.4.2.1 Proposed Suggestions

Following are given the proposed suggestions according to the analysis done on the basis of above given discussion:

- (i) Both PIE Router-1 and PIE Router-2 should be connected via redundant and reliable GE interface to avoid heart beat loss between two routers.
- (ii) Marston Rd SS of Vendor-B should be connected with both STPs (STP-A and STP-B) separately to achieve redundancy and to avoid complete dialing failure.

5. CONCLUSIONS

In this paper, we have compared and analyzed two soft switches provided by Vendor-A and Vendor-B. Both soft switches provides almost same basic and supplementary PSTN service, value added service and multi-media services. Overall performance of both soft switches is according to the PTA standards. Pak Capital SS is in not geographically redundant whereas Marston Rd SS is geographically redundant.

Moreover, both Pak Capital and Marston Rd soft switches are very strong switches. Network of Pak Capital and Marston Rd SS is not managed properly due to which overall isolation of switches occurs. Once network problem are overcome, both switches will work perfectly without any interruption. Pak capital SS also needs to be redundant hardware wise to reduce system failures due to hardware failures.

Further to this, we aim to analyze the dual homing technology offered by soft switches in detail as performance characteristics may be obtained.

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