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Reliability Assessment Of Cisco Nexus 9500 Modular Switch N9K-XP636PQ In Data Centre Switching System

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***Abstract:** A relative reliability study assessment performed on seven emerging data centre switching system (DCSS) with Switching Cloud Scale Technology in Nigeria is presented in this paper. The Reliability of Cisco Nexus 9000 Series Chassis Switches used in Tier III and Tier IV Green Data Centre in Lagos, Nigeria is the comparison of the Mean Time before Failure (MTBF) and Mean Time to Repair (MTTR) with respect to the base failure rate. We illustrate and focus our analysis on the theoretical convergence properties of MTTR, MTBF and Base failure rate result with the probabilistic (average case) studies through analytical approaches (stochastic processes). The Result reveals a higher key performance Indicators for the reliability of the system used in Rack Centre as compared to the other operating data centres in Lagos Nigeria where this assessment was performed. The time the Cisco Nexus 9500 Modular Switch N9K-XP636PQ Line cards in the data centre switching system is expected to operate before failure (MTBF) in Rack Centre Lagos is 3 years as against 8 years in other operating data centres in Lagos Nigeria. The base failure rate ratio 30: 80 shows that the system fails eight times earlier in these emerging data centres as compared to three times later in Rack Centre environment.*

***Keywords:** Base Failure Rate, ICT, Data Center, MTTF, MTBF, MTTR*

I. INTRODUCTION

The Nexus 9000 series chassis is a data centre switching infrastructure that designed to handle most critical applications in telecommunication, Information and Communication Technology (ICT) hosted services in the data center environment. Data centre is a large repository of servers essentially for large scale computation, storage facility and Information and communication technology based applications which provide divers services such as social networking, e-mails, cloud computing, storage, security firewalls and load balancers.

The performance of the Data Center Switching system in this reliability assessment study environment- Lagos Nigeria is the focus of this work. Lagos is a city in Lagos state of Nigeria, located within the south west zone of Nigeria. The latitude of Lagos 06°25'N, 03°27'E falls within the tropical zone but the climatic conditions are not entirely tropical in nature. Lagos has a population of over 25 million with high subscribers and traffic capacity ().

In Nigeria, the data market is developing very quickly in proportion to the economy growth at 6% a year. The data centre market is growing at twice that rate.

There are seven emerging data centres in Nigeria and West Sub-Saharan Africa namely; MTN Data Centre, Broad based, Rack centre, Global com, Venema data centre, MainOne and Computer Warehouse Group. Data centre will continue to be at the heart of businesses online experience grows. The major driver of this transformation is the proliferation of mobile devices and smart phones. This pose as a tremendous opportunity for data centre business.

According to (Cisco White paper 2015), the reliability of data centre switching system is measured by the performance in a typical three-tier architecture commonly deployed in many data center environments. The distinct core, aggregation and access layers provide the foundation for any data center operation. Factors such as the reliability of line cards, transceivers and chassis End of Life (EoL), time of usage, energy usage effectiveness, layer 2 mobility, bandwidth, latency and symmetrical paths through load balancers and firewalls are important when planning for data centers. This will ensure the reliability and successful business services in data center infrastructure.

Summarizing the main contributions as follows:

- ✓ We compare the modular switch failure rate, MTTR, modular switch reliability, switch availability, modular Switch down time in hours and outages due to fault in Line cards and expansion modules of 36-ports 40-Gbps with enhanced Quad Small Form Factor Pluggable (QSFP+).
- ✓ The performance test of this data center switching system (DCCS) is with proper layered approach in the data center design that seeks to improve scalability, performance, flexibility, resiliency and maintenance
- ✓ We present the reliability assessment with extensive total reliability Indices of Tier III and IV Data centre Nexus 9500 modular switch for the year 2014 – 2017.

In this paper, section 1 is an overview assessment of the current data centre landscape in Nigeria, the challenges, opportunities. Section 2 focuses on the architecture Cisco Nexus 9500 modular switch N9K-XP636PQ. We carefully review the system description of a typical modeled layer three-tier architecture commonly deployed in many data center environments. We survey the related research in this study of data center switching system. Section 3 presents a research method for the data centers in this paper. In section 4, we collate the DCSS field data across the data centres and summarize the Tier III AND IV Data centre Nexus 9500 Modular Switch Reliability, availability, failure rate, MTTR, outages due to fault and total reliability indices between 2014 to 2017, Section 5 studies the reliability assessment result through analytical approaches (stochastic processes). The focus of the analysis is the theoretical convergence properties of the reliability in emerging data centres. Evaluation of data is analyzed utilizing tools which include probabilistic (average case). In Section 6.0, we present the result of the measured Mean Time before Failure (MTBF) and Mean Time to Repair (MTTR) with respect to the base failure rate. The conclusion and future research direction work is in Section 7.0.

II. DATA CENTRE SYSTEM DESCRIPTION

A. BACKGROUND

In this section, we describe the Data Centre switching system (DCSS) at the core of the data centre and its components. A typical device model for energy usage and reliability assessment study in this paper for Nexus 9500 modular switch N9K-XP636PQ is shown in figure 2.0 below.

This consists of next-generation capabilities in Nexus 9000 series with application centric infrastructure (ACI) capabilities. The application centric infrastructure (ACI) Cisco Nexus 9500 Series includes 10/40-Gbps connectivity, Layer 2 mobility and high performance and programmability functionalities

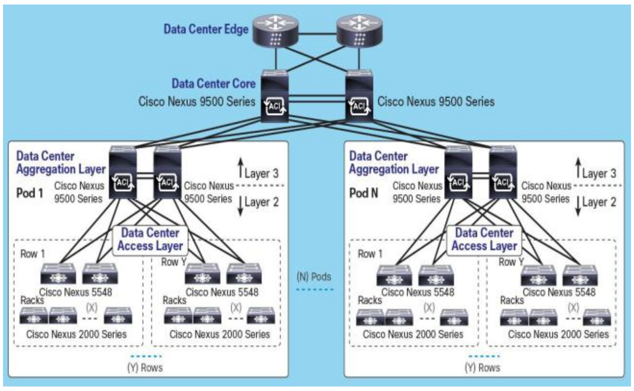

Figure 1.0: Cisco Nexus 9500 modular switch N9K-XP636PQ in the architectural layers in DATA Center Design

The switching feature is made up of a comprehensive Cisco® NX-OS Software, line cards and expansion module of 36-ports 40-Gbps with enhanced Quad Small Form Factor Pluggable (QSFP+).

It is also referred to as a data center switching system (DCSS) that provides connectivity at Open Systems Interconnection (OSI) Layers 1 through to 3 between the end devices using Virtual Lan (VLANs), switched virtual interfaces (SVIs), Virtual Routing and Forwarding (VRF), Access Control Lists (ACLs) during routing. It is deployed in end of row (EoR), middle of row, (MoR), aggregation layer and core layer. The data center switching system (DCSS) is based on support of current configuration syntax default settings OS such as FEX, Spanning Tree Protocol, vPC, layer 3 Access and VXLAN (Cisco Nexus 9500).

In this reliability studies, we consider backbone routers and edge routers and gigabit passive optical network (GPON) and capture time of usage efficiency by uptime per Gbps, or U/Gbps (i.e amount of numbers or uptime for forwarding gigabit data)

For the backbone, we consider one Cisco Nexus 9000 Series with a focus on Cisco Nexus 9516 Switch with 16 slots in a single shelf. 16 line cards, each supports 100 Gigabit Ethernet connectivity and at its peak power consumption of 504W. The Mean Time before failure by default is 558,730 Hours.

According to Cisco White paper 2015), Cisco Nexus 9516 Switch has 2 supervisor modules, 2 chassis controllers, 3 fan trays, 6 fabric modules, and 10 power supplies. Cisco Nexus 9516 Switch supports comprehensive Layer 2 and 3 functions on non blocking 1, 10, 25, 40, 50, and 100 Gigabit Ethernet ports and interfaces which makes it an ideal choice for the reliability assessment studies.

In this paper, all switches use the same supervisor, system controller and power supplies. The Cisco Nexus 9500 Series consists of Layer 2 and 3 non blocking Ethernet switches with backplane bandwidth of up to 172.8 terabits per second (Tbps) through a comprehensive selection of modular line cards (Cisco White paper 2015) and (Cisco Nexus 9500).

B. RELATED WORK

We begin this section with an overview assessment of existing Data Centre Network architectures into switch-centric and server-centric topologies in (Kashif Bilal et.al, 2012). The data centres classifications are topology based or hierarchical based from design and planning perspectives. Recently, cloud computing for data centre storage and energy-efficient date centre has been a popular research topic within the academic research community. To reduce green house gas (GHG) effect, researchers have been working on scalable and efficient data centres to deliver a cloud scale technology in data centres. In (A. berl, E. gelenbe, M. di Girolamo, G. Giuliani, H. de Mmeer, M. Quan Dang, k. Pentikousis, 2010), A. Bearl et al discussed the potential impact of energy saving strategies for the management of integrated systems energy from the perspective of cloud computing and proposed virtualization and cloud computing as major driver to close the gap between trade-offs such as performance, QoS and energy efficiency. Their conclusion is that specific plug-ins or charging sites and energy-control centres for networked hardware like transceivers, line cards and software can assist in monitoring and reducing GHG. Our work is a close match to the propositions in (A. berl, E. gelenbe, M. di Girolamo, G. Giuliani, H. de Mmeer, M. Quan Dang, k. Pentikousis, 2010) and (X. zhang, T. Lindberg, Krister Svensson, Valerity Vyatkin, Arach Mousavi, 2015) where the argument is based on the concept of identified level of energy consumption and assessment of an IT equipment in a data centre room.

Consequently, (Waqar Ahmeda, , Osman Hasana, Usman Perveza, Junaid Qadirb, (2016) discussed the modeling of a reliable communication networks by studying the advantages and disadvantages of modeling techniques (such as reliability block diagrams, fault trees, Markov chains, etc.) and analysis techniques (such as mathematical analytical methods, simulation methods, and formal methods).We draw insight from their work.

As explained in (X. zhang, T. Lindberg, Krister Svensson, Valerity Vyatkin, Arach Mousavi, 2015), an improved data centre energy consumption models could be designed to assess the reliability of data centre infrastructure from facility to IT equipment and component in the architecture. The authors aim is to utilize the data from the simulated models for numerous data centre design and operational use cases which is not our sole aim in this paper, however, we can improve the energy efficiency of Cisco Nexus modular switch by studying and statistically analyzing the data collected from simulating the power consumption of the complete data centre facility including the racks, CRAH, cooling systems, cooling tower, UPS, IT servers and chillers.

The realities of the next generation network infrastructure is a study in (Will Venters, Edgar A Whitley, 2012) similar to (A. berl, E. gelenbe, M. di Girolamo, G. Giuliani, H. de Mmeer, M. Quan Dang, k. Pentikousis, 2010) but a framework proposed in (Will Venters, Edgar A Whitley, 2012) can only be utilized by IT cloud users because it structured around a series of cloud scale technology with technological and service dimension. The simplicity of the cloud computing review in (Will Venters, Edgar A Whitley, 2012) enumerates the emerging cloud value networks for innovation. The separations of the desires and realities categorized desire for variety, scalability, variety and abstraction as technological while the desire for simplicity, efficiency and creativity as service dimension. In (Kaishun WU, Jiang XIAO, Lionel M.NI, 2012), the authors show us that the advances in architecture design of data center networks can be affect the reliability assessment of data centre switching Cloud Scale Technology especially with the global campaign for Internet of Things. They discussed the fact that optimizing the interconnection of data centres should be done with the rate of data applications growth and the supply of higher bandwidth for the network.

In (Kaishun WU, Jiang XIAO, Lionel M.NI, 2012) and (Ting Wang, Bo Qin, Zhiyang Su, Yu Xia, Mounir Hamdi, Sebti Foufou, Ridha Hamila, 2015), bandwidth is not only supplied but towards an energy-efficient architecture that can positively affect the time of usage (ToU) of the data center facilities and IT equipment such as transceivers and line cards. In order to reduce the Green House Gas (GHG) effect and improve climate change, authors in (James P.G. Sterbenz and Prasad Kulkarni, 2013) and (Han QIyz1, Muhammad SHIRAZ1, Jie-Yao LIU1, Abdullah GANIy1, Zulkanain ABDUL RAHMAN2, 2014) proposed the idea of energy efficient data center mechanism by designing an energy-aware bandwidth allocation and routing algorithm to reduce the power usage and achieve power conservation in the data centres.

The proposal in (Debessay Fesehaye Kassa, Klara Nahrstedt, 2014) is similar to our contribution in this paper. In large-scale clusters, (Ting Wang, Bo Qin, Zhiyang Su, Yu Xia, Mounir Hamdi, Sebti Foufou, Ridha Hamila 2015) identified bandwidth as a scalable bottleneck and proposed data center communication architecture that leverages commodity Ethernet switches to deliver scalable bandwidth for large-scale clusters to lower cost. Their contribution on harnessing the potential of commodity switches to replace high-end switches in data centers -to achieve low downtime in time of usage effectiveness. Scalable energy-aware services can be achieved in data centers.

The work presented in (Yong Zhan, Du Xu, Yiqi Ou, 2014) investigate how designing a decentralized resource allocation method and a dynamic pricing policy can enhance network state and tenant demands. This is possible by taking advantage of the emerging scalable service chaining in data centers with the use of software-defined networks (SDN) based source routing architecture. (Debessay Fesehaye Kassa, Klara Nahrstedt, 2014).

In this section, our focus is a data centre switching infrastructure and ways to reduce down times.

III. RESEARCH METHOD

Our research method is divided in two parts, namely a qualitative and quantitative assessment. In the qualitative assessment, we analyze the reliability assessment by comparing the Mean Time before Failure (MTBF) and Mean Time to Repair (MTTR) of the Reliability assessment of Cisco Nexus 9500 Switch N9K-XP636PQ in rack centre operating environment with other emerging data centres with respect to the base failure rate. In the quantitative assessment, we study the accuracy of the measured data i.e. the Key performance Indicators such as MTTF, MTTR, and Base Failure rate, Availability, Time of operation and base failure rate.

For the purpose of the reliability assessment studies, we consider seven emerging data centers in Nigeria West Sub-

Saharan African region. The MTN Datacenter, Broad based, Rack Centre, Globacom Internet Data Centre, Venema Data Center, MainOne and Computer Warehouse Group (CWG) data centre.

According to the up time institute rating (& 2016), The uptime rating of the various level of Tiers has different availability percentage ratings as shown in Tab 1 below:

Data Centre Tier	Availability	Downtime per year
Tier 1	A guarantee of 99.671%	28.8 hours of downtime
Tier 2	A guarantee of 99.749%	22 hours of downtime
Tier 3	A guarantee of 99.982%	1.6 hours of downtime
Tier 4	A guarantee of 99.995%	26.28 minutes of downtime

Table 1.0: Availability percentage uptime rating of the various level of Data Centre Tiers

In this paper, we study the Reliability assessment and result through analytical approaches (stochastic processes). Our focus of the analysis is the theoretical convergence properties of Reliability assessment by utilizing the tools used in this analysis which include probabilistic (average case) studies.

Our project make use of stochastic and probability comparison using weibull & log-on distribution for modeling because it integrates theoretical properties of reliability with the probability case studies of the seven emerging data centres in Nigeria and technology multi platforms.

IV. DATA COLLECTION

In this section, we collate data from the seven emerging data centers. Table 2 – Table 12 and present the graphical analysis of the analyzed data in figure 1-5.

Network Subsystem NSS	Years			
	2014	2015	2016	2017
MTN Business	7.89	6.71	21.67	9.30
Broad based – Marina	9.58	7.13	9.79	6.18
Rack Centre	6.15	5.51	25.23	18.56
Globacom	4.97	4.22	7.11	13.53
Venema	6.30	5.39	8.49	11.43
MainOne	5.42	6.41	7.51	12.45
Computer Warehouse Group	8.20	6.98	7.00	14.86

Table 2.0: Summary of the Tier III AND IV Data centre Nexus 9500 Modular Switch MTTR (Hours) (2014 -2017)

Network Subsystem	**Years**				
		2014	**2015**	**2016**	**2017**
MTN	Number of Outages	6	15	10	15
	DownTime (Hours)	10.58	41.01	19.35	60.43
Broadbased	Number of Outages	50	67	31	37
	Down Time (Hours)	374.57	450.18	393.22	344.23
Rack Centre	Number of Outages	9	11	12	12
Globacom	Down Time (Hour)	86.19	161.34	117.42	74.18
Venema data center	Number of Outages	76	62	17	21
	Down Time (Hours)	467.64	342.08	429.3	390.01
MainOne	Number of Outages	95	63	71	33
	Down Time (Hours)	472.33	274.37	505.17	446.01
Computer Warehouse Group	Number of Outages	6	15	10	15
	Down Time (Hours)	10.58	41.01	19.35	60.43

Table 3.0: Summary of the Tier III and IV Data centre Nexus 9500 Modular Switch Failure rate (2014 -2017)

Network Subsystem NSS	Years			
	2014 ()	2015()	2016 ()	2017
MTN Business	50	9	76	95
Broad based – Marina	67	11	62	63
Rack Centre	31	12	17	71
Globacom	0.03134	6.177	31.908	80.64
Venema data center	0.02667	5.651	37.495	84.93
MainOne	0.01791	11.031	55.835	80.24
Computer Warehouse Group (CWG)	0.01	0.89	6.86	40.97

Table 4.0: Tier III AND IV Data centre Nexus 9500 Modular Switch outages due to fault (2014 -2017)

Network Subsystem NSS	Years			
	2014	2015	2016	2017
MTN Business	70	63	61	76
Broad based – Marina	345.57	476.18	393.67	344.23
Rack Centre	9	11	12	12
Globacom	86.19	161.34	117.42	74.18
Venema data center	45	56	17	89
MainOne	467.64	342.08	429.3	390.01
Computer Warehouse Group (CWG)	67	63	56	33

R = Reliability, NSS=Network Subsysten

Table 5.0: Summary of the Tier III AND IV Data centre Nexus 9500 Modular Switch Reliability (2014 -2017)

Network Subsystem NSS	Years			
	2014	2015	2016	2017
MTN Business	76	62	17	21

Broad based – Marina	467.64	342.08	429.3	390.01
Rack Centre	95	63	71	33
Globacom	472.33	274.37	505.17	446.01
Venema data center	6	15	10	15
MainOne	10.58	41.01	19.35	60.43
Computer Warehouse Group (CWG	11.76	32.09	20.87	54.98

Table 6.0: Total Reliability Indices Tier III AND IV Data centre Nexus 9500 Modular Switch for 2014 – 2017

Network Subsystem	Years			
	2014	2015	2016	2017
MTN Business	394.57	86.19	467.64	472.33
Broad based – Marina	450.18	80.48	342.08	274.34
Rack Centre	393.22	117.42	429.30	505.17
Globacom	344.23	74.18	380.10	446.61
Venema data center	200.11	28.01	184.76	172.85
MainOne	300.42	85.41	271.00	428.62
Computer Warehouse Group (CWG)	388.00	145.75	435,40	500.20

Hrs= Down time in hours NSS= Network Subsystem

Table 7.0: Tier III AND IV Data centre Nexus 9500 Modular Switch down time in hours over (2014 -2017)

Year	Failure Rate	MTTR	MTBF	Availability	Reliability
	(hr)	(hr)	(hr)	(%)	(%)
2014	86.64%	82.41%	91.49%	97.65%	88.77(%)
2015	97.54%	97.00%	96.72%	89.99%	87.93(%)
2016	80.26%	83.80%	95.22%	96.74%	92.76(%)
2017	75.95%	83.21%	81.35%	94.16%	89.43(%)

Table 8.0: 36-ports 40-Gbps enhanced Quad Small Form Factor Pluggable (QSFP) down time in hours (2014 -2017)

Network Subsystem NSS	Years			
	2014	2015	2016	2017
MTN Business	00.05977	0.008063	0.004397	0.003037
Broad based – Marina	0.001038	0.0012667	0.001389	0.001382
Rack Centre	0.00165	0.007365	0.002041	0.002678
Globacom	0.001045	0.00356	0.004587	0.008495
Venema	0.000542	0.00467	0.003489	0.004348
Main one	0.001245	0.00387	0.003290	0.003484
Computer Warehouse Group	0.000981	0.007498	0.002984	0.002449

Table 9: Summary of the Tier III AND IV Data centre Nexus 9500 Modular Switch Availability (2014 -2017)

Year	Failure Rate	MTTR	MTBF	Availability	Reliability
	(hr)	(hr)	(hr)	(%)	(%)
2014	7.89	6.71	12.67	9.30	7.70
2015	9.58	7.31	9.79	6.18	4.67
2016	6.15	5.51	25.23	18.56	11.55
2017	4.97	4.22.	7.11	13.53	7.52

Table 10: Four Years 36-ports 40-Gbps enhanced Quad Small Form Factor Pluggable (QSFP) outage due to fault

Year	Failure Rate	MTTR	MTBF	Availability	Reliability
	(hr)	(hr)	(hr)	(%)	(%)
2014	0.001260	2.47	793.65	99.69	97.02
2015	0.004059	2.47	793.65	99.69	97.02
2016	0.004059	3.94	246.37	98.40	90.72
2017	0.004159	2.91	240.44	98.79	90.50

Table 11: Summary of 36-ports 40-Gbps enhanced Quad Small Form Factor Pluggable (QSFP) reliability indices for the year 2014 -2017

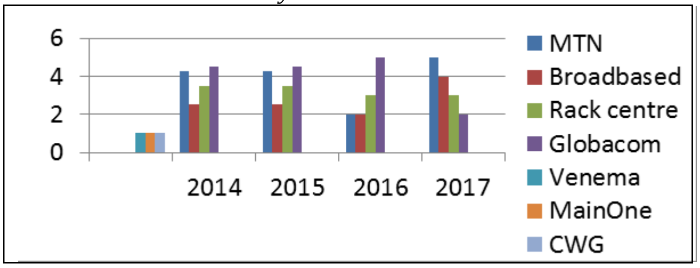

Figure 1.0: Summary of the Tier III and IV Data centre Nexus 9500 Modular Switch Reliability Indices over 2014 -2017

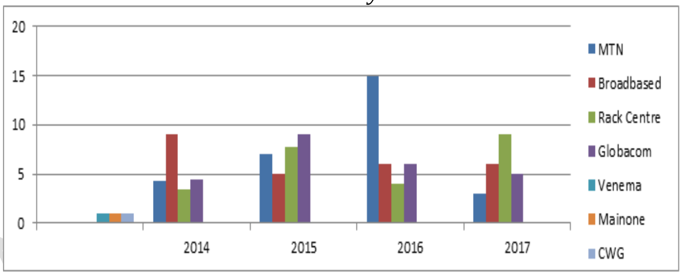

Figure 2: Summary of the Tier III AND IV Data centre Nexus 9500 Modular Switch MTBF (Hours) over 2014 -2017

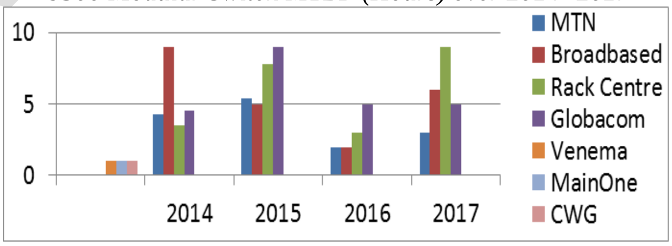

Figure 3.0: Summary Of The Tier Iii And Iv Data Centre Nexus 9500 Modular Switch Mttr (Hours) Over 2014 -2017

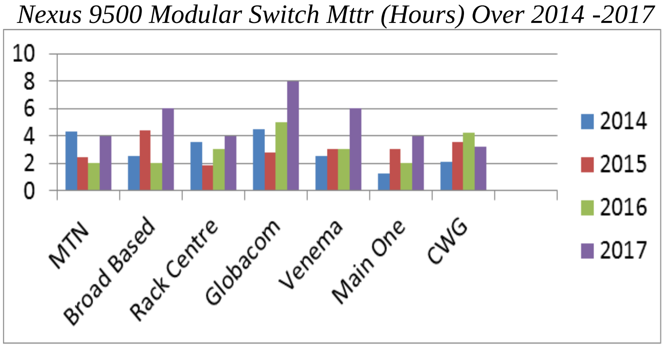

Figure 4.0: Summary of the Tier III AND IV Data centre Nexus 9500 Modular Switch Failure rate over 2014 -2017

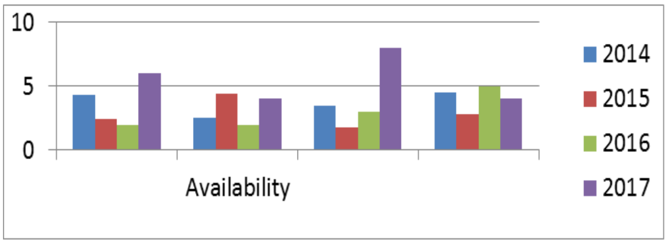

Figure 5.0: Summary of the Tier III AND IV Data centre Nexus 9500 Modular Switch Availability over 2014 -2017

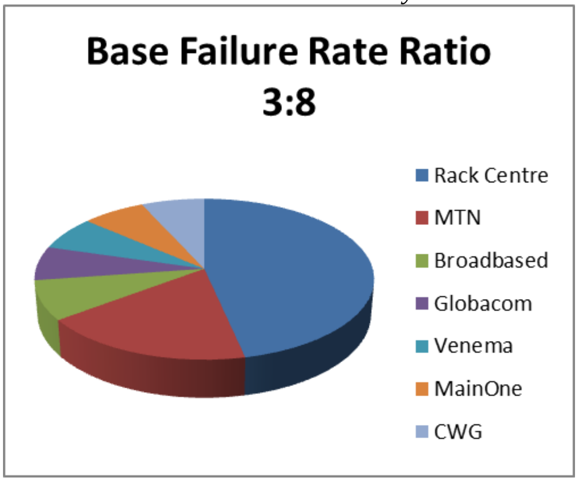

Figure 6.0: Base Failure Ratio (3:8) of Rack Centre to other Emerging Data Centre

A. EVALUATION AND ANALYSIS

In this section, we apply data centre switching system (DSCC) knowledge to analyze processes that takes a lot of reverse engineering and postulations on how the data center will actually function in the seven data centre operational environments.

In evaluating the performance of the seven emerging data centres for reliability assessment based on the key performance indicators such as Failure Rate, MTTR, MTBF, Availability and Reliability in this section, for each model and type of Cisco Nexus 9500 series modular switch equipment have a distinct reliability curve that shows how the efficiency and availability changes with line card or transceiver -IT load and based on this curve, transceivers or redundancy is required in the data centre switching system (DCSS).

The base failure rate of Cisco Nexus 9500 Modular Switch N9K-XP636PQ in these emerging data centres can be successfully modeled and described by Weibull distribution.

The Weibull Density functions are as follows:

$f(t) = (\beta/\eta)(t/\eta)^{\beta-1} \exp[-(t/\eta)^{\beta}]$ (1)

$f(t)=(\beta/\eta) \{t\text{-}t0)/\eta\}^{\beta-1} \exp[-((t\text{-}t0)/\eta)^{\beta}]$ (2)

Weibull Reliability functions for a 9500 Modular line card of t hours assuming the system has not been used before:

$R(t) = \exp(-(t/\eta)^{\beta})$ (3)

$R(t) = \exp(-((t\text{-} t0)/\eta)^{\beta})$ (4)

Weibull Hazard functions: (MTTF)

$h(t) = (\beta/\eta)(t/\eta)^{\beta-1}$ (5)

$h(t) = (\beta/\eta)[t\text{-}t0]/\eta)^{\beta-1}$ (6)

This is similar to a stochastic process and modeling in this paper.

Let us denote by α_i^s, s = 0,1, i > 0, the probability that in the operating data centres modes s exactly i new line cards and transceiver are replaced during the time of service of the DCSS.

A^s_{i}, s = 0, 1, I > 0 the probability that in operating mode s not less than I new line cards and transceiver are replaced during the time of service of the DCSS; γi, I > 0 the probability that immediately the line cards are removed without redundancy, when the DCSS was empty, there will be exactly i line cards and transceivers in the DCSS.

$\alpha_i^s = \sum_{k=0}^{i} ßsk\alpha^k_i$, s = 0,1 i > 0, (1)

$A_i^s = \sum_{k=1}^{i} \alpha\, k^s$, s = 0,1 i > 0, (2)

$\gamma_I = \sum_{k=1}^{i+1} \omega k^{0-0}\, \alpha_{i-k+1}$, i > 0, (3)

$ß^s_k = \frac{\lambda s}{K!} ß^{(k)}(\lambda s)$, s = 0,1, k > 0, (4)

$\alpha_i^s = \sum_{k=0}^{i} ßsk\alpha^k_i$, s = 0,1 i > 0, (5)

$\gamma_I = \sum_{k=0}^{i} \omega k^{0-0}\, \alpha_{i-k}$, i > I, (6)

The following theorem contains formulas for calculating the stationary distribution {pj,s}

THEOREM: stationary probabilities of the stochastic process X(t) are given by

$P0,0 = \frac{v}{\lambda_0} q0,0$

$Pj,0 = v(\gamma j q o,o + \sum_{i=1}^{\min(j,H-2)} \alpha j\text{-}iqi,o)$, j = 1,….R -1,

$PR,0 = v(\sum_{i=R}^{\alpha)} \gamma i\, q o,o + \sum_{i=1}^{\min(j,H-2)} Aj\text{-}iqi,o)$, (7)

$Pj,1 = v \sum_{i=1}^{\min(j,R-2)} \alpha j\text{-}iqi,o$, j = 1,….R -1, (8)

$PR, 1 = v \sum_{i=L}^{,R-2)} Aj\text{-}iqi,1$, (9)

Pj,2 = vbqR- 1,-2, j = H+1,….,R -1

V. RESULTS AND DISCUSSION

In this assessment study we measured MTBF, MTTF, and MTTR in the modern data centre with software's. Software tracks MTBF, MTTF, and MTTR history by individual product. This improve the data center and service desk performance. Many packages offer reports that detail the individual failure rates and repair cycles of MTBF and MTTF products, including creating product baselines to measure improvement; predicting failures before they occur; and reducing MTTR times and increasing MTBF and MTTF times.

Meaningful MTBF calculations obviously require many more observable data points as shown in figure 9, 11 and 12. MTBF formulas generally use the same equations as for an MTBF product, but they only record one data point for each failed item. The MTBF predicts the average time between chassis failures. MTBF is commonly used to designate failure rates for both repairable and replaceable (non-repairable) chassis and line cards. The Mean time to repair (MTTR) graph in figure 3.0 represents the average time to repair or replace a failed data centre switching system (DCSS) or subsystem.

Mean Time To Repair (MTTR) = (Total System downtime)/ (Number of failure). The Weibull is a versatile distribution and is useful in analyzing DCSS field data due to

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the fact that the database was large enough so that an accurate analysis is possible.

VI. RECOMMENDATION

We recommend that reliability assessment should include the Mean Time to Failure (MTTF). Mean Time to Failure (MTTF) also predicts failure rates for a chassis. Unlike MTBF items, MTBFs cannot be used to designate failure rates for replaceable (non-repairable) products, such as UPS, batteries and processor board.

We highlight the importance of Redundancy. Redundancy is the provision of more than one means of setting a data centre switching system (DCSS) to perform a given function. These improve reliability of system by reducing stress on the component within the availability of systems and maintainability.

We also highlight the importance of effectiveness of energy of usage (EUE) studies to better manage line cards, transceiver & Chassis as they exhibit IT loads such as high line-card losses. Finally, we recommend more investigation is needed to analyze and improve the effectiveness of time of usage at both distribution and core layers.

The low base failure rate as a result of poor operating conditions, intermittent environmental climatic conditions and improper layered approach in the data center design can be carefully planned and designed to improve scalability, performance, flexibility, resiliency and maintenance. Bottom-Line, the outcome of this assessment will inform the engineers if core switching equipment outside the data center must be on the data centre switching (DCS) system.

VIII. CONCLUSION AND FUTURE WORK

In this paper, we have presented the first large scale assessment of network reliability of Cisco Nexus 9500 switch. We focused our assessment on characterizing reliability indices and key indicator performances of Cisco Nexus and analyzing the effectiveness of time of usage (ToU) in masking reliability. To undertake this assessment, we developed and compare stochastic and well-bull probability model that correlate numbers of transceiver, line cards & chassis modules with logs of partial IT load percentages to fill a large volume of non- imparting use due to spurious notification and errors in stimulations.

FUTURE WORK: This study impact the occurrence of transceiver & line cord failures in Data Centre environments. This is the only one aspect of effectiveness of time of usage of Cisco Nexus 9500 Modular Switch N9K-XP636PQ in data center networks. A relevant direction for future work is correlating logs from core-level monitors with the logs collected by network operators and content providers to determine what fraction of observed energy losses do not impart care network and what fraction of network errors are not observed (e.g because of a line cord or transceiver failure that we cannot observe) This will enable us to understand what fraction of core line card failures can be attributed to network energy losses. Another extension to our study would be to understand what these low level energy losses mean in terms of low carbon efficient technologies. In our future research papers, Open flow technologies such as SDN controlled backbone routers, analysis and the impact on end – to-end network operations with active or stand-by redundancy will be discussed.

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