

IETS CHALLENGES IN MIGRATION TO SOFTWARE DEFINED NETWORKS: A CASE STUDY OF IT INDUSTRY IN NEPAL

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Abstract

Software-Defined Networking (SDN) is a new principle in the networking paradigm, which decouples networking into data plane and control plane thus making the network programmable. It is a new concept and has slowly been getting attention by many companies around the world as it has many advantages over the traditional networking process. But the process of migrating from traditional networking to SDN architecture is a difficult process especially for companies in developing countries. The purpose of this paper is to find the present situation of SDN in IT companies in context of Nepal and also to find the major challenges of migrating to SDN. For this, a survey was conducted among various IT professionals who have some knowledge about SDN or have worked in SDN involving both manual and online survey. This research used quantitative analysis approach to answer the research questions of this dissertation. From the analysis of 253 responses obtained from the survey it was found that SDN is still in infancy stage in Nepal as most of the companies surveyed only used it for testing purpose or control only small part of the networking infrastructure. It was found that SDN is still not fully integrated into majority of the companies and most of the IT professionals have just started out in SDN with majority having only 1 to 5 years' experience in it. Similarly, regarding the limitations of SDN migration it was concluded that the major limitation of SDN is cost i.e. the cost of installing new devices supporting SDN. Other challenges included security, scalability issues, lack of knowledge and vendor support.

Keywords: SDN, Testing, networking.

1 Introduction

1.1 Background

In the last century, internet has grown from small research network connecting several US universities to worldwide information communication it is today. Internet has become an indispensable and important part of infrastructure as well as key to social production, public life and international communication. This is all because of rapid development of TCP/IP technology and high demand of information sharing.

Nowadays most of the peoples are using network for their everyday life that may be calling a friend, browsing the internet, shopping online, listening to a music in mobile or watching a video. Companies are also fully dependent in network to maintain their daily operation and their business. These types of services are provided by the help of cloud computing which is mostly managed by large data centers. These type of data centers manage huge amount of resources with lot of equipment's and complications that they had to deal with. Cloud service popularity has been in rapid increase since the concept of cloud computing and virtualization were introduced and popularized by large organizations. With these constantly increasing organizations using cloud services, in order to remain competitive and cost-effective, data centers need to be broad-minded and reevaluate the way companies manages ICT infra structure. Thus, network technology has become a crucial in the

success of cloud technology, but the slow innovation and improvement of scalable ICT infrastructure has caused competitive problems (S, et al., 2013).

Software defined networking distinguishes the network control plane from the hardware plane, making it more adaptable to the constantly changing nature of the computer network. SDN framework has three layers as shown in the figure given below.

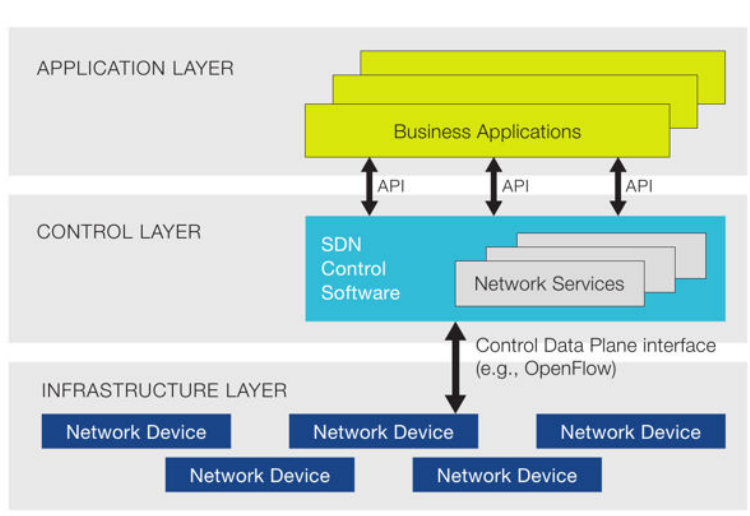


Figure 1: SDN Framework (Shokeen, 2019)

The functionality of the layers can be further explained below:

- Application layer:** Applications for SDN reside in the layer of application. The applications transmit their resource and service needs through APIs to the control layer. This layer has applications that can be used by mostly network operators or concerned professionals to display information related to networking and enable the network operators to take the appropriate actions to be carried out. This is like operating system to hardware for example windows operating system to control a desktop. Some of the other examples include system applications that collect, analyze and control data more automatically and provide alerts when necessary (Ram, 2014).
- Control Layer:** This layer includes the Network Control Software, bundled in the Network Operating System. This provides an abstract look on the architecture of the underlying network. It collects the SDN applications specifications and passes them on to the network components. Control layer collects all the information from the network layer of OSI layer and control all the network equipment. All the information collected by the control layer of SDN is collected and stored in a distributed database which can be accessed by the upper layer network applications and network services. This part of information collection and access is important or even the most crucial part of SDN architecture, as it allows the network related equipment like routers, firewalls, switches and more to be viewed and controlled at a network-wide level (Wee & Jose, 2014).
- Infrastructure layer:** Also called the Data Plane Layer, this layer contains the actual components of network. The network devices are located in this layer, displaying their network capabilities to the data-plan interface through the Control. The architecture of the network includes physical and virtual network equipment. This type of networking equipment like routers, firewalls, switches, access points and more are configured, controlled, operated and managed using standardized protocols such as SNMP and NetFlow, industry-specific protocols or applications or agents or services such as CDP (Cisco Discovery Protocol), or Zabbix agent and control line interfaces (CLIs) accessed by accessing each network system (Wee & Jose, 2014).

1.2 Problem statement

Software defined network is a revolutionary step towards managing and improving network management situation. In present context for any company to manage network, to provide effective communication and information sharing, the network operators have to personally interact with the networking devices and configure the device as per the requirements. It is a quick and simple process if there are limited number of devices for the operators to work on but it quickly becomes tiresome as the number of devices starts increasing. This makes the work very slow and it is prone to errors or bugs. Similarly, as network device are usually managed in different places to reduce risks, it is not feasible to travel to every site where the devices are setup especially if the devices are located in different countries.

Monitoring vast numbers of networking devices and servers is a difficult process as there are vast amount of information the need to be closely inspected which is difficult in traditional networking.

So, the major problems can be summarized by following points:

- Configuring and managing individual network resource is very slow and exhausting process especially in large network areas (Caraguay, et al., 2012).
- Decentralized networking are harder to monitor and manage and traveling to every location or hiring people to look after the location is expensive and tiresome process especially for small organizations (Xia, et al., 2014)

1.3 Research Questions

For the purpose of this research below questions were asked:

- What is the present situation of Software Defined network in IT industry of Nepal?
- What are the major challenges when migrating from traditional network to SDN?
- What are the main advantages of implementing SDN?

1.4 Objective of the study

The main research objectives of this paper are as follows:

- To analyze the present SDN situation in the organizations.
- To examine the major challenges of migration from traditional network to software defined networks.

1.5 Scope and limitation of the study

This research paper focuses in the challenges of migration to SDN and its present situation in IT industry of Nepal. This paper will only be focused in IT industry but not to other organizations like banking industries, manufacturing industries or more. Similarly, this research will only be done in the context of Nepal and no other countries will be taken into consideration.

1.6 Significance of the study

This research paper is significant to all the companies that are improving and getting more and more internationalized as well as for the companies that needs to think about their networking services in the future. As with the passage of time the number of online users has been exponentially and the data consumption is also rapidly growing. This rapid growth of data consumption cannot be managed forever using traditional networking. This requires the simplicity and power of SDN to control and manage all the networking functions from a single place so that companies can be secured for the future of internet. Thus, the companies have to start thinking of policies and plans to migrate to SDN.

This paper deals with the challenge's companies may face when migrating to SDN from their traditional networking architecture. With the help of this paper the major challenges can be highlighted and proper plans can be made to avoid or solve such challenges.

2 LITERATURE REVIEW

2.1 Related Works

Evolving and newly introduced mega-trends (e.g., mobile, social, cloud, and big data) in Information and Communication Technologies (ICT) is challenging and changing the future of Internet, for which omnipresent accessibility, higher bandwidth, and dynamic management are very important. Manual configuration of all the proprietary devices are complicated and, error-prone and is unable to fully grasp and utilize the physical network infrastructure capabilities in traditional networking architecture (Xia, et al., 2014). Recently, software defined networking or SDN is being taken as a serious and promising solution to resolve all of those problems needed for the future internet.

Another survey conducted on SDN is Advancing Software-Defined Networks: A Survey by Jacob h, Joaquin et al in 2017 (H, et al., 2017) states that the road to the implementation of SDN technology is challenging, so that it can be implemented in an ad hoc manner that organizations do not easily adopt. This paper examines the current state of SDN in the government, universities or academic and industrial sectors and identifies the challenges of implementing SDN. Some of the challenges includes cost, lack of employee skills, integration with exiting systems and security. This paper also described the working of SDN, its architecture like control plane, network plane and application plane and SDN standards.

3 RESEARCH METHODOLOGY

For any work being performed, research methodology is one of the most important parts. It determines the method of research and establishes the strategy, approach and the components of the methodology.

Research methodology is important tools to classify the problems that need to be addressed and to hit the defined artifacts in a research study (Mohamed Al Kilani, 2016). The purpose of research methodology is to provide a clear and concise information of what techniques or procedures to be used and to analyze research problems to resolve them.

3.1 Research Approach

For the purpose of this research, recognized and approved journals and databases for both information system and computer science research were used. Some of the used databases for this research purposes are IEEE, Springer, ProQuest, Research gate, Science direct, Research gate, Google scholar, LCBS. Only the journals that were of or newer than 2012 were chosen. These searching of journal papers were done by using specific keyword i.e. SDN, Software Defined Networking, SDN evolution, SDN impacts, SDN challenges, Architecture of SDN, History of SDN and SDN uses.

These searches lead to many journals that covered at least some concept of SDN but after analyzing it deeply only 20 research journals were chosen to be used as the reference material. Along with the journal papers, other information sources like Wikipedia, websites, blogs, videos, interview magazines, books, teachers and colleagues were taken to gather as much information as possible in the topic. This research is primarily based on primary data sources and a secondary emphasis in the secondary data sources

Primary Data Source

- Questionnaires
- Survey
- journals

Secondary Data Source

- Internet
- Documents

3.2 Survey design and content

The survey paper was created using google forms. The survey was carefully created with the sense that the questions were to be answered by IT professionals with limited free time thus the questions were short, precise and always targeted the research population.

The questionnaire included 18 close ended questions as they are considered as they accumulate the most correct answers in the least amount of time. The survey only had multiple choice questions keeping the questions short and simple accordance to the busy population the survey was targeting. The survey questions were divided into three sections:

- Section1: Collection of demographic data like age, gender and Job role.
- Section2: Collection of information on the situation of SDN in the Industry the participant is working for.
- Section3: Collection of questions regarding the participants thought on the benefits and limitations of SDN.

3.3 Data Collection

The aim of this research is to analyze and understand the present situation of SDN in IT industry of Nepal and also to examine the major challenges of migrating from traditional network to Software defined networking. To achieve this survey of different IT companies inside the Kathmandu valley was chosen. The survey was conducted among the various professionals working in those IT companies who had some or full understanding of SDN.

IT professionals were asked to fill an online survey paper containing a total of 18 questions. The questions in the survey were divided to find the demographic data and to interpret the result for this research. The survey was conducted for a total of 30 days from October 25 to November 25. Among the survey papers distributed there were 64 responses to manual survey and rest is online survey thus collecting 253 data from the survey.

The information collected from the survey was analyzed using quantitative analysis method to fulfill the objective of the study and answer the research questions.

Table 1: Data Collection Sample Size

Mode of distribution of Questionnaire	Distributed	Received
Online	256	189
Hardcopy	78	64
Total	334	253

4 DATA ANALYSIS

4.2 Results from Questionnaires

4.2.1 Are you familiar with SDN?

This question was raised in this survey to know about the familiarity of participants to the topic of research. This survey was only conducted among participants who has at least some idea about SDN ignoring those that don't have any idea about SDN. This was done as there would be no reason to continue the survey if the participants were not at least bit familiar with the topic of research.

From the survey it was found that 142 participants were familiar with the SDN concept which is 56.1% of the total participants. Among the respondents only 17 participants were confident with their knowledge in SDN to choose very familiar which amounts to 6.7% which reflects that most of the participants are not absolutely sure of their knowledge in SDN which is justified as the topic of SDN is very new and innovative concept. Similarly, 98 participants chose have heard of it option which means that they know of the topic but are not able to perfectly explain the full concept of SDN like how it works.

Table 5: Familiarity frequency table

Is_familiar		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Familiar	142	56.1	56.1	56.1
	Have heard of it	94	37.2	37.2	93.3
	Very Familiar	17	6.7	6.7	100.0
	Total	253	100.0	100.0	

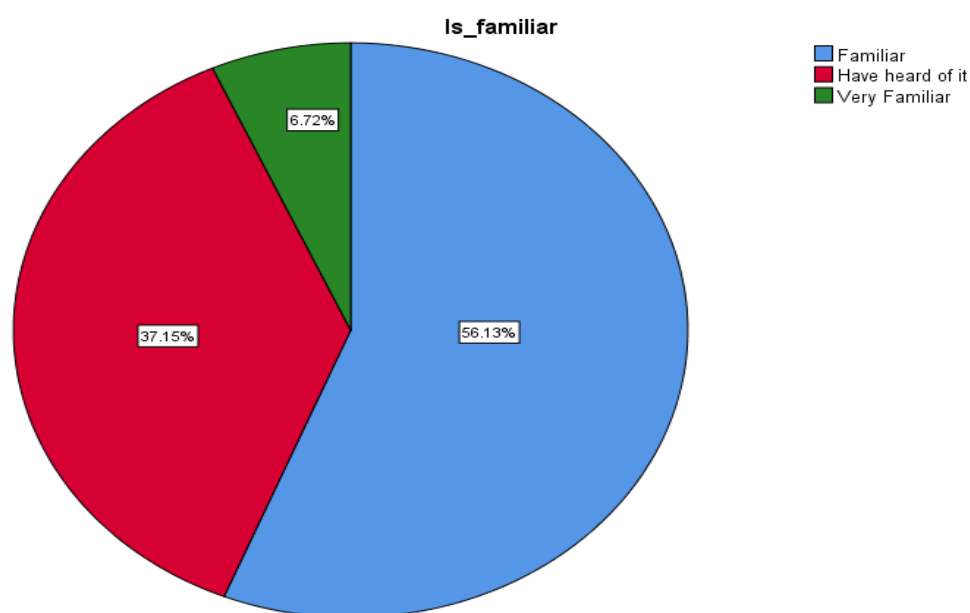


Figure 5: Familiarity Chart

4.2.2 How long have you been using SDN?

This question was raised to know how long have the participants been using SDN in their professional life. The answer was divided into 3 choices to determine the familiarity of respondent to SDN. From the choices provided it is revealed that most of the participants are new to SDN as 135 of total responders i.e. 53.4% have been using SDN for less than 1 year. 98 participants responded with 2 to 5 years whereas 20 participants responded with 5 to 10 years.

This shows how new the concept of SDN is to Nepal’s IT industry as most of the employees have just ventured into the world of SDN and how limited the personals are with higher familiarity to SDN.

Table 6: SDN usage time

how_long		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2 to 5 years	98	38.7	38.7	38.7
	5 to 10 years	20	7.9	7.9	46.6
	Less than 1 year	135	53.4	53.4	100.0
	Total	253	100.0	100.0	

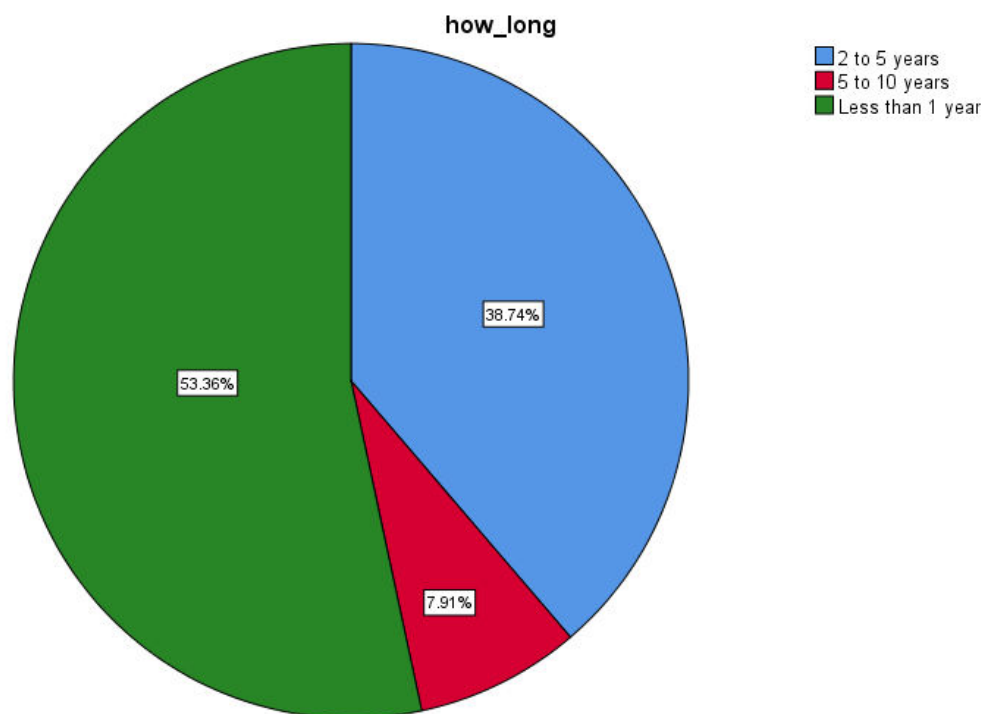


Figure 6: SDN usage time chart

5 FINDINGS AND CONCLUSION

5.1 Findings

After the analysis of all the data gathered from the survey, the research questions now can finally be answered. The research questions for this research was to find the present situation of SDN, major challenges and advantages of SDN in IT industry of Nepal. To answer all of these questions the survey included several questions to analyse and find the answer to them.

Research Question 1

What is the present situation of SDN in IT industry in Nepal?

For the first question that is to find the present situation of SDN in Nepal, questions like how long you have been using SDN, what is the controller software you have been using, is SDN fully integrated into your organization and who is responsible for maintaining SDN in your organization were asked. After analysis of the information obtained from the above questions it was found that SDN is still new and taking its first step into Nepali IT industry. It is evident from various statistics obtained from the data analysis like 53.4% of the IT professionals have only been using SDN for less than 1 years and 38.7% using only for 2 to 5 years. This suggests that SDN is new to the market and to the companies surveyed. Similarly, most of the responses suggests that SDN is not fully integrated into the company's architecture as 45.5% said that SDN was used only as a testing purpose or rarely used and 33.2% responses suggesting that SDN is only used sometimes. Only 21.3% responses were towards full integration of SDN to the company's network architecture which is very low compared to negative response from other respondents. This concludes that SDN is a very new concept to the Nepal's environment and most of the companies have yet to fully adopt SDN as an important part into the industry. From other two questions it was found that SDN maintenance and operation was mostly handled by vendors as 51.8% respondents supported by this fact but it not totally dominated by it as 47.8% responses suggested that companies also employ their own staffs to maintain and operate SDN. This proves that experienced and skilled professionals that can manage SDN is not centralized to a single company or vendor. This is beneficial for SDN as there are many skilled professionals decentralized in the market. Another fact evident from the questionnaire is that the most popular SDN controller software in Nepal is Nox/Pox with 34.4% responses. Other controller software like Onos, Open vSwitch, OpenDaylight are also widely used with no clear dominating controller software. Similarly, the questions asked about the usefulness of SDN suggested that only few peoples are confident about its usefulness as only 11.1% response was 'very useful'. Another question regarding difficulty of using SDN implied that using SDN is a difficult and requiring knowledge and skill to operate it. This was supported by 86.6% responses in the survey.

This suggests that there is no standardization established in the SDN controller software in Nepal. From all these questions it is clear that the present situation of SDN in IT industry of Nepal is a mess and not stable with not standardization in controller software evident, few companies fully adopting SDN as the main networking architecture and lack of highly skilled workers present. The difficulty of operating SDN as per the survey and lack of support regarding its usefulness also suggests that SDN has not yet been able to leave a good impression into the Nepali market.

Research Question 2

What are the major challenges when migrating from traditional network to SDN?

The second question was to find the major challenges while migrating from traditional networking to Software defined networking. To answer this question, the survey included questions like is what is major limitation of SDN, is migration difficult and what is stopping other companies from migrating to SDN were raised. From the question about the major limitation SDN it is clear that Costing is the main limitation of SDN as evident by 36.0% responses towards it. Migration to SDN means that the legacy networking devices has to be changed that supports SDN platform and similarly it also needs

investment to experienced skilled workers of SDN are required. This needs major funding to support and may not be feasible for every organization (O'Reilly, 2014). Next major challenges of SDN is scalability. The decoupled structure of SDN needs a lot of communication messages between data plane and control plane for exchanging messages. Single controller based SDN architecture will not be able to handle the influx of messages if the networking architecture is scales up. This is a major challenge for many organizations as they may have to add up more networking applications in the near future. So, scalability is also a major challenge to SDN as evident by 22.1% responses. Security is also a major concern in SDN architecture. Since, SDN is a relatively new and upcoming concept all the security aspects have not been fully conceptualized. The data may be vulnerable in SDN due to interception, protocol failures and similarly the controller software itself may be prone to cyber-attacks thus causing untold damages to the company (Akhunzada, et al., 2015). Performance of SDN is another challenge in SDN as the performance of controller software with the increase in networking applications and information may degrade. Thus 19.8% peoples also find this as other challenges to SDN migration.

The question in the survey about the factor stopping other companies from migrating to SDN is similar to previous question but it is different in the fact that this question is asked to know the stopping factor in Nepal only without consideration to international trend. From this question it was evident that costing is the main stopping cause as 34.4 percent responded with the high cost of changing hardware resources to support SDN being the main cause for low adoption. Every human being has a primitive instinct to resist change. This reason is also the factor stopping SDN implementation which is also evident by 25.7% responses in the survey. Another factor is single point of failure. SDN is like operation system to networking service thus the controller software is the sole application to control and operate all the features of SDN. If in any time the controller software fails or crashes the whole networking service will stop (Caraguay, et al., 2012). This is devastating to any organization thus 20.6% of the respondents recognized it as a major stopping factor for SDN migration. 19% of the response was lack of knowledge as the major stopping factor. This is true as many of the peoples in the world especially in technologically backward country like Nepal. Many people don't know about SDN or what are the benefits of using SDN while other peoples don't know about how to start with SDN or operate it. Another single response was lack of vendors providing SDN support which is especially true for Nepal. There is lack of vendor companies that provide SDN services like SDN migration. This is also stopping other companies from migrating to SDN.

Research question 3

What are the main advantages of implementing SDN?

Like the saying goes every rose has its thrones, everything has its advantages and disadvantages. SDN is no exception to this fact. The disadvantages were discussed in the previous paragraphs. The third question of this research is to find the advantages of SDN. SDN has many advantages some of them include centralized networking, low operating costs, robust network security, scalability and more. From the survey it was found that the major advantage of SDN is more control over network resources as supported by 26.1% responses. In SDN the controller software monitors and manages all the networking devices. From this software, we can manage the overall performance of the networking device like if it is performing in optimal capacity or if it is underperforming and corrective actions can be taken to make optimal use of hardware. The second most popular advantage of SDN as obtained from the survey is centralized networking as seen from 23.7% responses. The decoupling of data and control plane means that all the networking activities like monitoring, switching and routing, policy enforcement and more are managed and controlled by a single controller software. This is helpful as there is no need to open a dedicated software to control a single networking device like application to open firewall device or application to open router and switches. Along with this we don't need to travel to every single device to make some changes to it. Another advantage of

SDN is the lower operating costs. This may contradict the point of being costing as the major challenge but here this point speaks about the lowered operating costs rather than initial cost require to setup SDN. With the help of the available network devices can be utilized more effectively and also the number of staffs needed to maintain traditional network can be lowered in the SDN architecture. This accumulates to lowered day to day expenses for the company. Thus 20.2% also recognize this as advantage of SDN. Similarly, robust network security is also a advantage of SDN. This point can be a disadvantage if the users doesn't possess sufficient knowledge and skill to operate SDN. But if installed and operated carefully it will greatly improve network security. This is because SDN enables easy collection and analysis of network traffic it makes mitigating security threats easier and it can also lower human intervention required by automatically detecting security threats and responding to it as specified by specific algorithms that have been programmed to fight against network attacks or ransomware or virus attacks. Thus 19.0% have responded to security being major boon of SDN. Similar to security, scalability has also been chosen as advantage of SDN by 10.3% in spite of also being disadvantage. This is because scalability is an issue in single controller based SDN architecture if the requirement increases exponentially but this can be overcome by using multi-layered controller software and if the increases are minimal then it can be easily facilitated in SDN.

5.1 Conclusion

Software Defined network is a new and innovative technology. The main aim of SDN is to simplify networking process by decoupling control plane and data plane. This helps to create programmable and agile networking. This process has numerous advantages and benefits that can help any Industry to manage and control their networking services like providing more granular control over the networking services, increased security, lowered operating costs and more. But like every new piece of technology it is has some disadvantages also like single point of failure, high initial investment, lack of trained professionals and more. Because of this the rate of adoption of SDN into the company network architecture has been slow process.

This process aims to know the cause of slow SDN process by looking into the migration challenges of SDN in IT industry of Nepal. The paper questions many IT professionals about their thoughts in SDN, its limitations and benefits to know more about the overall present situation of SDN in Nepal and also to point out the challenges in migration process. From the survey of 253 participants it was concluded that the present situation of SDN in Nepal is a slow and shaky condition right now as most of the IT professionals are themselves new to this and the lack the required skill and experience to properly steer towards proper integration of SDN into their companies internet architecture. Similarly, it was also found that the some of the major challenges of migrating to SDN included high investment, lack of knowledge, security issues, scalability issues, performance and more. Thus, we can say that SDN is like any new technology that has not its chance to shine and people to take notice of it. If the issues and limitations of SDN can be addressed it is my belief that SDN can become the future of Networking and more companies will start migrating to SDN.

5.2 Future Work

This paper is only a study of migrations challenges from traditional networking to Software defined networking in the context of IT industry in Nepal. This paper can be referenced by other researchers to include other industries like manufacturing industries, financial institutions, and educational industries to know what can be the challenges as per the type of industry. Similarly, in future, the research can be also done to include other countries except of being only including Nepal. The challenges of SDN may differ from country to country like the lack of highly skilled workers and vendors may not be a problem for more developed countries like USA. This can be studied in the future.

In this paper the limitations of SDN are only briefly discussed. In the future the limitations of SDN can be studied in more detailed manner and solutions to these challenges can also be provided to improve the quality and acceptance of this research paper.

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