

Analysis of Machine Learning Based DDoS Attack Detection Techniques in Software Defined Network

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ABSTRACT Software Defined Network (SDN) is a novel way of network management. In SDN, control plane and data plane are separated and the incoming traffic is controlled by control plane. Incoming data packets are not handled by the network switches, if there is no matching entry in the forwarding tables, the inbound packet is routed to the controller, the SDN's operating system, for further processing. However, due to this SDN becomes prime target of Distributed denial of services (DDoS) attack. Due to DDoS attack the services of SDN becomes unavailable to its users. Hence, the purpose of this study is to analysis of machine learning based DDoS attack detection techniques in Software defined network (SDN). We analysis the Scopes indexed papers in this study and present a comparative analysis from them.

KEYWORDS DDoS, Machine learning, Software-defined network (SDN)

I. INTRODUCTION

SDN is the latest network virtualization technique, which separates the data plane from the control plane. Before software-defined networking (SDN), network-based algorithms were often implemented on the hardware to govern and monitor data flow in the network, manage routing patterns, and determine how various devices are coupled. These routing rules and algorithms are often implemented on special hardware. But this hardware implementation makes an alteration of the routing algorithm a difficult task. Because, to change the routing rules, one has to change the hardware of the switch [1]. This problem is solved by the introduction of SDN, as in SDN the data plane and control plane are separated. All control planes are centrally controlled; hence, it is possible to change the network traffic rules of any switch at any time.

The basic architecture of SDN is presented in Figure 1. SDN has two layers or planes [2]:

- Infrastructure Layer: This layer consists of all the physical devices such as router and switches.
- Control Layer: This layer is used to control the infrastructure layer. This layer consists of a flow table that has all the routing rules. The traffic through the infrastructure layer is controlled by the flow tables.

However, single-point control makes the SDN vulnerable to different types of security attacks [3]–[5] such as distributed denial-of-services attacks (DDoS) [6], [7]. DDoS attacks [8], [9] are decade-old cyber-attacks in which attacker flood

the victims system with many compromised devices. The basic operation of DDoS attack is presented in Figure 2. As represented in the Figure 2 the attacker traffic consumes all the resources of the victim; hence, it is not available for the legitimate users [10]. In this context, we analysis different DDoS attack detection strategies related to SDN, in this paper.

TABLE 1: Main Information

Description	Results
Time Duration	2018:2022
Sources Information	67
Published Articles	102
Total References	3853
Total Keywords	275
Unique Authors	343

II. LITERATURE REVIEW

Researchers have proposed many techniques for the detection of DDoS attacks [11]–[13] for different environments such as cloud [14]–[17], [17]–[19], IoT [20]–[23], SDN, VANET [24]–[26] and healthcare [27]–[31]. The author in [32] proposed a DDoS attack detection technique based on game theory. In other work, author [33] proposed DOM-based attack detection technique. The authors in [34] proposed DNS based bot net detection technique. Authors in [35] explains different security issues and mitigation techniques for social media. Authors in [36], [37] different encryption and decryption techniques for attack detection. Author in [38]

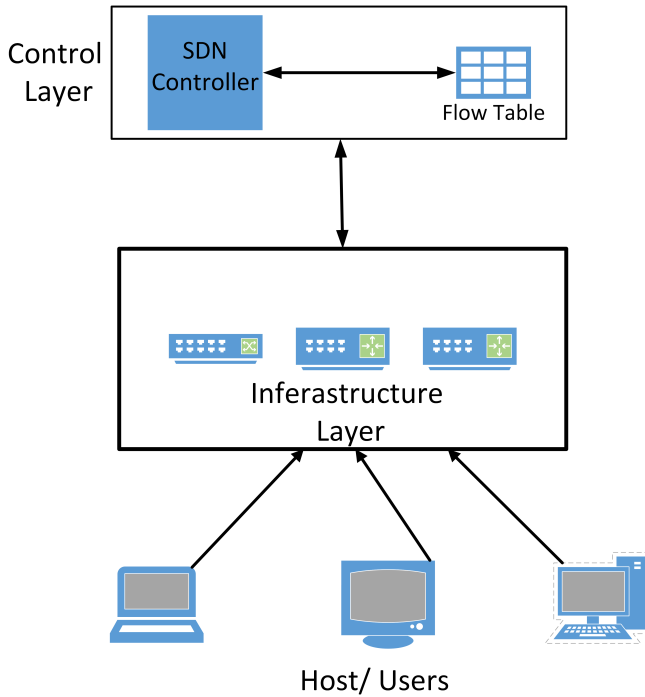


FIGURE 1: SDN Architecture

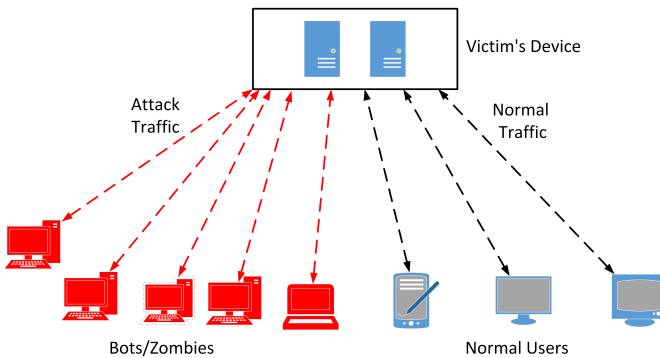


FIGURE 2: DDoS Attack Structure

proposed statistical techniques for DDoS attack detection. The RFID based security measures are proposed by author in [39], [40]. Authors in [41] proposed DDoS attack detection technique for the MEANET environment. Authors in [42] proposed an attack detection technique using 3D technology. Authors in [43] proposed packet filtering methods for DDoS detection. Authors in [44] proposed a SIP based technique for DDoS attack detection. Authors in [45] presents different testbeds for attack detection. Author in [46] proposed a URL-based attack detection technique. The author in [47] presents a risk assessment technique. A cooperative attack detection technique is presented by the author in [48]. Authors in [49] DDoS attack detection technique in healthcare systems. Author in [50] proposed a identity based attack detection technique for maritime environment.

The authors in [51] proposed a machine learning-based attack detection technique. The author in [27] proposed a deep

learning-based attack detection technique. In other work, the authors [20] proposed a deep learning-based attack detection technique for cloud computing. The author in [52] proposed an attack detection technique using the fuzzy technique. Author in [53] proposed attack detection technique for smart homes. Author in [11] the big-data-based attack detection technique. Author in [54] proposed reinforcement machine learning based technique for attack detection. Author in [55] proposed an attack detection technique using the search engine technique. The author presented the review of smart card security in [56]. The authors in [57] presented a review of different attack detection technique. The author in [58] present a neural network based technique for attack detection. Author in [59] presents a matching technique for attack detection. The author in [60] proposed a feature detection technique. Author in [61] proposed an attack detection technique based on graph technique.

III. RESEARCH METHODOLOGY

In this paper, we try to analysis the machine learning based techniques for DDoS attack detection for SDN environment. We selected the Scopus database for our study; as it include papers from majority of the journals.

A. SELECTION CRITERIA

We include all the journal papers publish in-between 2018 to 2022 in English language. Few papers were disqualified because they were irrelevant to the study's fundamental objectives. Our study, for instance, is limited to the field of computer science.

B. DATA SOURCE

The information was collected in October of 2022 using the Scopus database. The search strategy used to address the study topic used the following key phrases.

- SDN
- Software defined network
- DDoS
- Distributed denial of services
- Machine learning

C. SEARCH QUERY SELECTION

We used different queries to get required information form the Scopus database.

- **Stage 1:**

```
"(TITLE-ABS-KEY(SDN OR "software defined network") AND TITLE-ABS-KEY("distributed network" OR ddos))AND TITLE-ABS-KEY("machine learning")) AND ( LIMIT-TO ( LANGUAGE,"English" ) )"
```
- **Stage 2 :**

```
(TITLE-ABS-KEY(SDN OR "software defined network") AND TITLE-ABS-KEY("distributed network" OR ddos))AND TITLE-ABS-KEY("machine learning")) AND ( LIMIT-TO (
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LANGUAGE, "English")) AND LIMIT-TO (DOCTYPE, "ar"))

IV. THEORETICAL AND PRACTICAL IMPLICATIONS

We used the Scopus database in this research. As Scopus database contains majority of papers, we get the latest development related to the research topic. The development in the field of detection of DDoS attacks in the SDN network using the machine learning method is presented by Figure 3a. The details of selected paper for this research is presented in Table 1. From Figure 3a, it is clear that the annual growth rate is 78.93% for the papers.

We then examine the most recent trends and developments in the field of study. To kick off the investigation, we check at how the paper's keywords are laid together. The keywords in a document are a shorthand for the paper's central argument. Figure 3b represents the important keywords; the size of the keyword in Figure 3b depends on its occurrence in the literature.

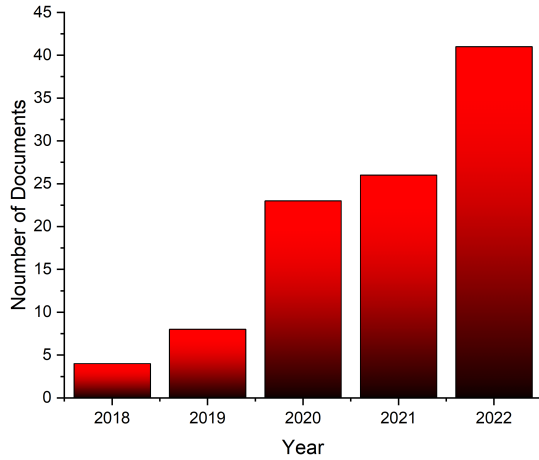
We look at how the sources are broken up as well. The quantity of papers produced by a source is used to rank the sources in order of their productivity and influence. The ranking of the sources are represented in Figure 3c. We also try to find out the most popular authors. One method to find the most popular author is according to the number of published documents. The author statistics is presented in Figure 3d. The details of most cited papers are presented in Table 2. In Table 2, the documents are represented according to the citation.

V. CONCLUSION

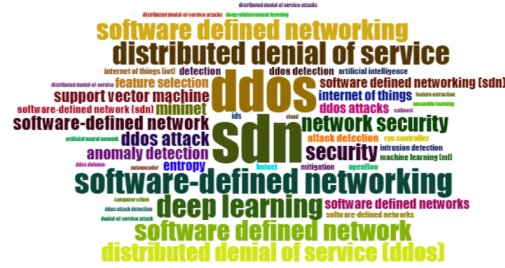
SDN, or software-defined networking, is a method of designing networks that makes it possible to deploy software programs for centralized, high-level network administration and scheduling. Its adaptability, agility, and scalability are the driving force behind its increasing appeal. By moving the control layer to the data layer, SDN increases network programmability and speeds up network variation. However, SDN is vulnerable to different types of cyber-attacks such as DDoS attack. In this Research Paper, we review some of the important DDoS attack detection techniques. We analyze only the papers included in the Scopus database in the future, we include the papers from the ore database.

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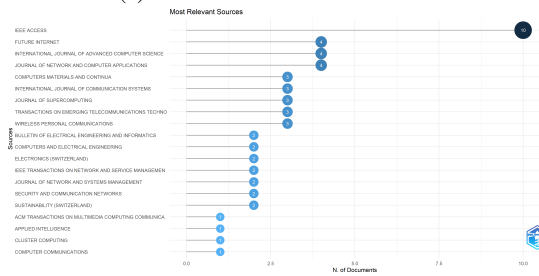
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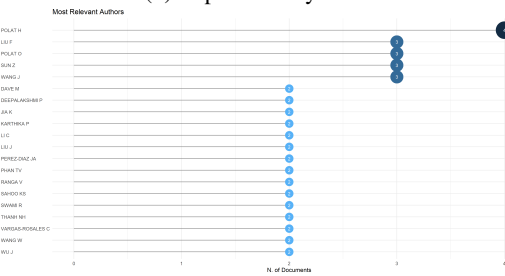
(a) Annual Scientific Production



(b) Important Keywords



(c) Important Sources



(d) Popular Authors

FIGURE 3: Analysis of Topic

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TABLE 2: Highly Cited Papers

Paper	DOI	Total Cita-tions	TC per Year	Normalized TC
LI C, 2018, INT J COMMUN SYST [62]	10.1002/dac.3497	119	23.8	2.6011
RAVI N, 2020, IEEE INTERNET THINGS J [63]	10.1109/IIOT.2020.2973176	81	27	3.4564
PHAN TV, 2019, IEEE ACCESS [64]	10.1109/ACCESS.2019.2896783	67	16.75	4.5424
POLAT H, 2020, SUSTAINABILITY [65]	10.3390/su12031035	66	22	2.8163
SAHOO KS, 2020, IEEE ACCESS [66]	10.1109/ACCESS.2020.3009733	62	20.667	2.6456
PEREZ-DIAZ JA, 2020, IEEE AC-CESS [67]	10.1109/ACCESS.2020.3019330	57	19	2.4323
HAN B, 2018, SECUR COMMUN NETWORKS [68]	10.1155/2018/9649643	52	10.4	1.1366
DONG S, 2020, IEEE ACCESS [69]	10.1109/ACCESS.2019.2963077	46	15.333	1.9629
BANITALEBI DEHKORDI A, 2021, J SUPERCOMPUT [70]	10.1007/s11227-020-03323-w	44	22	5.2
ALZHRANI AO, 2021, FUTURE INTERNET [71]	10.3390/fi13050111	39	19.5	4.6091
ZHIJUN W, 2020, IEEE ACCESS [72]	10.1109/ACCESS.2020.2967478	34	11.333	1.4508
TAN L, 2020, IEEE ACCESS [73]	10.1109/ACCESS.2020.3021435	32	10.667	1.3655
KRISHNAN P, 2019, COMPUT COMMUN [74]	10.1016/j.comcom.2019.09.014	28	7	1.8983
TUAN NN, 2020, ELECTRONICS (SWITZERLAND) [75]	10.3390/electronics9030413	25	8.333	1.0668
ASSIS MVO, 2021, J NETWORK COMPUT APPL [76]	10.1016/j.jnca.2020.102942	22	11	2.6
ABOU EL HOUDA Z, 2020, IEEE TRANS NETW SERV MANAGE [77]	10.1109/TNSM.2020.3014870	21	7	0.8961
KACI A, 2020, J NETWORK SYST MANAGE [78]	10.1007/s10922-020-09532-1	19	6.333	0.8108
AHUJA N, 2021, J NETWORK COMPUT APPL [79]	10.1016/j.jnca.2021.103108	19	9.5	2.2455
PHAN TV, 2020, IEEE TRANS NETW SERV MANAGE [80]	10.1109/TNSM.2020.3004415	17	5.667	0.7254
ALJUHANI A, 2021, IEEE ACCESS [81]	10.1109/ACCESS.2021.3062909	16	8	1.8909

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