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1. SYN-flood

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1.

DoS-

2.

DoS-

3.

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5. ( ) \_\_\_\_\_  
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6. .1) ( , , , , )

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1		09.11.21-09.11.21	
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2		10.11.21-17.11.21	
3		18.11.21-23.11.21	
4		24.11.21-01.12.21	
5		02.12.21-07.12.21	
6		08.12.21-09.12.21	
7		10.12.21-11.12.21	

08 2021 .

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: 83 ., 16 ., 6 .,

2 ., 30 .

- , , ,  
JMETER, XAMPP, - , HTTP.

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(SOM)

(LVQ).

SOM

« » « », LVQ

SOM,

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## ABSTRACT

Master's thesis: 83 pages, 16 figures, 6 tables, 2 appendices, 30 sources.

WEB APPLICATION, TESTING METHODS, TESTING TOOLS, PERFORMANCE TESTING, TESTING AUTOMATION, JMETER, XAMPP, WEB SERVER, HTTP.

In this thesis the perspective intrusion detection method, capable to increase accuracy of attacks detection is presented. This intrusion detection method is based on Kohonen's neural network, specifically the combination of Self-Organizing Maps(SOM) and Learning Vector Quantization(LVQ) algorithms. SOM algorithm is used to group input data into "attack" and "normal" clusters, whereas LVQ fine-tunes resulting separation by retraining the resulting SOM in order to increase the accuracy of the attack detection. The detailed treatment is given to intrusion detection systems, their history, types, architectures, strengths and weaknesses. The main incorporated algorithms are also described. Main performance measures for method evaluation are investigated in order to compare it with competing algorithms. The results of evaluation corroborate the correctness of presented model. For real-world data sets it exceeds both competing algorithms to chosen criterion.

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				11
1.1				11
1.2				12
1.3				14
1.4			(IDS)	17
1.5				20
2				21
2.1				21
2.2				25
2.3				29
2.3.1	IDS			32
2.3.2	IDS			34
2.3.3	IDS			36
2.3.4				37
2.3.5				42
2.4				43
3				44
3.1				44
3.2				51
3.3				54
3.4				56
4				
				57

4.1	.....	57
4.1.1	.....	58
4.1.2	.....	59
4.2	.....	63
4.3	.....	66
	.....	68
	.....	70
	.....	73
	.....	82

DDoS – (., Distributed Denial of Service attack);

DoS – (., Denial of Service);

LAN – (., Local Area Network);

LVQ – (., Learning Vector Quantization);

NM – (., Neural Network);

SOM – (., Self-organizing Map);

TCP – (., Transmission Control Protocol);

UDP – (., User Datagram Protocol).



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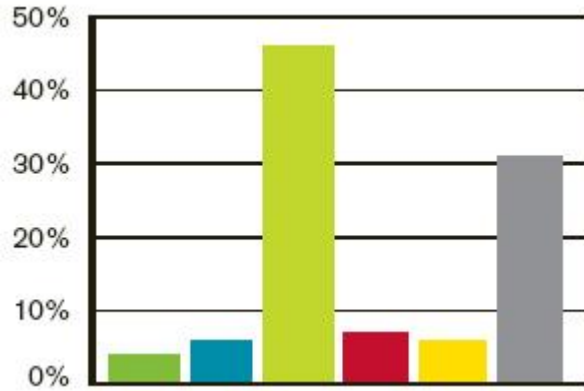
[1].





(36%

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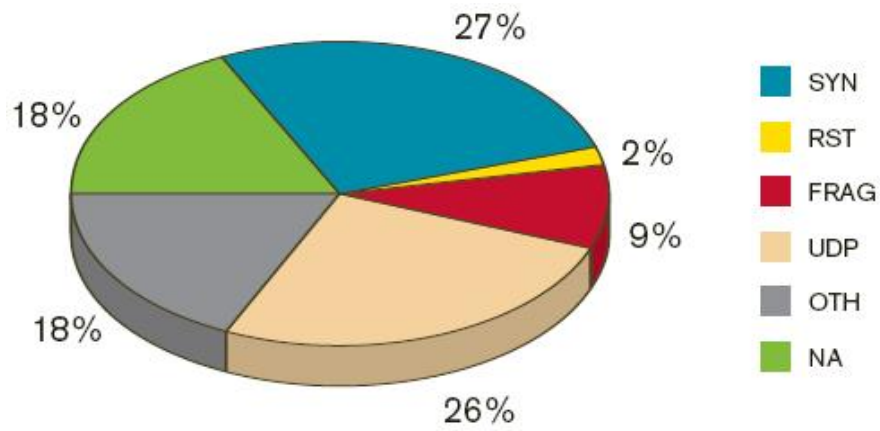


1.1 –

DDoS-

1.2,

SYN (27%) UDP flood (26%).



1.2 – DDoS-

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 42 / .  
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1.3

1996  
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 ( SYN)  
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(SYN flooding). [1]

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1.4 (IDS)

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 [3]. 1984 ,  
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 IDS 1986 ,  
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 IDES ( Sun  
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 , [5]. IDES  
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 . [6]

IDES, NIDES (Expert System  
 ), ' 1993 . MIDAS (Multicast Intrusion  
 Detection and Alerting System), P-BEST  
 LISP, 1988 . [7].

« »,

. [8] W&S (Wisdom & Sense),

1989

. W&S

. 1990 TIM (Time-based inductive machine)

Common LISP

[10].

VAX 3500.

NSM (Network Security Monitor),

Sun-3/50 [11].

1990 ISOA (

),

. [12] ComputerWatch,

AT&T Bell Labs,

[13].

, 1991 ,

DIDS (Distributed intrusion detection system), . [14] 1991

(ICN) NADIR (Network anomaly detection and intrusion reporter).

. [15] NADIR

1998

Bro,

libpcap [16].

libpcap

NFR (Network Flight

Recorder),

1999

[17].

1998

APE,

libpcap.

APE

Snort. [18] 2001

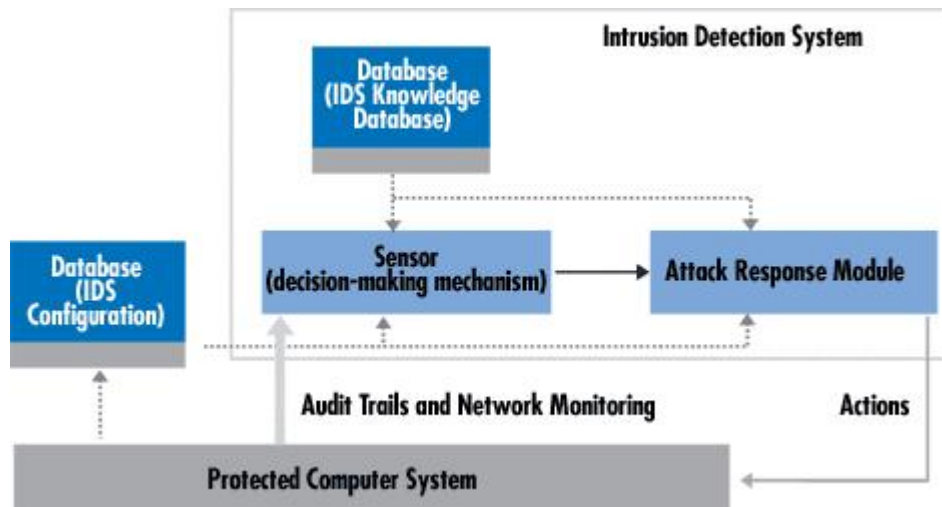
ADAM IDS (Audit data analysis and mining IDS).

tcpdump

[19].

(IDS)

( , ).



1.3 –

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1.3

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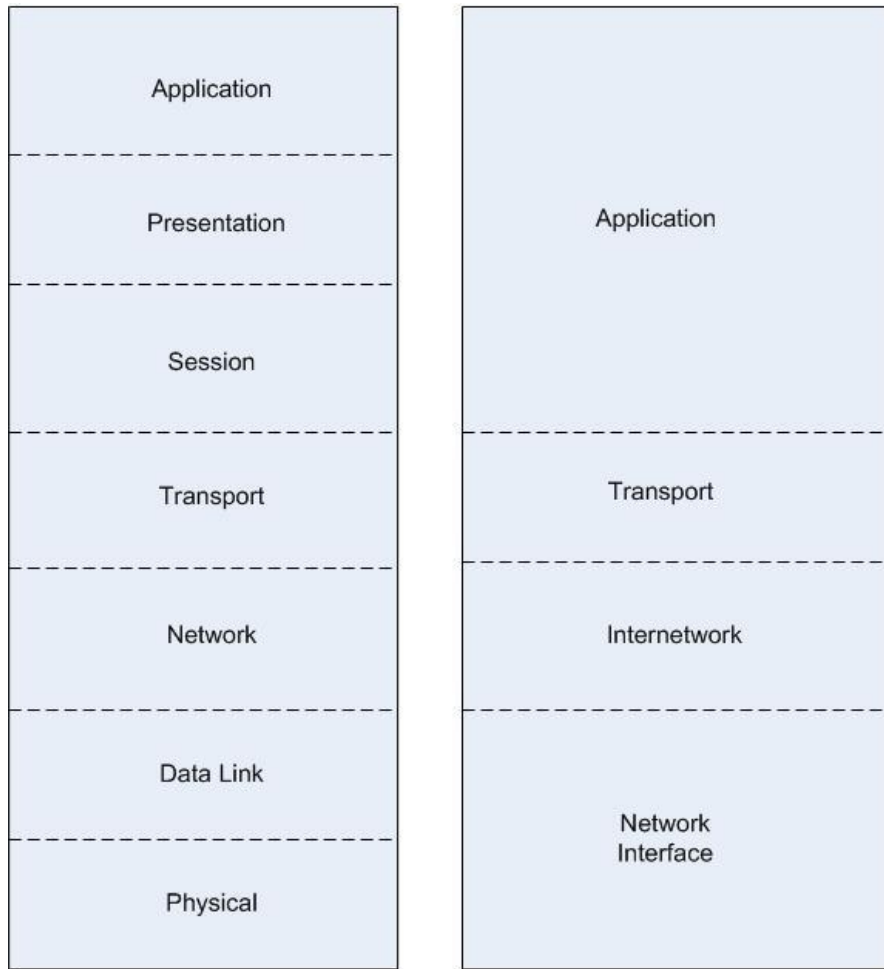
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CRC (Cyclic Redundancy Checksum);

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, TCP/IP,  
2.1.



2.1 – OSI TCP/IP

OSI, TCP/IP

TCP/IP

OSI

TCP/IP

TCP/IP

OSI,

TCP/IP

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OSI

[20].

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 . , Telnet, FTP,  
 SMTP, HTTP ,

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 IP- , .  
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OSI. :

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 TCP ( ) UDP ( )  
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IPv4

IP ( ).

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ARP (Address Resolution Protocol) RARP  
 (Reverse Address Resolution Protocol). ,

( ) IGP  
EGP.

IP.

OSI

. TCP/IP

IP

TCP/IP

TCP/IP

## 2.2

OSI,

[21].

[21]:

OSI;

OSI

TCP/IP,

TCP/IP

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 2.1 – , SPI  
 (Stateful Packet Inspection) ( ):

DoS-  
 H.323, SIP, FTP

2.1.

2.1 –

Firewalls		
Network	Network filtration	Stateless
	Session filtration	
Personal	Application level filtration	Stateful (SPI)

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(VPN) -

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, PPTP L2TP. VPN  
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IDS –

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[22].

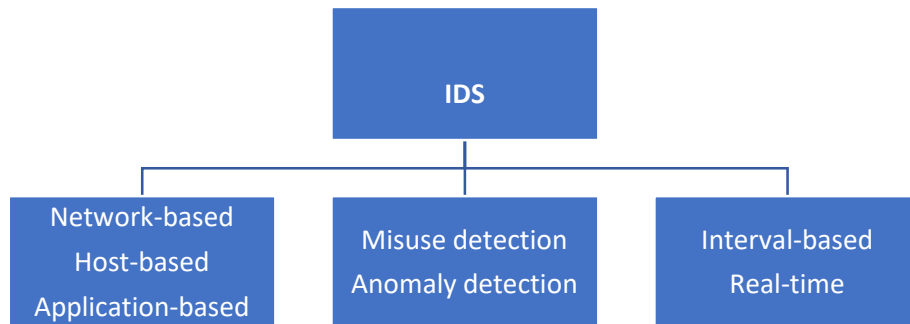
IDS

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IDS [22]



2.2. –

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TCP/IP



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, : (LVQ)  
(SOM). ,

SOM LVQ .

SOM

« » « », LVQ

SOM

3.1

KDD CUP'99.

TCP,

TCP- '

3-

1999

[24].



SYN,

KDD CUP'99

DoS/DDoS-

: neptune (synflood) smurf (icmpflood),

TCP/IP

- DoS / DDoS

( )

TCP/IP,

TCP/IP.

Neptune (synflood)

TCP.

(SYN)

IP-

synflood

TCP.

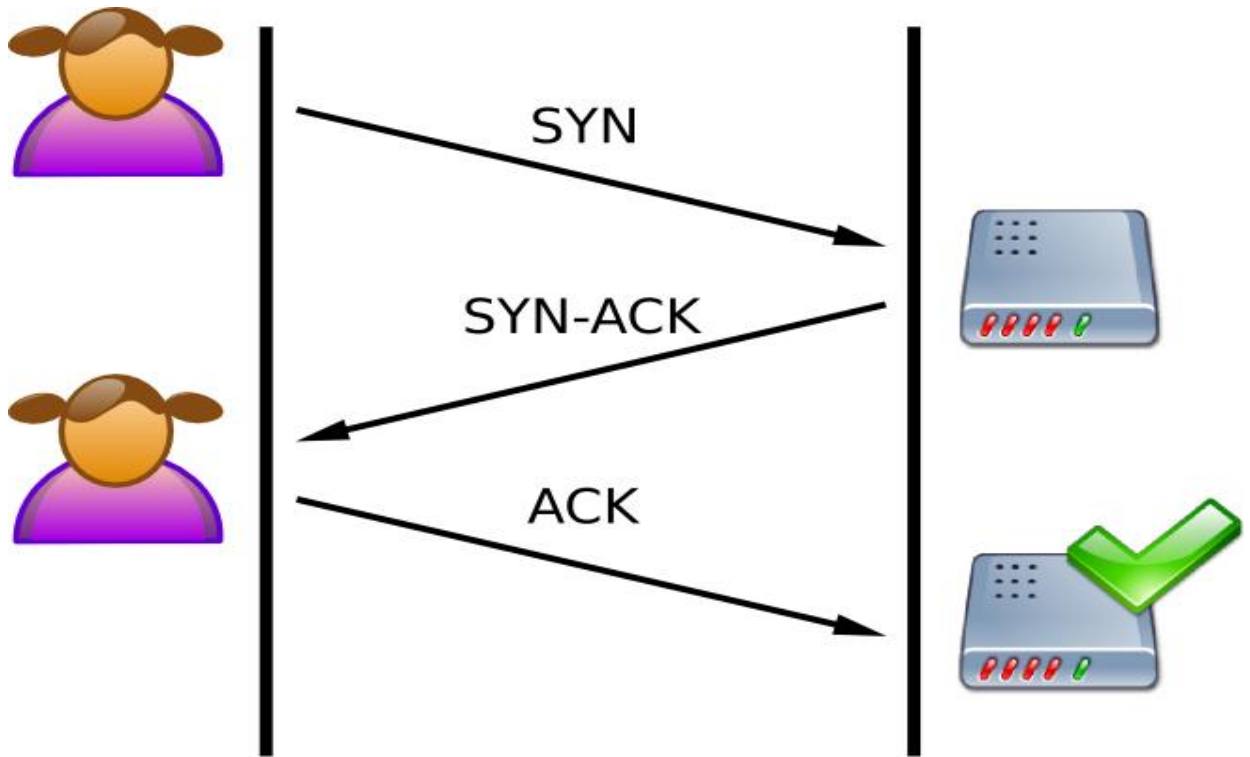
3.2.

TCP

SYN.

SYN+ACK,

ACK.



3.2 –

synflood

SYN

IP-

( 3.3).

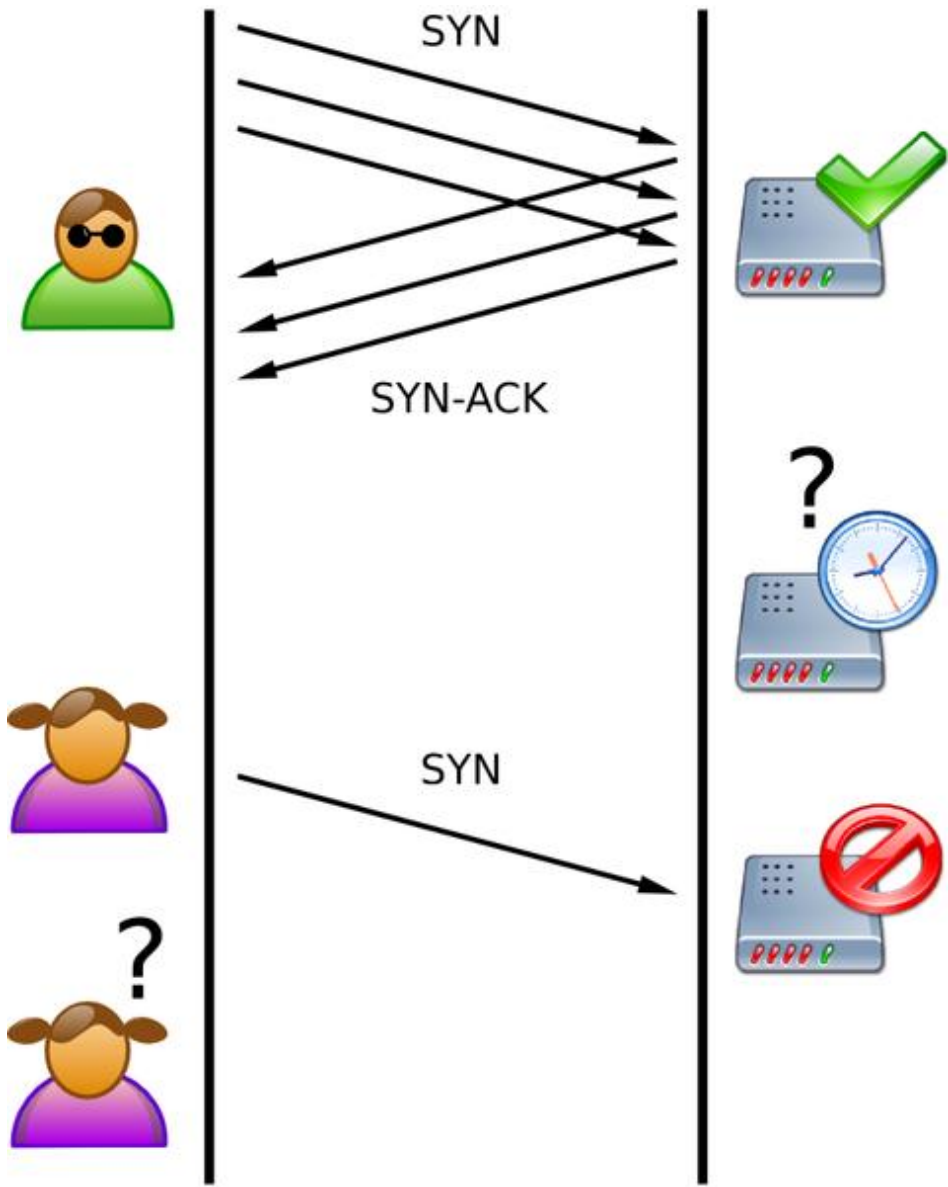
SYN+ACK.

IP-

(ACK)

( - 180 ).

SYN



3.3 – synflood

synflood, smurf

ICMP,

ICMP echo

( ICMP

). - ICMP

IP-

ICMP echo.

Smurf

KDD CUP'99

Neptune Smurf.

1. Count – 2

2. Serror\_rate – «SYN».

3. Rerror\_rate – «REJ».

4. Same\_srv\_rate –

5. Diff\_srv\_rate –

6. Srv\_count – 2

7. Srv\_serror\_rate – «SYN».

8. Srv\_rerror\_rate – «REJ».

9. Srv\_diff\_host\_rate –

9

10

: same\_src\_port\_rate ( )

: , Neptune Smurf. 5

510 510 0,00 0,00 0,00 0,00 1,00 0,00 0,00 255 255 1,00 0,00 1,00 0,00 0,00  
 0,00 0,00 0,00 .

10 21 0,00 0,00 0,00 0,00 1,00 0,00 0,24 255 255 1,00 0,00 0,00 0,00 0,00  
 0,00 0,00 0,00 .

19 20 0,00 0,00 0,00 0,00 1,00 0,00 0,10 255 255 1,00 0,00 0,00 0,00 0,00  
 0,00 0,00 0,00 .

256 12 1,00 1,00 0,00 0,00 0,05 0,06 0,00 255 12 0,05 0,07 0,00 0,00 1,00  
 1,00 0,00 0,00 .

122 15 1,00 1,00 0,00 0,00 0,12 0,06 0,00 255 15 0,06 0,05 0,00 0,00 1,00  
 1,00 0,00 0,00 .

, 10%  
 KDD CUP'99. 500 .

3.1. , :

- min – ;
- max – ;
- – .

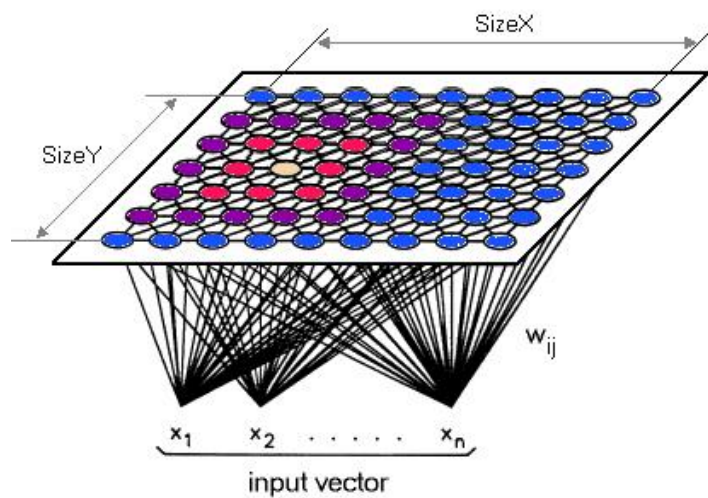
3.1 –

	Min	Max	Mean	
1	2	3	4	5
count	1	511	337,4	210,7
srv_count	1	511	298,6	245,4
serror_rate	0	1	0,181	0,3848
srv_serror_rate	0	1	0,181	0,3848
rerror_rate	0	1	0,05311	0,2241
srv_rerror_rate	0	1	0,05317	0,2239
same_srv_rate	0	1	0,7904	0,3887
diff_srv_rate	0	1	0,01816	0,06163

## 3.1

1	2	3	4	5
srv_diff_host_rate	0	1	0,02681	0,1356
dst_host_count	1	255	233,6	62,94
dst_host_srv_count	1	255	190,3	105,4
dst_host_same_srv_rate	0	1	0,7569	0,4094
dst_host_diff_srv_rate	0	1	0,02578	0,08578
dst_host_same_src_port_rate	0	1	0,6052	0,4812
dst_host_srv_diff_host_rate	0	0,67	0,00487	0,02343
dst_host_serror_rate	0	1	0,1812	0,3849
dst_host_srv_serror_rate	0	1	0,181	0,3848
dst_host_error_rate	0	1	0,0535	0,2232
dst_host_srv_error_rate	0	1	0,05299	0,2217

## 3.2



SOM –

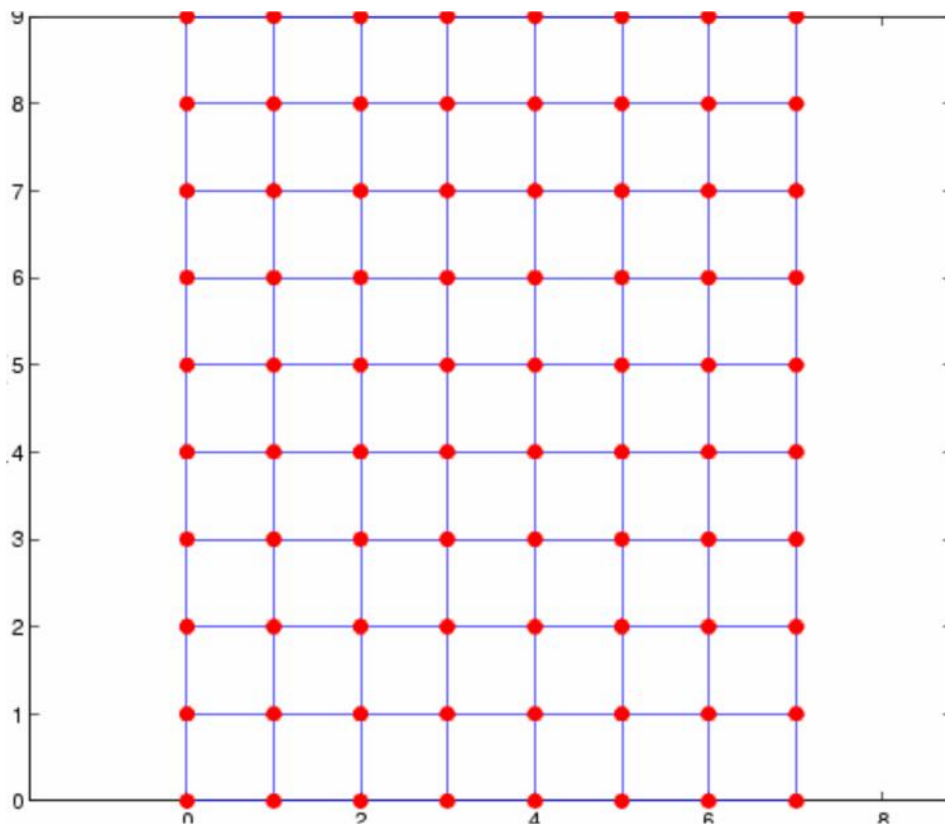
[25]. ,

( .3.4).

$$\check{S}_{ij} = [\check{S}_{ij1}, \check{S}_{ij2}, \dots, \check{S}_{ijN}] \quad (3.1)$$

ij – , N – .

( 3.5).



3.5 –

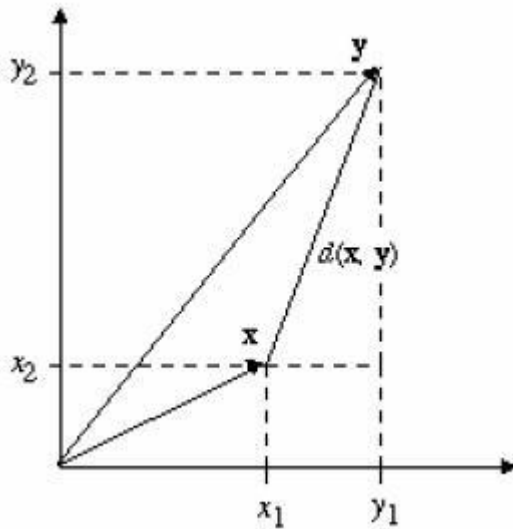
SOM.

( 3.6) ( ), :

$$d(x, \check{S}_{ij}) = \|x - \check{S}_{ij}\| = \sqrt{\sum_{k=1}^N (x_k - \check{S}_{ijk})^2}, \tag{3.2}$$

N - ; :

$$\check{S}_{ij}(t+1) = \check{S}_{ij}(t) + y(t)G(i, \check{S})(x - \check{S}_{ij}(t)), \tag{3.3}$$



3.6-

t - ( ), (t) - , (

),  $G(i, \check{S}) =$  ( , ),  
:

$$G(i, \check{S}) = e^{-\frac{d^2(i, \check{S})}{2\check{\sigma}^2}}, \quad (3.4)$$

$$d(i, \check{S}) = \sum_{i=1}^N |i - \check{S}_i| -$$

, - ,

$$\check{\sigma} = \check{\sigma}_i (\check{\sigma}_n / \check{\sigma}_i)^{t/t_{\max}}, \quad (3.5)$$

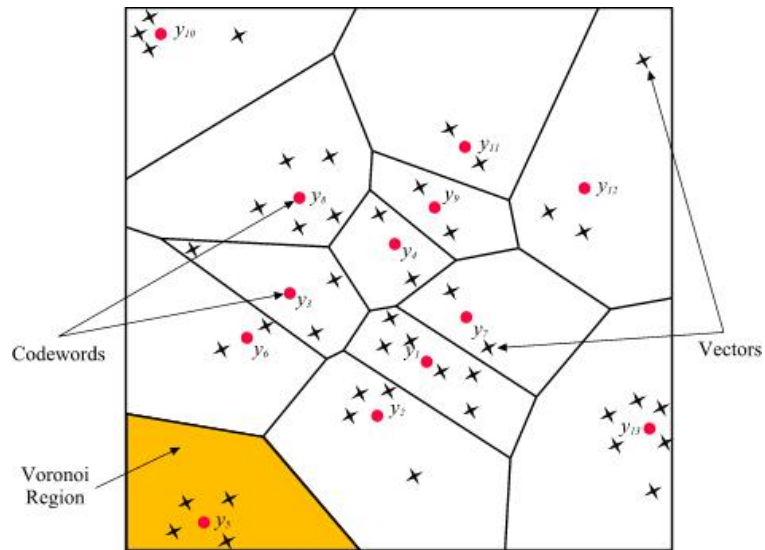
$\check{\sigma}_i - \check{\sigma}_n$  } ,  
 $t -$  .

(t).

3.3

SOM, LVQ

( . 3.7) [25].



3.7 –

LVQ

SOM.

NN.

LVQ

SOM

[26],

LVQ

LVQ

:

$$\check{S}_{ij}(t+1) = \check{S}_{ij}(t) + \} (t)(x - \check{S}_{ij}(t)) , \tag{3.6}$$

$$\check{S}_{ij}(t+1) = \check{S}_{ij}(t) - \check{\gamma}(t)(x - \check{S}_{ij}(t)), \tag{3.7}$$

,  
 ,  
 :

$$\check{\gamma} = \check{\gamma}_i (\check{\gamma}_n / \check{\gamma}_i)^{t/t_{\max}} \tag{3.8}$$

$\check{\gamma}_i \check{\gamma}_n -$  ,  $t -$   
 $\check{\gamma}_i, \check{\gamma}_n t$  ,  
 SOM. LVQ SOM.

### 3.4

,  
 SOM LVQ.  
 SOM LVQ :  
 - SOM ;  
 - LVQ  
 SOM,

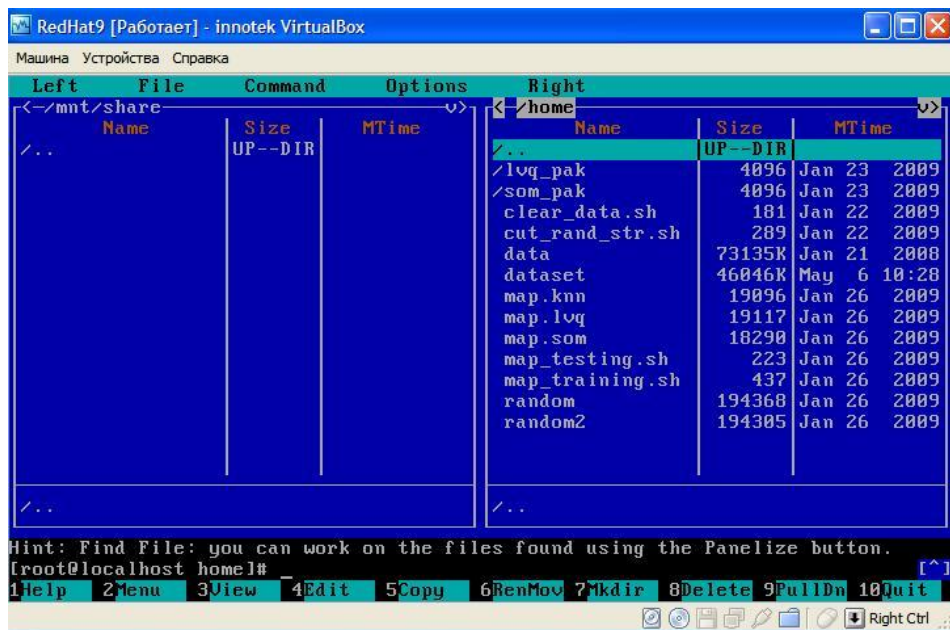
4

4.1

Linux – RedHat,

innotek VirtualBox.

4.1.



4.1 –

:

- ;

SOM LVQ;

- ( )

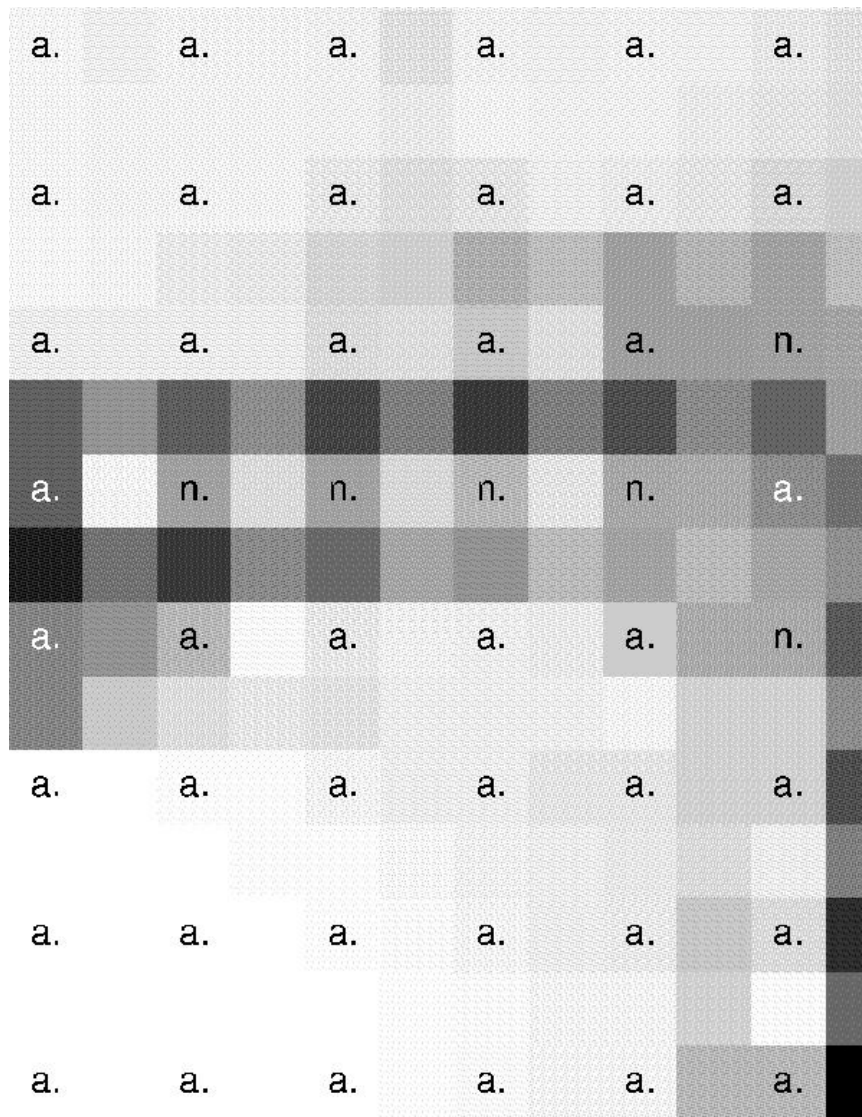
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4.1.1

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,
clear_data.sh ( ).
SED AWK.
.
SED
,
AWK
: normal, neptune (synflood) smurf.
, AWK
, :
.
clear_data.sh
.
SOM, 4.2.
4.2
, ( ,
). :
- « .»: smurf ( ) 4.2 - ;
- « .»: .
, bash SED
cut_rand_str.sh.
( ). , cut_rand_str.sh
.

```



4.2 –

4.1.2

– SOM LVQ.  
 SOM\_PAK LVQ\_PAK,  
 [27].  
 SOM LVQ.  
 SOM\_PAK LVQ\_PAK:

```

- randinit:          ,
                    ,
                    ,
                    ;
- vsom:              SOM.
                    , randinit, ;
- setlabel:         ,
                    . k-
                    ;
- lvq1:              LVQ.
setlabel;
- qerror:
                    , lvq1;
- : ,
  SOM_PAK, LVQ_PAK ,
                    .
                    map_training.sh.
                    . 4.3
map_training.sh.
                    4.1. ,
LVQ,                4.2. ,
                    .

```

```

RedHat9 [Работаer] - innotek VirtualBox
Машина Устройства Справка
Password:
Last login: Thu Aug 27 12:38:59 on tty2
You have mail.
[root@localhost root]# cd /home/
[root@localhost home]# ls -l
total 119728
-rw-rw-rw- 1 root root 181 Jan 22 2009 clear_data.sh
-rw-rw-rw- 1 root root 289 Jan 22 2009 cut_rand_str.sh
-rw-rw-rw- 1 root root 74889749 Jan 21 2008 data
-rw-r--r-- 1 root root 47150732 May 6 10:28 dataset
drwxr-xr-x 2 102 games 4096 Jan 23 2009 log_pkt
-rw-r--r-- 1 root root 223 Jan 26 2009 map_testing.sh
-rw-r--r-- 1 root root 437 Jan 26 2009 map_training.sh
-rw-r--r-- 1 root root 194368 Jan 26 2009 random
-rw-r--r-- 1 root root 194305 Jan 26 2009 random2
drwxr-xr-x 2 102 games 4096 Jan 23 2009 sum_pkt
[root@localhost home]# sh map_training.sh random random2
map initialization
map training with SOM
 1/ 1 sec. ....
map tuning with LVQ
 0/ 0 sec. ....
 0/ 0 sec. -----
finished
[root@localhost home]# _

```

#### 4.3 – Map\_training.sh

#### 4.1 – SOM

Dimensionality of the grid	2
X (grid width)	10
Y (grid height)	10
Neighbourhood function	Gaussian
Neural network topology	Rectangular
	1
	10
t	20000

#### 4.2 – LVQ

	1
t	5000

map\_training.sh,

SOM

, randinit , 100 ( )

SOM 2000

cut\_rand\_str.sh.

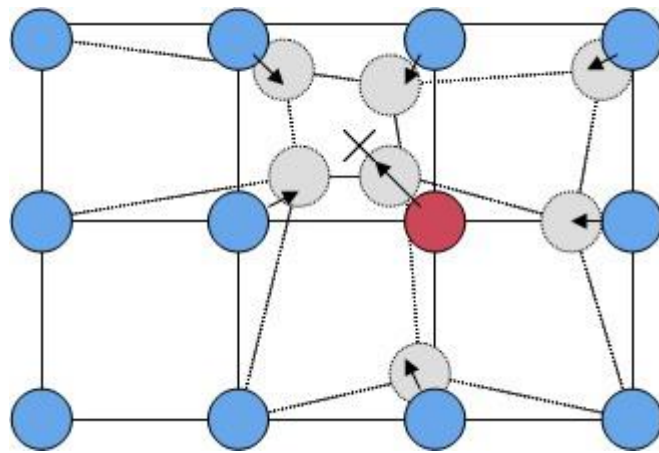
SOM

4.4,

«X»

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4.4 –

SOM

20000

SOM

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LVQ

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SOM,
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setlabel, k-
, map_training.sh, LVQ
. LVQ lvq1.
5000 ,
. lvq1
, 2000 .
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4.2
,
map_testing.sh ( ).
, SOM
MP13 [28, 29].
MP13 ,
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map_testing.sh qerror
, SOM
SOM, LVQ,
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4.3

. : (a) , (b)  
(c) .

SOM

-

4.3 -

<b>a</b>	<b>b</b>	<b>c</b>
smurf	280790	99.91%
neptune	107201	99.49%
normal	97278	99.80%
<b>TOTAL</b>	<b>485269</b>	<b>99.80%</b>

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k=10.

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 cut\_rand\_str.sh  
 2000  
 SOM LVQ. ( , )  
 SOM SOM+LVQ ( map\_testing.sh).  
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 ( ).  
 4.4.

4.4 –

	1	2	3	4	5	6	7	8	9	10	mean
	99.3	98.8	99.1	99.2	98.5	99.8	99.2	99	98.9	98.9	<b>99%</b>
MP13	-	-	-	-	-	-	-	-	-	-	<b>97%</b>
SOM	97	97.8	96.2	96.7	97.5	97	97.2	96.7	96.8	96.9	<b>97%</b>

,  
 , 99%. MP13[28] SOM  
 97% .  
 DDoS- .

4.3

DoS/DDoS

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IDS Snort.

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WinPcap

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IDS Snort.

Cisco, Juniper, CheckPoint .

: SOM LVQ.

SOM+LVQ

SOM LVQ.

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DDoS- ,  
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Snort,  
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