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A NOVEL ALGORITHM FOR DETECTING TCP/IP NETWORK ATTACKS USING HYBRID FIREWALL SCRIPT APPLIED IN LINUX OPERATING SYSTEM

Abstract: A novel algorithm for detecting TCP/IP network attacks using hybrid firewall script written in Linux operating system is made.

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ntroduction

The hybrid firewall is the most modern and effective means of combating unauthorized access to computer system and network resources. The hybrid firewall monitors the status of each incoming or outgoing network connection and checks for the presence of analytical web platforms that collect different user information in the Internet space [1], [2], [3], [4], [5], [6], [10], [11], [12], [13].

The built-in hybrid firewall consists of a firewall with packet filtering, a dynamic firewall with full inspection, a firewall with an attached gateway, a NAT network, a firewall and a host-based firewall. This ensures complete protection of the host from malicious network cyber attacks [7], [8], [9], [14], [15], [16], [17], [18], [19], [20], [29].

The Hybrid Firewall serves to protect the information resources of the web site of the Technology transfer center (ctt.shu.bg), the web site of annual of the Faculty of Technical Sciences (annuals.shu.bg) and the web site of the Faculty of Technical Sciences (ftn.shu.bg) at Konstantin Preslavsky University of Shumen [30], [31], [32], [33], [34], [35], [36], [40], [41], [42].

2. A Linear algorithm to build a hybrid firewall using script written in Linux

To protect against the TCP/IP network attack, a versatile scripting algorithm was developed to build a hybrid firewall to protect against unauthorized access to the resources of a particular host on a small private computer network.

11 scripts were used as the basis for the modified script. The script [] is characterized by the fact that it has secured blocking of the ECN field in IPv4 and TCP protocols, as well as security to block cyber attacks from file sharing and P2P. A major flaw in scripts [1] and [2] is the activation of the ICMP protocol. This Script [4] does not use security to block different types of port scanning cyber attacks on the input chain. The [3] shows basic firewall configurations, but without the implementation of detailed security policies against network scanning attacks [21], [22], [23], [24], [25], [26], [27], [28].

Only 6 command lines for blocking port scanning cyber attacks are used in Script [5], and this is not the most effective protection because it does not cover the full flags combination. A major flaw in the script [1] continues to be the use of the ICMP protocol, as well as the non-use of protection against various types of port scanning attacks. An advantage in this script is the activation of the IPv6 protocol. The Script [4] only provides basic protection against the major types of port scans of cyber attacks. Script [7] has a huge drawback by allowing all users to implement inbound network connections using the SSH, HTTP, and HTTPS protocols. The security script [6] is not configured to block the ECN field

in IPv4 and TCP protocols, as well as security to block cyber attacks from file sharing and P2P networking. The script [8] does not provide protection against cyber attacks targeting different countries and anonymous proxy IPs [34], [35], [36], [37], [38], [39], [40], [41], [42].

To remove all these shortcomings, a modified script that implements a hybrid firewall in a Linux-based operating system was created.

The hybrid firewall algorithm consists of basic 3 subsystems and 27 security solutions. Each of the algorithms, as well as the security solutions, are standalone software scripts designed to counteract various types of malicious cyber attacks.

The basic algorithm (Fig.1) of the hybrid firewall includes the following basic steps:

- Configure the logical IP addresses of all host network interfaces.
- Logical IP address of the firewall.
- Default gateway, whose role is to provide the host with access to the Internet space.

• Virtual Network Interface eth1:1, which acts as a router for the entire local computer network, thus all traffic passes and is processed through the dynamic firewall.

• Loading system firewall protection features in the kernel of the Ubuntu 18.04.2 LTSdesktop-i386 operating system kernel. In order to provide greater protection against malicious network cyber attacks, other non-kernel protections are being loaded, such as xtables extensions.



Fig.1. The basic algorithm of the built hybrid firewall

3. Experiment

The scientific research is realized in a real university local computer network, consisting of three hosts and one router. Fig.2 shows the way the hybrid firewall works in a local computer network at the Faculty of Technical Sciences.



Fig.2. Implementation of hybrid firewall against modern types of cyber attacks

The research is realized in a real local computer network consisting of three hosts and one router. The devices are configured as follows:

• The logical IP address of the real network interface eth1 of a hybrid firewall is set to a logical IP address 192.168.1.4 and a network mask 255.255.255.0. HP ProBook 4540s laptop with Intel® Core TM i3-3110M 2.40 GHz dual-core processor and 4.00 GB of RAM is used in the research. The installed operating system is Linux Ubuntu 18.04.2 LTS-desktop-i386.

• Configured the virtual network interface eth1:1 of the hybrid firewall with a logical IP address 192.168.254.1 and a network mask 255.255.255.0. This interface acts as a router for the entire local computer network, thus all network traffic passes and is processed through the hybrid firewall.

• A default firewall gateway is configured with a logical IP address of 192.168.1.1 and a network mask of 255.255.255.0. The role of this gateway is to provide access to the hybrid firewall to the Internet space.

• The logical IP address of the trusted host real network eth1 interface is set to logical IP address 192.168.254.4 and network mask 255.255.255.0. A desktop computer with a Gigabyte 7N400-L motherboard and a AMD ATHLON XP2500 + single core processor AMD ATXLON XP2500 + was used. The installed operating system is Linux Ubuntu 3.19.0-26-generic 14.04.2-desktop-i386. A default gateway host is configured with a trusted host with logical IP address 192.168.254.1. The role of this gateway is to provide trusted host access to the Internet space through detailed inspection and filtration by the hybrid firewall.

• The logical IP address of the attacking host's real network interface is set to logical IP address 192.168.254.2 and network mask 255.255.255.0. Asus x52j laptop with Intel® Core TM i5 CPU M460 2.53 GHz dual-core processor and 4.00 GB of RAM is used. The installed operating system is Microsoft Windows 7 Professional 64 bit. A default gateway host is configured for the attack host with logical IP address 192.168.254.1. The role of this gateway is to provide access to the attacking host to the Internet space through detailed inspection and filtration from the hybrid firewall.

• The Huawei HG532e wireless router with four FastEthernet (100 Mbps) connections was used in the research. Access to router settings is disabled by the BTC Broadband Service Internet provider (Vivacom) with dynamic IP address range 79.100.0.0 - 79.100.127.255. Despite the prohibition applied, the hybrid firewall successfully operates on the small local computer network.

4. Results

Results obtained from the real-time hybrid firewall monitoring module in the presence of the cyber attacks on figures 3, 4, 5 and 6 are illustrated.

	Oct 15 11:46:20 peshoaikido kernel: [2811.181677] PREVENT DOS & SYN FLOOD ATTACIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M							
	ACPROT0=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=44 TOS=0x00 PREC=0x00 TTL=44 ID=18266 PROT0=TCP SPT=63248 DPT=5998 SEQ=2910363933 ACK=0 WIN							
	DOW=1024 RES=0x00 SYN URGP=0 OPT (01010101) MARK=0x9							
	Oct 15 11:46:20 peshoaikido kernel: [2811.307474] PREVENT IP ECN ECN-Capable TrIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M							
\equiv	ACPROTO=0800 SRC=192.168.254.2 DST=192.168.254.1 EN=44 TOS=8x00 PREC=0x00 TTL=55 ID=46 40 PROTO=TCP SPT=63249 DPT=8290 SEQ=2910429468 ACK=0 WIN							
1200	DOW=1024 RES=0x00 SYN URGP=0 OPT (01010101) MARK=0x3							
P-	Oct 15 11:46:21 peshoaikido kernel: [2812.165145] Preventing 0.0.0.0/0 addresseIN=eth1 DUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M							
	ACPROT0=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=44 TOS=0x00 PREC=0x00 TTL=36 ID=38806 PROT0=TCP SPT=63249 DPT=9485 SEQ=2910429468 ACK=0 WIN							
	DOW=1024 RES=0x00 SYN URGP=0 OPT (01010101) MARK=6 9							
	Oct 15 11:46:21 peshoaikido kernel: [2812.165191] Preventing 0.0.0.0/0 addresseIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M							
	ACPROT0=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=44 TOS=0x00 PREC=0x00 TTL=37 ID=38806 PROT0=TCP SPT=63249 DPT=9485 SEQ=2910429468 ACK=0 WIN							
	DOW=1024 RES=0x00 SYN URGP=0 OPT (01010101) MARK=0x0							
	Oct 15 11:46:21 peshoaikido kernel: [2812.165305] PREVENT DOS & SYN FLOOD ATTACIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M							
	ACPROT0=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=44 TOS=0x00 PREC=0x00 TTL=36 ID=27870 P OT0=TCP SPT=63249 DPT=6502 SEQ=2910429468 ACK=0 WIN							
	DOW=1024 RES=0x00 SYN URGP=0 OPT (01010101) MARK=C.							
=	Oct 15 11:46:21 peshoaikido kernel: [2812.336714] PREVENT IP ECN ECN-Capable TrIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M							
	ACPROTO=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=44 TOS=0x00 PREC=0x00 TTL=40 ID=32943 PROTO=TCP SPT=63249 DPT=179 SEQ=2910429468 ACK=0 WIND							
	0W=1024 RES=0x00 SYN URGP=0 OPT (01010101) MARK=0x9							
	Oct 15 11:46:22 peshoaikido kernel: [2813.148708] Preventing 0.0.0.0/0 addresseIN=eth1 0 T= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M							
	ACPROTO=0800 SRC=192.168.254.2 DST=192.168.254.1 L N=44 TOS=0x00 PREC=0x00 TTL=37 ID=6490 PROTO=TCP SPT=63248 DPT=55055 SEQ=2910363933 ACK=0 WI							
_	NDOW=1024 RES=0x00 SYN URGP=0 OPT (010101) MARK=0.2							
-0-	Oct 15 11:46:22 peshoaikido kernel: [2813.148758] Preventing 0.0.0.0/0 addresseIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M							
A	ACPROT0=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=44 TOS=0x00 PREC=0x00 TTL=38 ID=64909 PROT0=TCP SPT=63248 DPT=55055 SEQ=2910363933 ACK=0 WI							
	NDON=1024 RES=0x00 SYN URGP=0 OPT (01010101) MARK=0x9							
	OCT 15 11:46:22 peshoatkido kernel: [2813.148803] PREVENT DOS & SYN FLOOD ATTACIN=eth1 OUT= MACSRC=20:CT:30:46:01:a7 MACDST=D4:D5:27:7C:50:1C M							
	ACPRO10=0800 SRC=192.168.254.2 DS1=192.168.254.1 LEN=44 10S=0x00 PREC=0x00 TTL=40 1D=45178 PR010=TCP SPT=63248 DPT=32778 SEQ=2910363933 ACK=0 WI							
	NDON=1024 RES-6x06 SYN URCP-6 OPT (01010101) MARK-6X9							
	Oct 15 11:46:22 peshoatkido kernel: [2813.32040/] PREVENI IP ECN ECN-Capable IFIN=eth1 OUT= MACSRC=20:CT:30:46:01:a7 MACDST=04:D5:27:7C:50:1C M							
	ACPROT0=0800 SRC=192.108.254.2 D5T=192.108.254.1 LEN=44 TOS=0x00 PREC=0x00 TTL=45 ID=4900 PROT0=TCP SPT=63248 DPT=20828 SEQ=2910363933 ACK=0 WIN							
	DOW=1024 RES=0x00 SYN URCP=0 DPT (01010101) MARK=0x9							
2								
100								
1								
1								
-								
	Fig.3. The results obtained from the real-time hybrid firewall monitoring module							

	Q	Oct 6 AD:42:42 machazikida karnal: [2006 664163] Dravanting A A A A A Addressati-athi AUT- MACSDC-20.cf.20.46.01.27 MACSDT-h4.h5.2f.7c.5d.tr M
	100	ACPROTO_BARGN SPC-192, 168, 254, 2, DST=192, 168, 254, 1, PLN-52 TOSCHWOND PERCENSION PERCENSION FILE 128, PDRTO_TCP SPT=17123 DPT=9337 SFC-117104014 ACK=0
		WINDOW=8192 RES=6x66 SVN UBCP=6 OPT (01010101010101010101010101010101010101
1		Oct 6 09:42:42 peshoaikido kernel: [2896.757633] PREVENT DOS & SYN FLOOD ATTACIN=eth1 UUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M
		ACPROT0=0800 SRC=192.168.254.2 DST=192.168.254.1 DST=52 TOS=0x00 PREC=0x00 TTI=128 TD=16.46 DF PROT0=TCP SPT=17138 DPT=9352 SE0=2051848584 ACK=0
ſ		WINDOW-8192 RES-6x80 SVN URCP-0 OPT (010101010101010101010101) MARK-0x9
	>_	Oct 6 09:42:42 peshoaikido kernel: [2807.055361] PREVENT ALL ICMP TYPES ATTACKIN=0th1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f;7c:5d:1c M
l		ACPROT0=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=60 TOS=0x00 PREC=0x00 TTL=64 ID=16309 DF PROT0=ICMP TYPE=8 CODE=0 ID=1 SE0=316
1		Oct 6 09:42:43 peshoaikido kernel: [2897.631950] Preventino 8.8.874 addressein=ethi OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M
		ACPROTO=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=52 TOS=0x00 PREC=0x00 TTL=128 ID=16421 DF PROTO=TCP SPT=17305 DPT=9519 SE0=3161239222 ACK=0
	1	WINDOW-8192 RES=0x00 SYN URCP=0 OPT (0101010101010101010101010) MARK=0x9
		Oct 6 09:42:43 peshoaikido kernel: [2897.678815] Preventing 0.0.0.0/0 addresseIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M
		ACPROTO=0800 SRC=192.168.254.2 DST=192.168.254.1 EN=52 TOS=0x00 PREC=0x00 TT =128 ID=16429 DF PROTO=TCP SPT=17315 DPT=9529 SE0=296421144 ACK=0
		WINDOW=8192 RES=0x00 SYN URGP=0 OPT (010101010101010101010101) MARK=0x9
		Oct 6 09:42:43 peshoaikido kernel: [2897.741291] PREVENT DOS & SYN FLOOD ATTACIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M
		ACPROTO=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=52 TOS=0x00 PREC=0x00 TTL=128 ID=16440 DF PROTO=TCP SPT=17326 DPT=9540 SEQ=2731378658 ACK=0
	3	WINDOW=8192 RES=0x00 SYN URGP=0 OPT (010101010101010101010101010) MARK=0x9
	~	Oct 6 09:42:43 peshoaikido kernel: [2897.963276] PREVENTING LOCAL PACKETS: IN=lc OUT= MAC=00:00:00:00:00:00:00:00:00:00:00:00:00:
		0.1 DST=127.0.1.1 LEN=70 TOS=0x00 PREC=0x00 TTL=64 ID=17946 DF PROTO=UDP SPT=46007 DPT=53 LEN=50
		Oct 6 09:42:43 peshoaikido kernel: [2898.054158] PREVENT ALL ICMP TYPES ATTACKIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M
		ACPROTO=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=60 TOS=0x00 PREC=0x00 TTL=64 ID=16507 DF PROTO=ICMP TYPE=8 CODE=0 ID=1 SEQ=318
		Oct 6 09:42:44 peshoaikido kernel: [2898.554180] PREVENT ALL ICMP TYPES ATTACKIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M
		ACPROTO=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=60 TOS=0x00 PREC=0x00 TTL=64 ID=16699 DF PROTO=ICMP TYPE=8 CODE=0 ID=1 SEQ=319
	E C	0ct 6 09:42:44 peshoaikido kernel: [2898.631229] Preventing 0.0.0.0/0 addresseIN=eth1 OUT= MACSRC=20:cf:30:46:01:a7 MACDST=b4:b5:2f:7c:5d:1c M
1	-0-	ACPROTO=0800 SRC=192.168.254.2 DST=192.168.254.1 LEN=52 TOS=0x00 PREC=0x00 TTL=128 ID=16719 DF PROTO=TCP SPT=17513 DPT=9727 SEQ=3513305945 ACK=0
	Δ	WINDOW=8192 RES=0x00 SYN URGP=0 OPT (010101010101010101010101010) MARK=0x9
	8	
	m	
		Fig.4. The results obtained from the real-time hybrid firewall monitoring module

Fig.4. The results obtained from the real-time hybrid firewall monitoring module



kern	.log	[] 2	'3 L:[10994+16 11010/11136] *(1166709/1200419b) 0107 0x06B	[*][X]
kido	kernel:	[21311.838692]	pscan 2: SYN/FIN:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.	168.254.1 LEN=
kido	kernel:	[21311.864717]	SCANNING AGAINST XMAS TYPE:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.	2 DST=192.168.
kido	kernel:	[21311.941736]	NULL_SCAN:IN=eth1 OU = MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.168.254	.1 LEN=60 TOS=
kido	kernel:	[21311.967814]	pscan 2. sin/in.in=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.	168.254.1 LEN=
kido	kernel:	[21311.993801]	SCANNING AGAINST XMAS TYPE:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.	2 DST=192.168.
kido	kernel:	[21314.047626]	NULL_SCAN:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.168.254	.1 LEN=60 TOS=
kido	kernel:	[21314.073672]	pscan 2: SYN/FIN:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.	168.254.1 LEN=
kido	kernel:	[21314.174752]	SCANNING AGAINST XMAS TYPE:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.	2 DST=192.168.
kido	kernel:	[21314.252884]	NULL_SCAN:IN=eth1_OUT=_MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00_SRC=192.168.254.2_DST=192.168.254	.1 LEN=60 TOS=
kido	kernel:	[21314.278864]	pscan 2: SYN/FIN:IN=th1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.	168.254.1 LEN=
kido	kernel:	[21314.304887]	SCANNING AGAINST XMAS TYPE:IN=eth1 0UT= MAC=D4:D5:21:7C:5d:1C:20:Cf:30:46:01:a7:08:00 SRC=192.168.254.	2 DST=192.168.
kido	kernel:	[21314.383006]	NULL_SCAN:IN=eth1_0U1=_MAC=b4:D5:27:7C:S0:1C:20:Cf:30:46:01:a7:00:00 SRC=192:108.254.2 DS1=192:108.254	.1 LEN=60 TOS=
Kido	kernel:	[21314.409017]	pscan 2: SYN/FIR:IN=eth1001= MAL=D4105:27:76:30:16:20:e10:01:07:08:00 SRC=192.168.254.2 D51=192.	108.254.1 LEN=
Kido	kernet:		SLANNING AGAINSI XMAS IYPEINSETTI UUTE MALED4:DS:ZT://CSGI1C/20:CT:30:40:01:a/:08:00 SRC=192.108.254.	2 051=192.168.
Kido	kernet:		NULL_SCAN:IN=eth1_UUI=_MAL=04:DS:ZT:ZC:SO:IC:Z0:CT:30:40:01:37:00:00_SKE=192.108.204.2_USI=192.108.204	.1 LEN=00 105=
kido	kernet:	[21317.981105]	DSCAN 2: SYN/FIN:IN=EUNI UUI= MAC=04:DS:21:7C:S0;IC:20;CT:S0;40:01:37:08:00 SHC=192.108:254.2 USI=192.	108.204.1 LEN=
	kernet:	[21310.082244]	SCANWING AGAINSE AMAS EFFECTEREDUTEOUTE MACED4:D5:21:70:30:10:20:01:30:40:01:37:00:00 SKC=192.100.234.	2 UST=192.108.
kido	kernel.	[21318,100327]	NOL_3CHM.IN-EURI 001- NA_04.03.01.07.3011.20110.20130.01001.01.00100 3K-0120.100.242.031-120.100.234	169 254 1 LEN-
kido	kernel.	21318,180342	SCANNING ACAINST YMAS TYPE IN-ALL ALL ALL ALL ALL ALL ALL ALL ALL ALL	2 DST-192 168
kido	kernel:	[21318, 288471		1 LEN-60 TOS-
kido	kernel:	[21318.314507]	NCL_JCHITTELTI 001- NCC010101-000000000000000000000000000000	168.254.1 LEN-
kido	kernel:	[21318.340482]	SCANNING AGAINST XMAS TYPE:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.	2 DST=192.168.
kido	kernel:	[21318.418547]	NULL SCAN:IN=eth1 QUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.168.254	.1 LEN=60 TOS=
kido	kernel:	[21318.444583]	pscan 2: SYN/FIN:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.	168.254.1 LEN=
kido	kernel:	[21318.470627]	SCANNING AGAINST XMAS TYPE:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.	2 DST=192.168.
kido	kernel:	[21320.394292]	NULL SCAN:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.168.254	.1 LEN=60 TOS=
kido	kernel:	[21320.420350]	pscan 2: SYN/FIN:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.	168.254.1 LEN=
kido	kernel:	[21320.521403]	SCANNING AGAINST XMAS TYPE:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.	2 DST=192.168.
kido	kernel:	[21320.598486]	NULL_SCAN:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.168.254	.1 LEN=60 TOS=
kido	kernel:	[21320.624601]	pscan 2: SYN/FIN:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.2 DST=192.	168.254.1 LEN=
kido	kernel:	[21320.650552]	SCANNING AGAINST XMAS TYPE:IN=eth1 OUT= MAC=b4:b5:2f:7c:5d:1c:20:cf:30:46:01:a7:08:00 SRC=192.168.254.	2 DST=192.168.

Fig.6. The results obtained from the real-time hybrid firewall monitoring module

ATTENTION: All the experiments and research in this paper are made in a specialized computer laboratory at the Faculty of Technical Sciences at Konstantin Preslavsky University of Shumen, consisting of several hosts and a home-based local computer network consisting of five hosts. Everything illustrated and explained in this paper is for research purposes and the authors are not responsible in cases of abuse.

5. Conclusion

As a result of the research it is concluded that an algorithm has been developed for blocking different types of port scanning cyber attacks for the input chain, which is practically realized with a

modified script in a Linux based operating system. The developed hybrid firewall can be used to train students from the Faculty of Technical Sciences in the subjects "Data transmission and computer communications", "Computer networks" and "Network administration", "Cybersecurity", "Technical means in the security sector", "Computer and network security", "Countering cyber attacks against information systems handling classified information and personal data", "Detection and Intrusion Prevention Systems", "Cybersecurity of information resources in the organization" and etc. The future scientific work will be related to the synthesis of an algorithm for detecting anomalies when transmitting network packets to local and global computer networks

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