Macroscopic Network Virus Statistics

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Abstract: Network viruses have become the primary security threats, so monitoring and macro statistics are important means to protect the Internet. Since network virus incidents are distributed incidents based on a large and complex system, so the macro description of network viruses is becoming a research topic. This paper introduces a comprehensive statistical analysis system of virus sample statistics, virus distribution statistics, virus network measurement, etc.
Keywords: network virus; macro statistics; network assessment; infected node

1. Foreword

Network virus outbreak is a serious and frequent network security incident which is basically in line with Moore's theorem, i.e. the number of viruses doubles every 18 months. Meanwhile, the network security incident is also in line with Metcalfe's theorem, i.e. the efficiency of the network is inversely proportional to the square of the number of users. It can be seen security incidents are inevitable for the internet because it is open and complex. As a result, virus monitoring and macro-statistics are essential for mastering the virus development trend and protecting the Internet.

The difficulty of network virus statistics lies in the massive and discrete incidents.

2. The Purpose of Macro Statistics

2.1 Observe the Virus Infection Trend

Through the macro statistics of network viruses, we can learn of the virus transmission situation in every region, and then develop virus defense solutions.

2.2 Control the Virus Transmission Situation

After we master the global virus trend, we can figure out the solution. For example, Worm.Win32.Blast infected plenty of systems and took up most of the bandwidth of the network. In this manner of situation, we can drop antivirus tools in specific locations to prevent it from spreading.

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2.3 Estimate the Virus Transmission Trend

We take an area subnet as the data set, virus attack times or types as the Y axis, and the time as the X axis. Then we can draw a curve graph of a virus. If we change a variant, we can get a corresponding statistical graph. We can then analyze the graph, and learn something about the virus transmission trend. Eventually, we can scientifically estimate the virus trend in the future,

3. Sample/Database Audit

As to analysis of the virus transmission trend, sample/database auditing is the most traditional and basic method.

As for the statistics for network viruses, a two-dimensional analysis is needed. One development dimension is the depth, i.e. the generation of new viruses. The other development dimension is the breadth, i.e. the transmission scope of a virus during its life cycle. The sample/database audit is a statistical method on the virus development depth. Generally anti-virus companies will determine the types of new viruses according to a sample and signature audit. Viruses come from infected users' reports and sample exchanges with partner companies.

We audit the statistics of reported virus numbers, names of new viruses, etc. The number statistics can help us with the virus infection situation, while the name statistics can help us with the virus generation and database situation.

For example, in 2004, Antiy Labs used this method to learn of the virus situation. We added 20,047 new independent viruses (including variants) to the database. The virus types are as follows:

Table 1 Virus Distribution

PE Virus	478
UNIX/Linux Virus	33
Worm	2239
Script	81
Trojan Horse	8969
Backdoor Tools	4010
Hacker Tools	1241
Virus Compiling Tools	279
Adware/Porn Plug-in Virus	668
Others	2049

The pie chart of new virus types in 2004 is as follows.

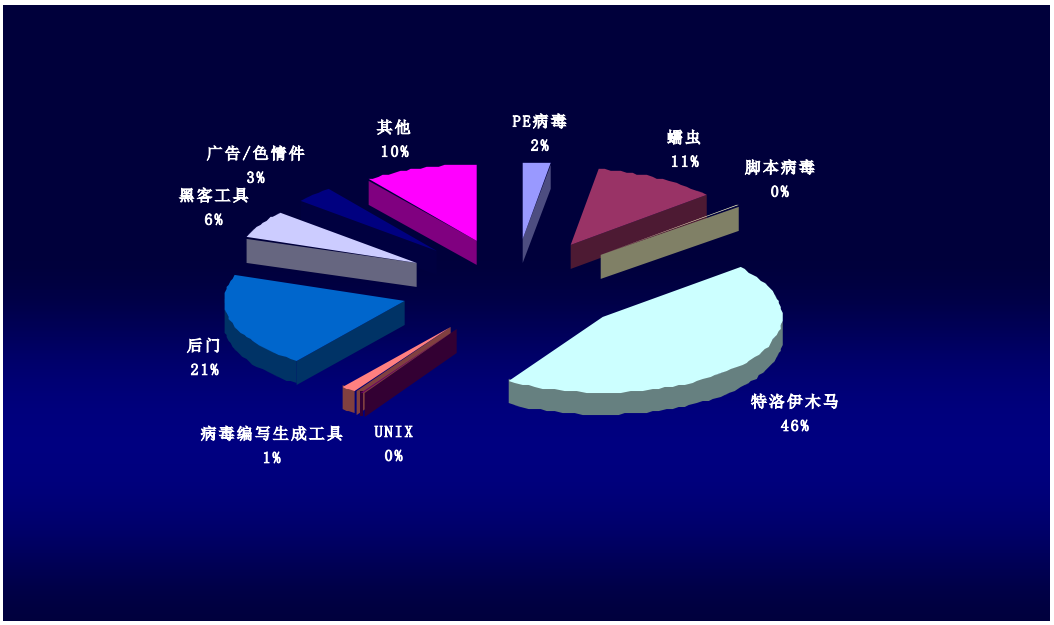

Figure 1 Virus Types in 2004

It can be seen that among all new viruses in 2004, Trojans, backdoor tools, and hacker tools account for 77%; worms account for 11%; and adware / porn plug-in viruses take up 3%. After analysis of this data, we can learn the generational trends of the new viruses.

4. A Contrast to Sample Auditing

Antivirus vendors usually make their TOP 10 worm/virus list according to the report times over some unit of time. From a macro perspective, the report times are proportional to the number of infected nodes. In 2004, Antiy used the contrast assessment method and got the TOP 10 list of scanning worms.

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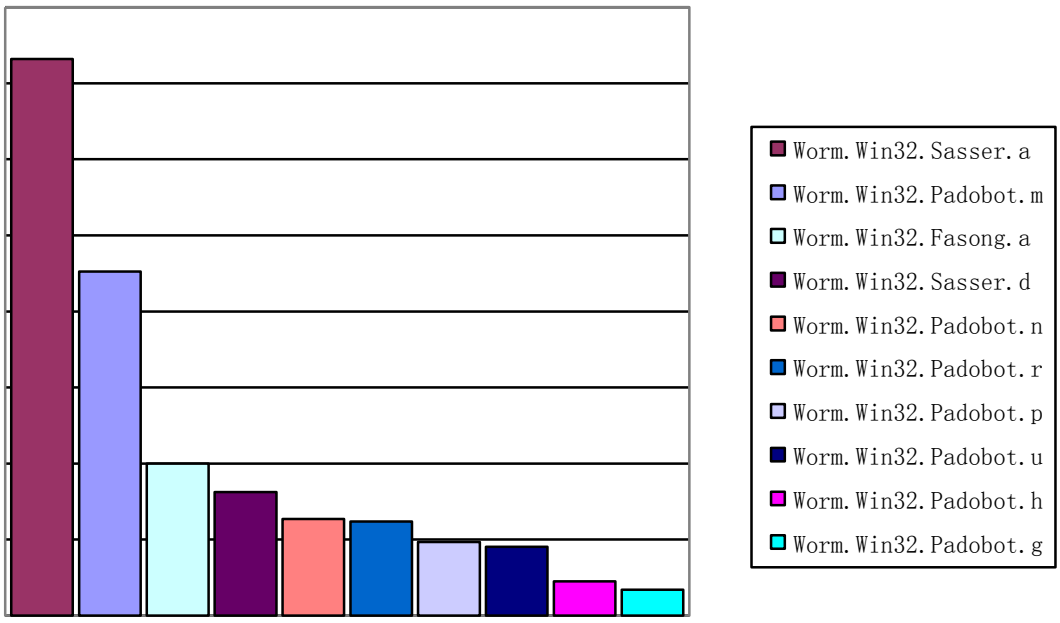

Figure 2 TOP 10 List of Scanning Worms in 2004（Antiy Labs）

We can merge some viruses according to their families. For example, Antiy got the TOP 10 list of BOTs in 2004.

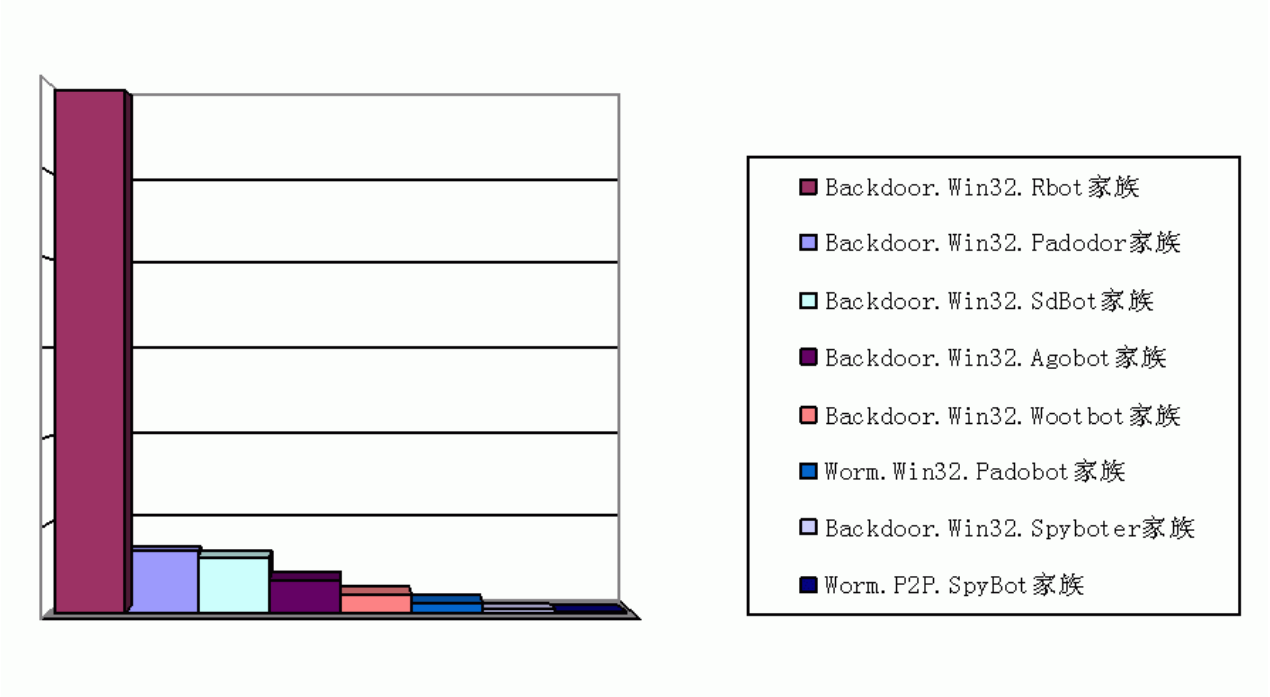

Figure 3 TOP 10 List of BOT Family in 2004（Antiy Labs）

5. Network Worm Detection and Pressure Assessment

5.1 The Current Situation

Traditional network virus monitoring is generally on the local nodes or routing nodes, and researchers can't evaluate the virus pressure on the network node devices or the entire network. To solve this, we designed a backbone network virus detection system (VDS) which can listen to network traffic, precisely detect viruses, locate the infection sources and monitor virus behavior. Using this system, we can find a method to compute virus pressure on network outlets, gateways, switches, turnover nodes and end nodes.

5.2 Virus Detection System（VDS）

VDS can listen to traffic in high-speed networks. The following figure shows its structure.

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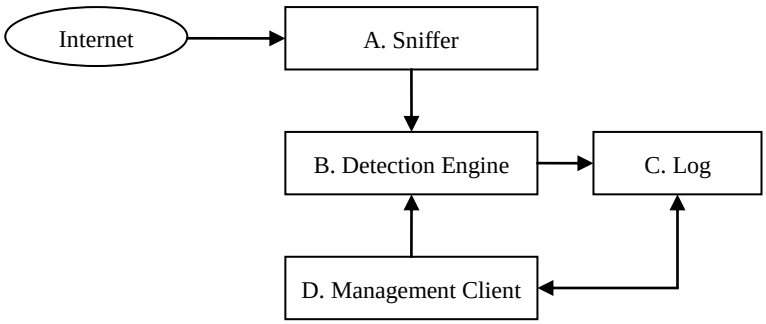


Figure 4 Structure of Virus Pressure Measurement System

The original data we get will be processed as follows.

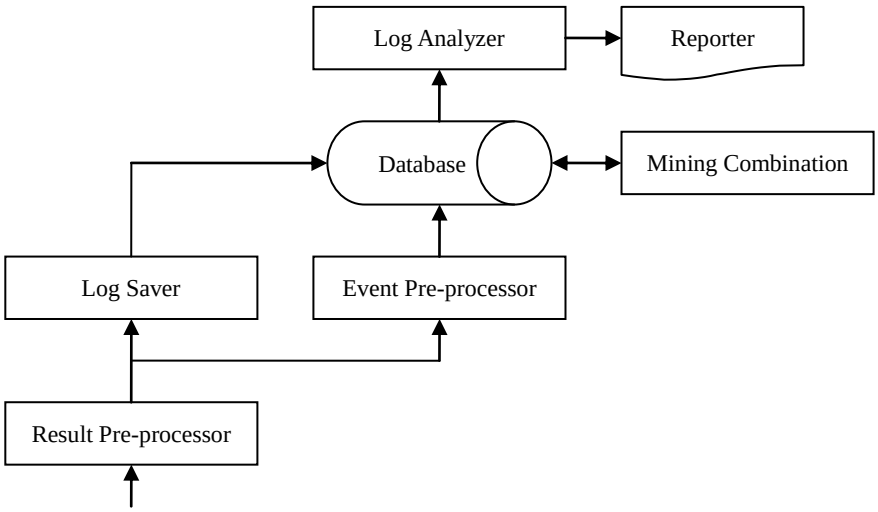


Figure 5 Data Processing

5.3 Original Data and Statistics

VDS can detect active worms, their behavior, attack times, traffic, etc. It can also get part of the statistical results.

5.4 The List of Active Worms

We can get a list of active worms using VDS which can further rank them according to their transmission times during a unit of time.

2003-7-7病毒扫描日志

统计数据：	
扫描数据流总数：	0
发现病毒体总数：	242573
发现已知病毒总数：	242573
发现未知病毒总数：	0

发现病毒体传输次数排行榜：

名次	病毒名	发现次数
1	I-worm.Klez.h	171267
2	I-Worm.Runouce.b	39661
3	I-Worm.Lentin.i	941
4	I-Worm.Lentin.m	167
5	I-Worm.Sobig.a	67
6	I-Worm.LovGate.f	54
7	I-Worm.Sobig.b	12
8	I-Worm.Sobig.c	2
9	I-Worm.Sobig	1
10	I-Worm.Tanatos.dam	1

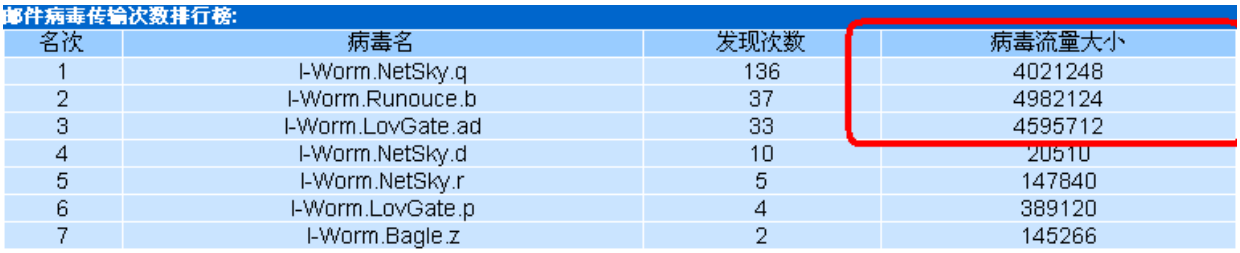
发现病毒体传输次数统计图：

Figure 6 TOP 10 Active Worms

（Screenshot of VDS 1 .0 WEB list; source: test nodes of HIT）

5.5 Virus Traffic Rank

We can also record the virus traffic to assess the virus pressure. This can be helpful for network administrators.



邮件病毒传输次数排行榜:

名次	病毒名	发现次数	病毒流量大小
1	I-Worm.NetSky.q	136	4021248
2	I-Worm.Runouce.b	37	4982124
3	I-Worm.LovGate.ad	33	4595712
4	I-Worm.NetSky.d	10	20510
5	I-Worm.NetSky.r	5	147840
6	I-Worm.LovGate.p	4	389120
7	I-Worm.Bagle.z	2	145266

Figure 7: Ranked list of Email Worm Transmission Times

（Screenshot of VDS 2.0 WEB report; source: test nodes of HIT; June 12, 2004）

5.6 Virus Stage Trend Statistics

The system can find the curve of virus trend statistics and can estimate the future virus transmission situation.

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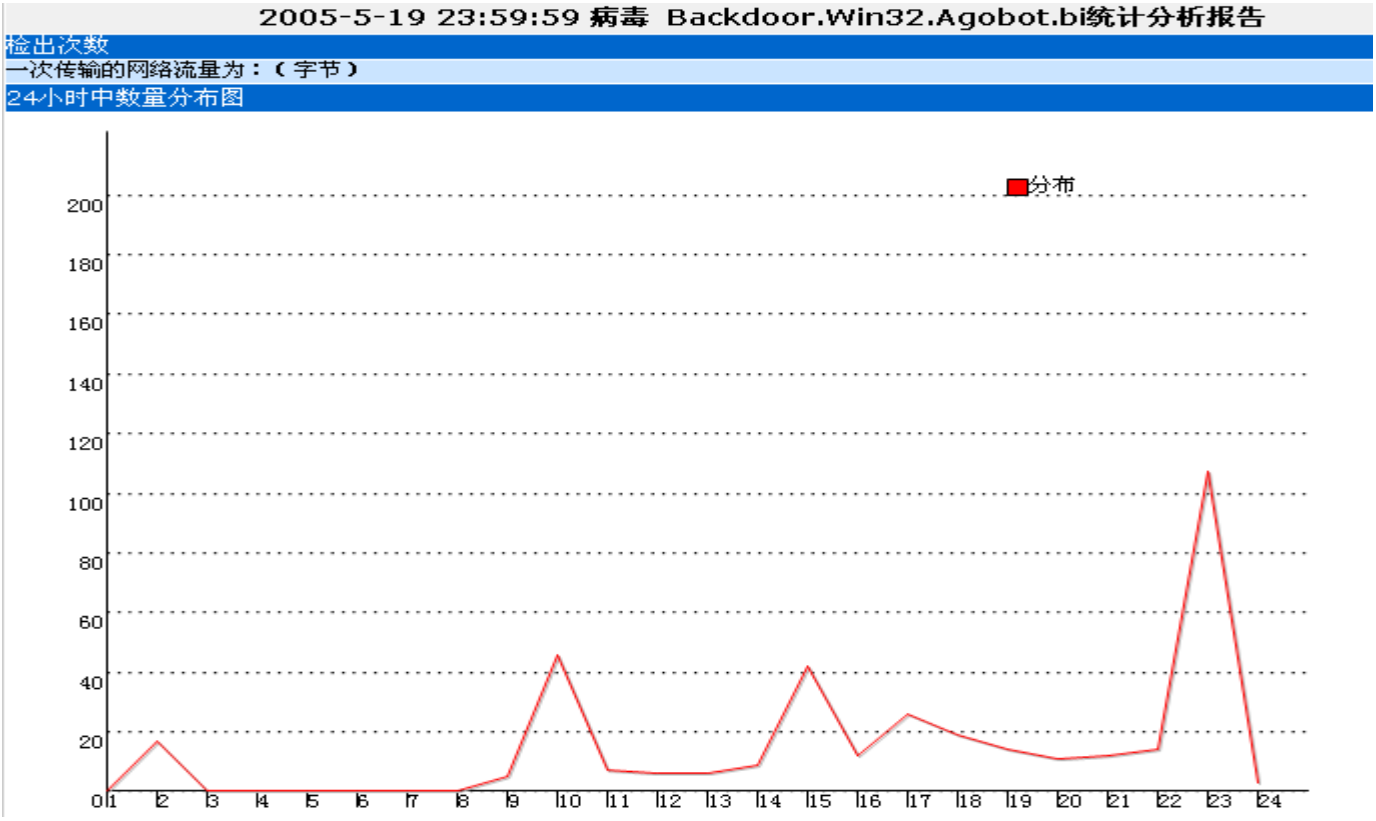

Figure 8: Virus Development Over Time

（Screenshot of VDS 2.0 WEB; source: test nodes of edu.cn; August 2004）

5.7 Network Virus Pressure Calculation

(1) **Parameter Description：**

K： Virus traffic per time unit (based on data in this paper)

Λ： Total virus package amount per time unit (based on data in this paper)

L： Average size of virus packages (based on data in this paper)

Θ： Effective nodes within the network (based on data in this paper)

Φ： Absolute flow to pressure ratio, i.e. the ratio of worm bandwidth to the total bandwidth

Ψ： Absolute amount to pressure ratio, i.e. the ratio of worm packet amount to upper limit of devices

Σ vm：Total number of virus emails per time unit (based on data in this paper)

Σ m：Total number of emails sent and received per time unit (based on data in this paper)

E： Environmental flow coefficient, experience coefficient; look up in the table

μ： Environmental Amount Coefficient, μ=1-ε

μ n：Device Amount Coefficient, μn=1-εn

δ： Device processing coefficient, experience coefficient; look up in the table

α： Broadcast coefficient, broadcast index used in measure scanning worms

γ： Response coefficient, used to measure the two-way flows of scanning worms

(2) Definition of Pressure Unit and Pressure Computation

Net-pa: Relative index used to assess network worm pressure on the network outlet

Net-pamax=1: The network outlet is totally occupied by worm pressure

Net-pamin=0: The network outlet is not subject to any pressure

Since the outlet devices are quite different in their capabilities, we use ε =0.5 for comprehensive computation.

In order to measure the pressure, we used the maximum Ethernet packet size of 1500 bytes as the analog worm packet. Without any background noise, we drop the worm packet on the outlet device. This way, the pressure on the outlet device is mainly traffic pressure, and the packet processing pressure can be ignored. As a result, the ratio can be considered as traffic-to-pressure ratio. We got the pressure curve Figure 9.

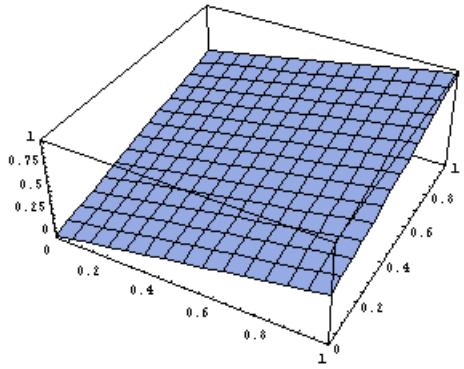

Figure 9 Traffic-to-Pressure Ratios

After that, we used a packet of 22 bytes as the analog worm packet. Without any background noise, we drop the worm packet on the outlet device. So, the pressure on the outlet device is mainly packet processing pressure, and the traffic pressure can be ignored. As a result, the ratio can be considered as amount-to- pressure ratio. We got the pressure curve in Figure 10.

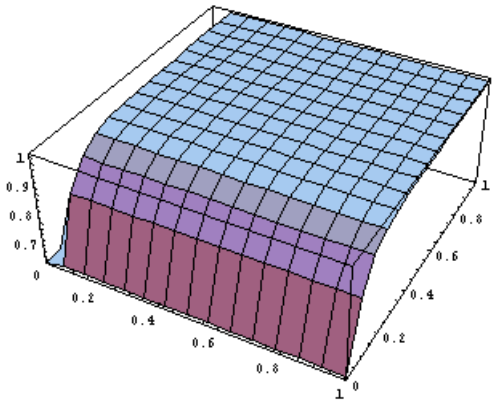

Figure 10 Amount-to-Pressure Ratios

Then, we got the experience surface individually, superposed them, and got the following figure.

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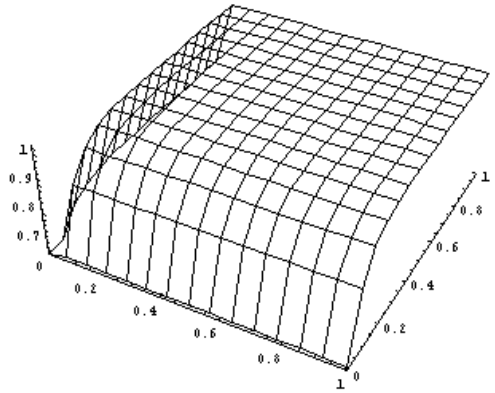

Figure 11 Superposition of Traffic-to-Pressure Ratios and Amount-to-Pressure Ratios

We carried out several algorithm analog, and then got the following experience module.

$$\text{Net-pa}=0.3-0.35e^{-13\gamma}+0.23\Phi^{\frac{1}{3200\pi}}-1.2*10^{-3}\varepsilon$$

Net-pa is the pressure unit. When it approaches 1, the network outlet is unavailable. In summary, measuring network worms is measuring a group of complicated network behaviors. We got the original data via a detection device that is based on bypassing traffic listening, and then we summarized the pressure computation formula and assessment methods of different nodes.

6. Geography Statistics (Virus Map)

The virus map tells us the virus distribution geography. With this map we can learn of the virus outbreak in different regions. This method is of great significance to mastering the virus situation from a macro perspective. A traditional virus map is based on reported IPs and emails, and IPs of online virus clearing users.

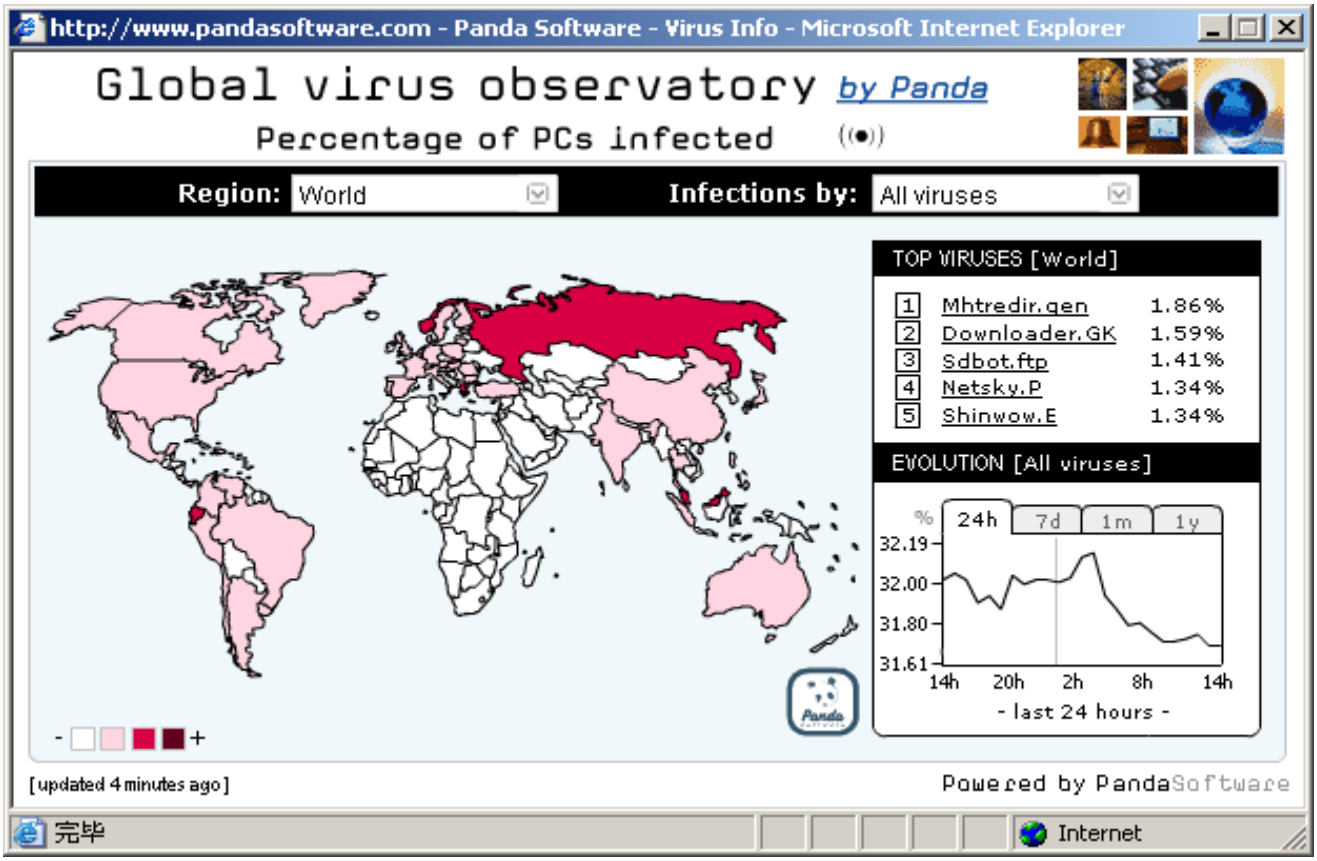

Figure 12 A Typical Virus Map

（Source:pandasoftware.com）

We could also use this method to get the virus distribution situation, but the result is of low granularity.

VDS can directly locate the source nodes of viruses.

当前位置：信息查询 → 按病毒名称

病毒名称（英）：netsky 查询

病毒名称	数量	源IP	目的IP	开始时间	结束时间
I-Worm.NetSky.r	1	210.46.70.153	61.136.62.73	2005-02-28 08:26:46	2005-02-28 08:27:00
I-Worm.NetSky.q	3	202.118.238.206	202.84.17.167	2005-02-28 08:25:53	2005-02-28 08:26:40
I-Worm.NetSky.r	1	218.104.83.140	202.118.224.153	2005-02-28 08:25:45	2005-02-28 08:26:00
I-Worm.NetSky.q	1	202.118.251.116	61.181.84.15	2005-02-28 08:25:24	2005-02-28 08:25:40
I-Worm.NetSky.r	1	218.58.71.174	202.118.224.153	2005-02-28 08:25:10	2005-02-28 08:25:20
I-Worm.NetSky.q	1	218.9.78.206	202.118.224.153	2005-02-28 08:24:54	2005-02-28 08:25:00
I-Worm.NetSky.q	1	211.93.37.15	202.118.224.153	2005-02-28 08:24:30	2005-02-28 08:24:40

Figure 13 Virus Source Nodes Location

（Screenshot of VDS 2.0 WEB report; source: test nodes of HIT, August 28, 2004）

When integrating it with the virus map, we can get more accurate virus regions.

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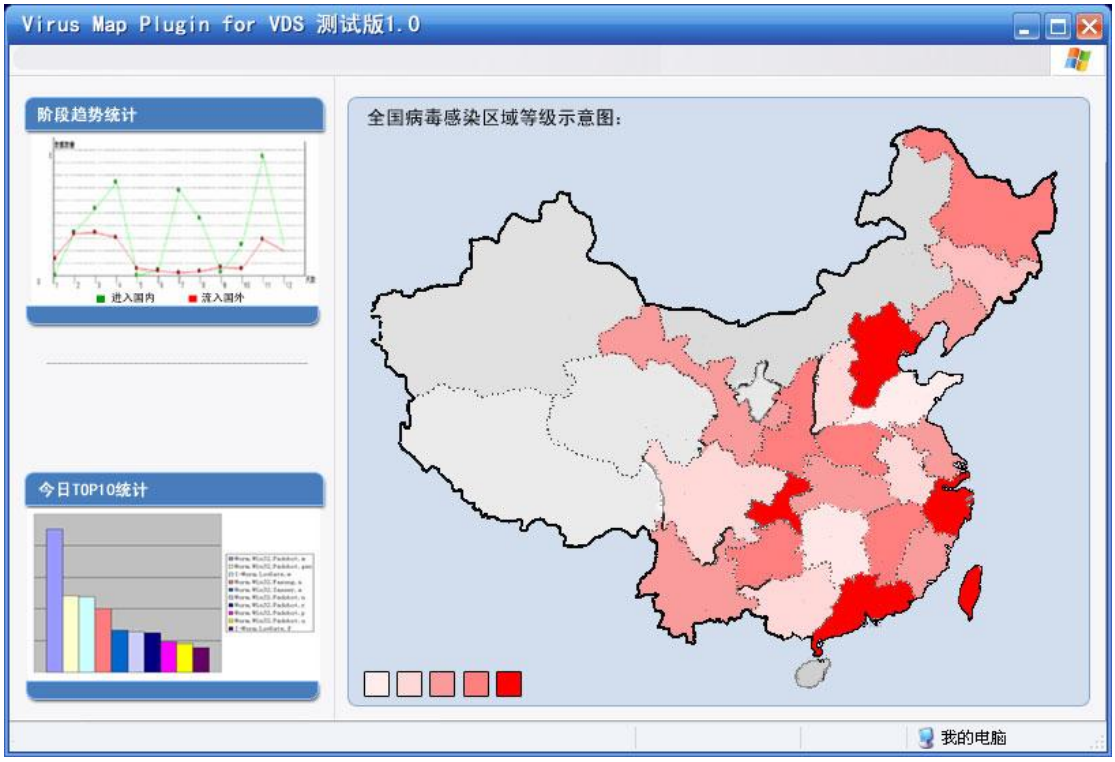

Figure 14 Virus Map

（Screenshot of VDS 2.0 Virus Map plug-in; source: test nodes of HIT）

7. Statistics on Infection Rate and Number

The statistics of infection rates and total infected nodes are the most difficult. The purpose of such statistics is learning of a virus infection within a period and then estimating virus development in the future.

At present, there are four statistical methods: sampling, user reporting, VDS monitoring, and probe scanning.

The sampling method is to sample a certain user group to get a result, and then use the statistical formula to apply the result to all the users. It is difficult and subject to a large margin of error.

User reporting is to analyze the reported viruses, and then record the regions of reporting users, and then get the infection amount. It can't get an accurate relationship between the reported infection amount and the actual infection amount.

VDS monitoring is using VDS to monitor the network and record the virus data. Due to the differences between proxy and email servers, some errors are inevitable, especially for the intranet users (features of some scanning worms are the same).

The probe scanning method is using a high-speed network segment scanner to scan and prove the existence of vulnerabilities on known ports. It can only be used for specific vulnerabilities, not specific viruses.

8. Calculation of Infection Nodes

This method is integrating the statistical reports of scanning tools and experience data, and then getting the results.

For example, we can compare the email worm transmission time's rank and the user report time's rank, and then reach the following conclusion.

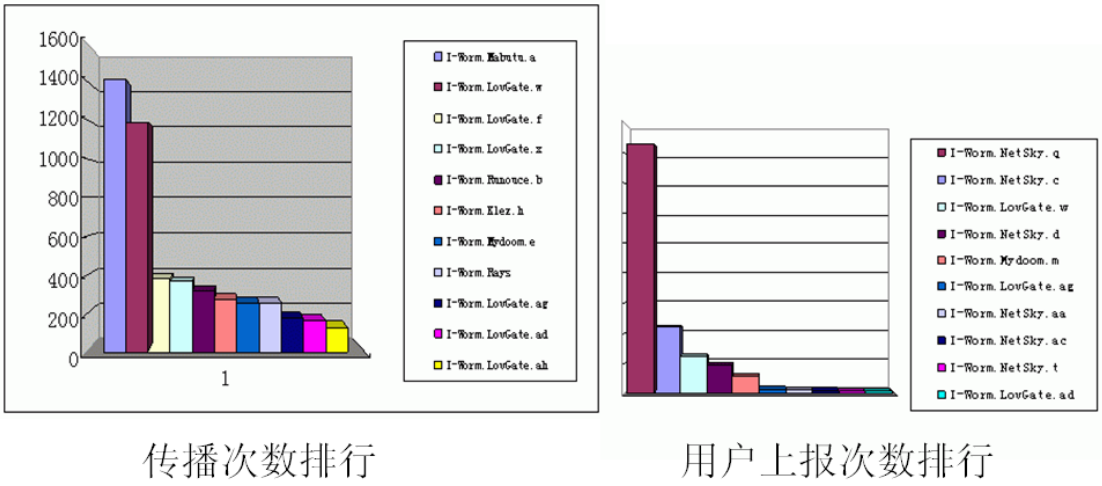

Figure 15Virus Transmission Time's Rank and User Report Time's Rank

Conclusion:

Transmission times reflect the network pressure and the worm's email sending ability. Users' reports reflect the infected nodes. It can be seen that there is not necessarily any correlation between email-sending ability and the number of the infected nodes.

Trusted link based transmission can result in more serious infections.

Some infected nodes are never repaired. Maybe they are control-free nodes on the Internet.

9. Conclusion

The methods described in this paper are used for virus statistics. We use them to get the results and figures in this paper.

References

[1] Deng Hui ， Research of Internet Worm， Doctorial Paper， Nan kai University， 2000

[2] Wu Bing, Yun Xiaochun, Xiao Xinguang， Backbone Network Worm Pressure Measurement System Based on Bypass Monitor， AVER 2004

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