



Universitatea
Politehnica
București



Facultatea de
Automatică și
Calculatoare



Catedra de
Calculatoare

Malsharp: Malicious Application Analysis

Bachelor Thesis, July 2013

Autor

Cristian Condurache

Conducător științific

As.dr.ing. Laura Gheorghe



- ▶ Why?
 - Popularity of Linux based OSs
 - Use in embedded systems



- ▶ Why?
 - Popularity of Linux based OSs
 - Use in embedded systems
- ▶ How?
 - Malsharp: malicious behavior pattern mining



- ▶ Signature-based
 - Problem: fails to detect new malware, obfuscation
- ▶ Behavior-based
 - Problem: behavior patterns require manual identification



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- ▶ Input: a malware sample and a set of benign programs
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- ▶ Creates graphs for sample malware and benign programs
 - A node represents a system call
 - An edge is an argument dependency
- ▶ Computes malware specifications as “difference” between graphs
 - Maximal common subgraph algorithm
 - Complement graph
 - Minimal transversal



► Initial nodes

$\text{open}(X_1, X_2) = \mathbf{A}$

$X_1 = \text{"bin/lis"}, X_2 = \text{O_RDWR}, \mathbf{A} = 3$

$\text{read}(\mathbf{Y}_1, Y_2, Y_3) = \mathbf{B}$

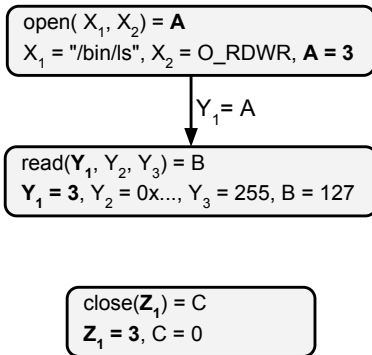
$\mathbf{Y}_1 = 3, Y_2 = 0x\dots, Y_3 = 255, \mathbf{B} = 127$

$\text{close}(\mathbf{Z}_1) = \mathbf{C}$

$\mathbf{Z}_1 = 3, \mathbf{C} = 0$

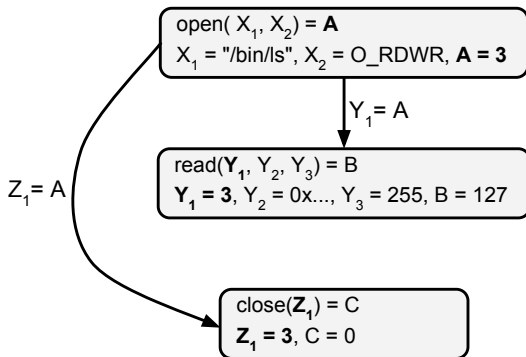


- Adding a dependency edge between open and read



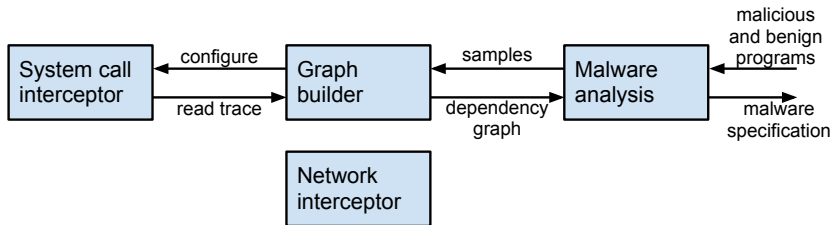


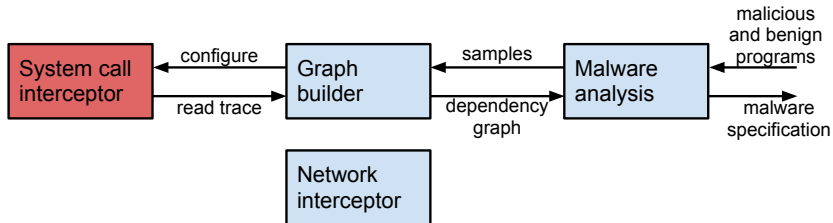
- Adding a dependency edge between open and close



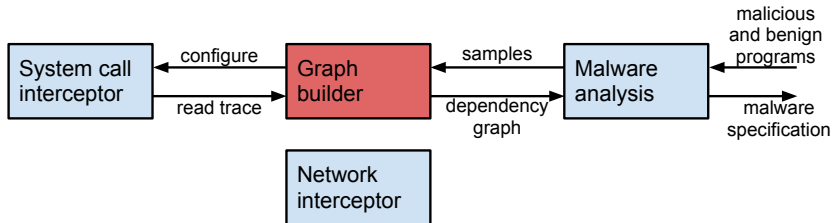


Malsharp Architecture



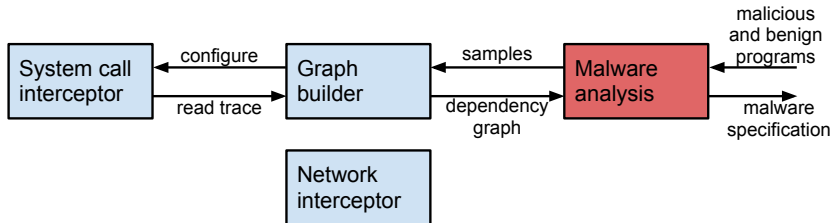


- ▶ System Call Interceptor Driver (SCID)
 - Logs execution trace for a process
 - Kernel module, registers by using miscdevice
 - Controlled via the ioctl system call



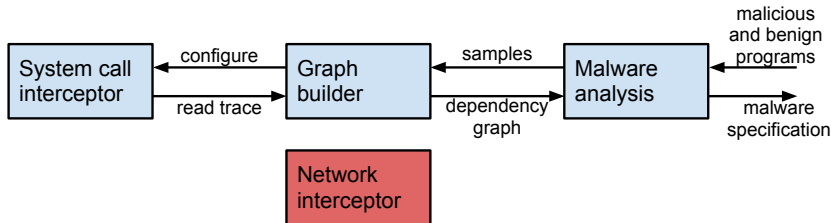
► Graph Builder

- Runs each program
- Reads execution traces from SCID
- Finds argument dependencies
- Node aggregation: a read of 1000 bytes is equivalent to 1000 individual reads of 1 byte



► Malware Analysis

- Uses the graph builder for each program
- Applies the malspec mining algorithm



- Network Interceptor (NI)
 - Used for monitoring malware networking activity
 - Netfilter hooks to monitor traffic
 - Can be configured to monitor specific protocols



- ▶ Virtual machine, snapshots
- ▶ Bridged network access
- ▶ Revert to snapshot before each test



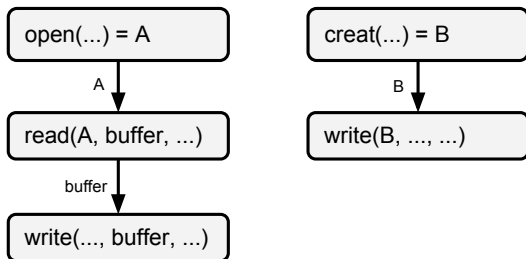
- ▶ Virtual machine, snapshots
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- ▶ Monitored two sets of system calls



- ▶ Virtual machine, snapshots
- ▶ Bridged network access
- ▶ Revert to snapshot before each test
- ▶ Monitored two sets of system calls
- ▶ A set of 20 well-known malware samples
 - Viruses: Virus.Linux.Rike.1627, Virus.Linux.Osf.8759
 - Backdoors: Backdoor.Linux.CGI, Backdoor.Linux.Phobi.1



- ▶ Execution traces, graphs successfully built
- ▶ Malware patterns identified, 3-5 nodes
- ▶ Results for Virus.Linux.Radix

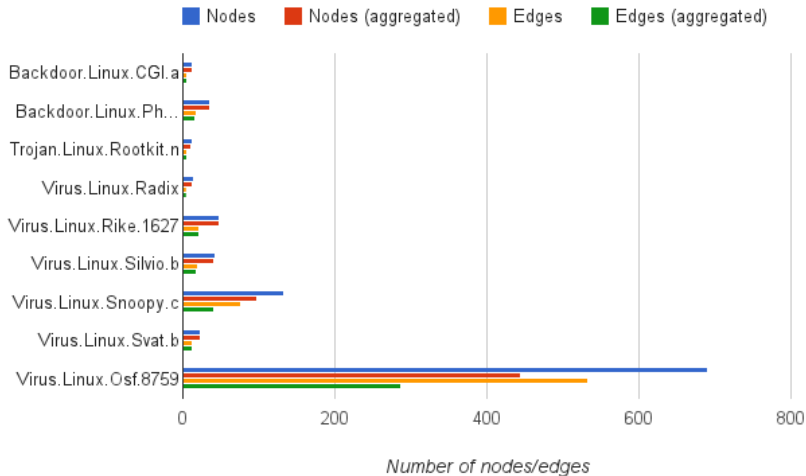


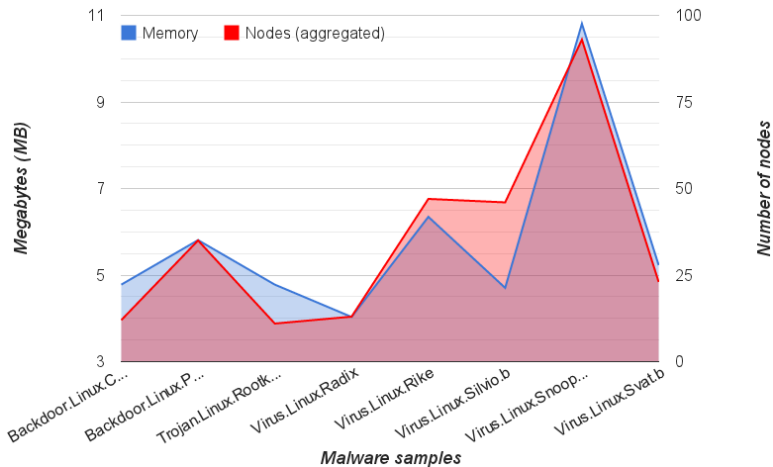


Sample	Nodes	Edges	Malspec	Time	Observed behavior
Backdoor.Linux.CGI.a	13	5	1	0.827s	open, read, close
Backdoor.Linux.Phobi.1	35	16	1	0.641s	open, read, close
Trojan.Linux.Rootkit.n	14	5	1	1.044s	open, read, close
Virus.Linux.Radix	22	6	1	0.673s	open, read, write; creat, write
Virus.Linux.Svat.b	25	12	0	3.495s	replaces stdio.h



Node aggregation results







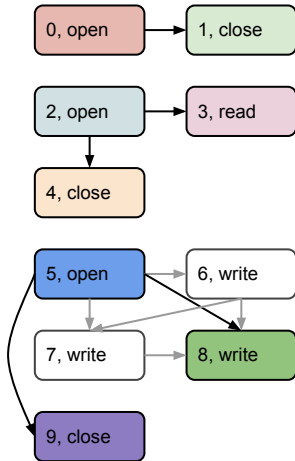
- ▶ Proof of concept for a Linux malware behavior miner
- ▶ Analysis detected malicious patterns
- ▶ Node aggregation successfully reduced total number of nodes
- ▶ Possible future improvements:
 - Additional pruning: node ordering strategies
 - Adding other types of dependency edges



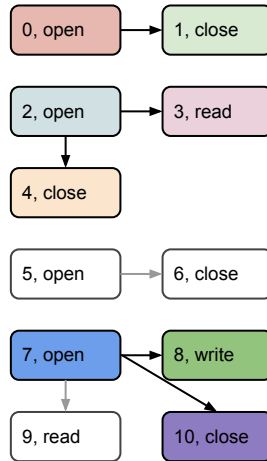
	program_test	diff_test
1	open(...) = fd1	open(...) = fd1
2	close(fd1)	close(fd1)
3	open(...) = fd2	open(...) = fd2
4	read(fd2, ...)	read(fd2, ...)
5	close(fd2)	close(fd2)
6	open(...) = fd3	open(...) = fd3
7	write(fd3, ...)	close(fd3)
8	write(fd3, ...)	open(...) = fd4
9	write(fd3, ...)	write(fd4, ...)
10	close(fd3)	read(fd4, ...)
11	-	close(fd4)



Maximal common edge set



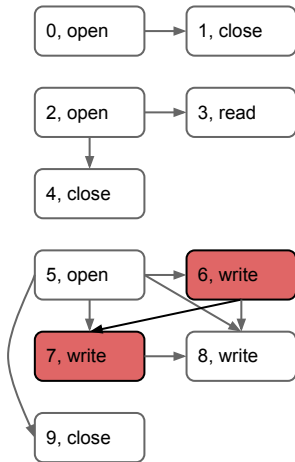
(a)



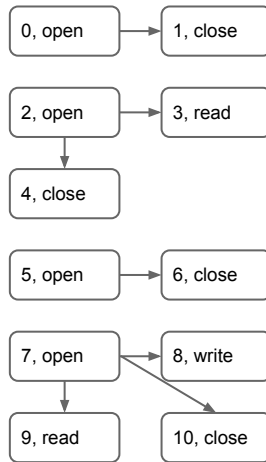
(b)



Complement and minimal transversal



(a)



(b)