

USBcat – Towards an Intrusion Surveillance Toolset

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This paper identifies an intrusion surveillance framework which provides an analyst with the ability to investigate and monitor cyber-attacks in a covert manner. Where cyber-attacks are perpetrated for the purposes of espionage the ability to understand an adversary's techniques and objectives are an important element in network and computer security. With the appropriate toolset, security investigators would be permitted to perform both live and stealthy counter-intelligence operations by observing the behaviour and communications of the intruder. Subsequently a more complete picture of the attacker's identity, objectives, capabilities, and infiltration could be formulated than is possible with present technologies.

This research focused on developing an extensible framework to permit the covert investigation of malware. Additionally, a Universal Serial Bus (USB) Mass Storage Device (MSD) based covert channel was designed to enable remote command and control of the framework. The work was validated through the design, implementation and testing of a toolset.

Keywords. Computer Security, Counter-Intelligence Surveillance Framework, USB MSD Covert Channel, Malware Analysis.

1 Introduction

Computer network defence is enhanced where there is an understanding and appreciation of an adversary's strategies and objectives. This is especially important when the network has been targeted by a sophisticated, persistent attacker. A challenge faced by network defenders is the ability to conduct an investigation of a compromised machine without alerting the cyber-intruder of the defender's activities. While tools such as honeypots exist to permit in-depth analysis of malware they do not necessarily provide for live analysis and interaction with the malware. The intent of our framework is to provide an extensible platform which enables covert and dynamic investigation of malware in real-time, in order to identify the attacker. A stealthy investigative capability is of particular importance when attempting to gain intelligence on well funded and highly skilled adversaries such as foreign intelligence agencies and criminal elements seeking unauthorized access to private and classified networks. Once an intruder has breached the perimeter security, subsequent actions they may take include further infiltration into the

network as well as the establishment of covert channels to exfiltrate information from the organisation. Information Technology (IT) security responses commonly seek to quickly isolate the threat from the network and perform an off-line investigation. While adequate for generic malware, this method of investigation will likely alert a more advanced attacker, permitting them the opportunity to conceal both the origin and depth of the attack. Equipped with an appropriate toolset, security investigators would then be able to perform live counter-intelligence operations by observing the behaviour, actions, and communications of the intruder. These counter-intelligence operations then provide a more complete picture of the attacker's intentions, capabilities, depth of infiltration, as well as their potential identity [1].

1.1 Motivating Scenario

To identify the capabilities required by an analyst in an investigation we considered a scenario in which an analyst is investigating a compromised machine where espionage activities are suspected. In order to conduct such an investigation the analyst will require the ability to watch the intruder in action. Any use of local Input/Output (IO) devices, such as keyboard, mouse, and monitor are considered off limits in our solution given that their use would be highly visible to the intruder. This implies that the analyst needs the ability to stealthily effect and observe actions taking place on the compromised host from a remote machine. These constraints were used to guide the course of our research.

1.2 Aim

This paper will proceed as follows. Section 2 provides background research that guided the development of our framework. Section 3 discusses the design of our framework and covert channel. Section 4 presents the validation of our toolset. Section 5 presents concluding remarks. Future work is addressed in Section 6.

2 Background Research

In the introduction we presented the motivation for the development of a toolset capable of discretely monitoring the actions of an intruder. In order to be stealthy our toolset must be able to execute on the compromised machine in a manner which is difficult for even a sophisticated attacker to detect. In order to advance towards these objectives we will require deeper insight into three areas of research, these include:

- Hiding the toolset on the compromised machine,
- Identification of the tools and capabilities the analyst will require, and
- Interacting with the toolset in a covert manner.

To conceal the presence of our toolset on the compromised machine, rootkit technologies were explored in order to identify techniques and capabilities that would offer our toolset stealth on the compromised host. Additionally, an operational scenario was explored for the purposes of identifying tools and capabilities pertinent to carrying out an investigation of a compromised machine. Also, the analyst must be able to interact with the toolset in order to carry out his investigation. Our research identified that a Mass Storage Device (MSD) based covert channel would serve our purposes well. We will therefore elaborate on MSD protocol attributes which supported this design decision.

2.1 Hiding The Toolset

Rootkits provide the capability of concealing the truth about what is actually taking place within the operating system and were therefore considered for the purposes of hiding our toolset on the compromised machine. The intent was to identify a rootkit which adequately addressed the three criteria: stealth, the semantic gap, and data exfiltration. Ultimately a novel Kernel Mode (KM) based rootkit known as Dark Knight [2] was identified as good platform through which to launch and conceal the presence of our toolset. Dark Knight is a developmental rootkit which has been designed for the purposes of IT security research. This rootkit leverages Asynchronous Procedure Calls (APC) within the Microsoft Windows Operating System (OS) as a means to provide stealth and conceal the presence of executable code [2].

Of particular interest is the ability for APCs to inject code into processes across the entire OS, providing access to variables and objects within the virtual memory space of the targeted process. The ability to target malware concealing its presence in a legitimate process is therefore enabled.

As will be discussed later, our framework does entail the launching of processes and threads. Dark Knight does not in itself conceal the presence of these artifacts and while other traditional KM rootkit techniques may be invoked for this purpose, such activity is considered outside the scope of our research.

2.2 Tools and Capabilities Identification

A key component of our framework must be its ability to facilitate an analyst's investigation of a compromised host. Of particular interest is investigation of the processes, executables, files and network connections associated with the malicious activity. Tools critical to this investigation included those that are native to the Windows environment. These include the capability to navigate the file system. Additionally tools such as netstat to list network connections and tasklist to list active processes are also critical.

There also exists many analytical tools that are not natively found on a Windows machine but are very useful in investigating process activity. These include memory dumping tools such as Userdump [3] and DumpIt [4]. Given that many analytical tools already exist for the purpose of analyzing software it will be a goal of our framework to incorporate and leverage existing capabilities. This will in turn ensure our framework is applicable across a wide variety of malware detection and analysis scenarios.

2.3 Command and Control

For the purposes of enabling covert communications within our framework a novel use of an USB MSD channel was developed and implemented. Previous research has demonstrated the use of USB based devices for hosting covert channels [5]. A covert channel implemented over an MSD was selected for its potential to enable high-bandwidth transmissions and support our requirement to off-load log/data files from the compromised machine. Intuitively, a covert MSD channel also offers enhanced stealth over a network based covert channel, in that communications cannot be observed by a third party residing on the network.

A host makes use of the Small Computer Systems Interface (SCSI) protocol to communicate and initiate data transfers with an MSD. Of particular interest to us in our research with respect to developing a covert command and control channel are the abilities to communicate discretely and carry out the transfer of large volumes of data. For example, the case where log files are off loaded from a compromised machine. For these reasons our focus was directed to the following SCSI commands: READ, WRITE and TEST UNIT READY. The READ and WRITE as their names suggest are the commands for reading from and storing information to the MSD. Data on an MSD is referenced using a logical block address

(LBA) scheme. Read and write requests therefore include in their request the starting LBA they intend to access in addition to the number of blocks that are being requested and/or written. Figure 1 depicts the fields in a READ command block. The first field carries the operation code of the command which is 28h in the case of a READ request. The address of the LBA occupies bytes 2 through 5 and the transfer length (number of LBAs requested) occupies bytes 7 and 8. A WRITE command block is similar in nature with the exception that its operation is designated by 2Ah.

Byte	Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (28h)								
1	RDPROTECT			DPO	FUA	RARC	FUA_NV	Obsolete	
2	(MSB)								
...	LOGICAL BLOCK ADDRESS								
5	(LSB)								
6	Reserved			GROUP NUMBER					
7	(MSB)								
8	TRANSFER LENGTH								
8	(LSB)								
9	CONTROL								

Figure 1: READ Frame (from [6])

In the interest of developing a covert channel the Control field (byte 9) was inspected further in order to identify any settings which might be open to subversion. As identified in Figure 2, bit 6 and 7 are to contain vendor specific information. In our development environment it was identified that these bits are not in use and we are able to set them as we saw fit without adversely affecting communications. With these bits the potential exists to distinguish between frames associated with a covert channel and normal host/MSD communications.

Bit	7	6	5	4	3	2	1	0
	Vendor specific		Reserved			NACA	Obsolete	Obsolete

Figure 2: Control Byte (from [7])

Further analysis of typical host/MSD communications revealed the presence of a heart beat type signal used to determine if the device is ready for use. This signal is the TEST UNITY READY signal and is sent at a frequency of approximately twice per second. Given that our toolset will need to be in regular communication with the analyst for the purposes of receiving command and control signals, the TEST UNIT READY command provides a good candidate signal for subversion. By leveraging it we would be able to hide within the noise of normal host/device communications.

3 Framework Design

Our design consists of components on two separate computers, the compromised computer and the analyst's computer from which commands are issued in order to carry out the investigation. Five major components form the basis of our architecture as depicted in Figure 3, these include an implanted toolset, a

covert communication capability, an MSD emulator, the Dark Knight rootkit and an USBcat client. This design models a client-server architecture, with the implanted toolset acting as a server and permitting the USBcat client (analyst) to establish investigative sessions on the compromised machine.

The choice of the name USBcat is based on our use of an USB channel for covert communications in addition to our integration of a netcat [8] like framework to execute analytical tools on the compromised machine. Detail regarding our netcat style framework will be presented within this section.

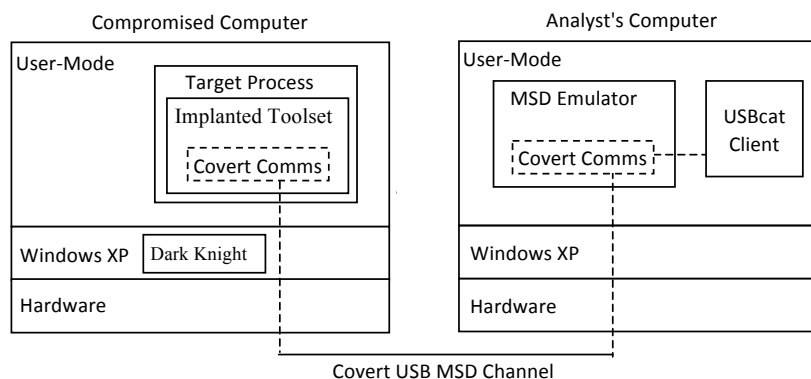


Figure 3: Surveillance Framework High-Level Design

The USBcat client will act as the analyst's main interface for carrying out command and control of the framework. The MSD emulator will emulate the existence of an MSD (eg. a thumb drive) which will be used to develop a covert communications channel. The Dark Knight rootkit will serve to conceal the presence of the implanted toolset on the compromised machine, in addition to providing a user-space foothold on the compromised machine. The implanted toolset itself will manage sessions in the target and provide a scalable architecture to allow multiple concurrent client sessions to be actively running investigative programs and tools. The covert communications capability will consist of a communications module leveraged by the implanted toolset on the compromised computer in addition to functionality incorporated into the MSD emulator on the analyst's computer.

3.1 Implanted Toolset

Our design seeks to produce an architecture which is modular, scalable, and architecturally independent from the communication channel on which it resides. These attributes are visible in the modular nature of our implanted toolset (Figure 4). The implanted toolset is the portion of our design that resides entirely on the compromised machine. This toolset was implemented as dynamic link libraries (DLLs) that are injected by the Dark Knight rootkit into a target process on the compromised machine.

The implanted toolset can be subdivided into a datagram management, a channel management and a payload management component, as depicted in Figure 4. The upper layer module is entitled the USBcat payload manager and is responsible for launching payloads as requested by the analyst. Payloads are analysis tools that the analyst can launch on the compromised machine.

USBcat Payload Manager. Our implanted toolset is capable of executing diagnostic commands on behalf of the analyst. This includes both native operating system commands and utilities in addition to custom system analysis tools. Rather than reimplement system diagnostic tools that already exist we

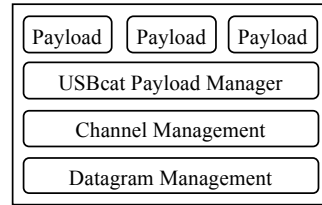


Figure 4: Surveillance Framework High-Level Design

chose to implement a mechanism that would make use of existing utilities. Our solution to meet this requirement was to design an architecture which models that of the netcat [8] application. Of interest to us is the technique used by the netcat architecture to spawn a child process and through the use of pipe streams direct commands to the child process as well receive the results of those commands. In this way a netcat listener session is able to relay commands received from a netcat client to the spawned process (i.e. the diagnostic tool) and respond with the results of those commands. By applying a similar design we are able to launch and control analytical tools on the compromised machine. Where analytical tools do not natively reside on the compromised machine our toolset incorporates the ability to transfer the executable from the analyst’s machine for local execution.

The USBcat payload manager is used to initially spawn the payload requested by the analyst. For the purposes of this explanation we will consider the launching of the command shell process as depicted in Figure 5. Communications with this child process are implemented with two threads of execution within the payload manager. One thread waits for commands to be received from the channel and subsequently issues a WriteFile() [9] command which directs the input into a shared pipe between the USBcat payload manager and the command shell’s stdin. While the other thread is responsible for issuing ReadFile() [10] commands in order to check the shared pipe connected to the stdout of the command shell. The command shell will then invoke the execution of commands and utilities it receives. These commands and utilities are then themselves executed as child processes of the command shell, thereby inheriting the input and output channels of their parent. Output from this command/utility is then directed back to the payload manager.

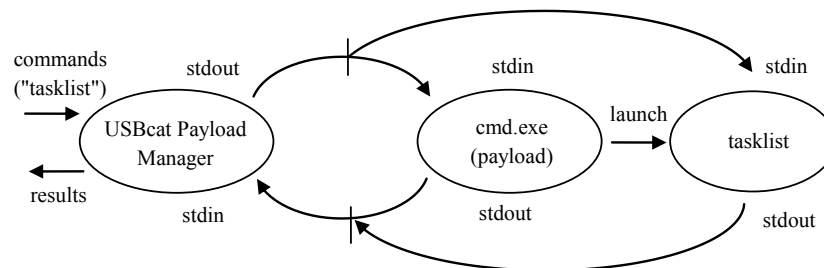


Figure 5: USBcat Payload Launching Behaviour

Channel and Datagram Management. The architecture of the USBcat implanted toolset is further supported by the channel and datagram management modules. These modules offer a layer of abstraction and separation from the actual implementation of the covert channel. The channel management module provides scalability to our solution by permitting multiple investigative sessions to coexist and

communicate with the analyst. The datagram management module is responsible for implementing the underlying covert communication channel between the implanted toolset and the USBcat client on the analyst machine. This module implements communication through direct reads and writes to blocks on the MSD.

3.2 Covert Communications Capability

Design elements for the covert communication between the implanted toolset and the analyst will now be presented.

MSD Emulator. A key component of our covert channel is the ability to intercept and generate MSD communications at the analyst's end of the channel. To facilitate the development of this channel we made use of an USB device development environment [11]. Our module is designed to inspect all communications received by the emulated MSD. Regular host to MSD communications will make use of the standard MSD implementation code, whereas communications identified as part of our covert channel will be diverted to our built-in toolset.

Covert Communications: Polling and Data Transmission. In order to implement our covert channel the implanted toolset requires the ability to be notified when the remote end of the channel has a datagram ready to send. This ability was implemented as a polling activity to be carried out by the implanted toolset. During the course of our research we identified that the native behaviour of a host machine with an attached MSD is to send it Test Unit Ready signals at regular intervals (approximately twice per second). We therefore implemented our own Test Unit Ready signals for the purposes of polling the USBcat client for commands. The decision was made to leverage the Test Unit Ready signal given the fact that we are seeking to hide our channel within the existing noise of standard host/MSD communications.

Given that there now exists multiple Test Unit Ready commands being received by the MSD, our covert communication module in the MSD needs a means to distinguish between regular host signals and our covert polling signals. This is achieved by making use of the control byte in the Test Unit Ready packet and setting one of the vendor specific bits. The toolset at the analyst end of the channel is therefore able to identify Test Unit Ready signals sent by the implanted toolset. The covert communication module in the MSD is able to alert the implanted toolset when the analyst has a command ready to send by delaying the Test Unit Ready packet acknowledgement by a fixed amount of time as depicted in Figure 6. A delay of 40 msec was sufficient for our purposes. This delay is identified by the implanted toolset, which then issues a Read request to the analyst side toolset in order to request the next available message.

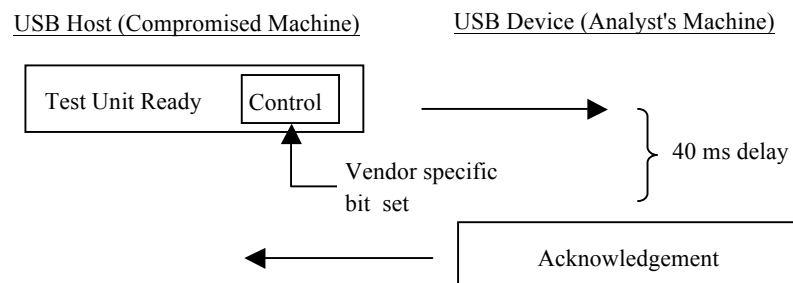


Figure 6: Covert Signal – Polling Mechanism

To distinguish our covert channel Read requests from that of normal MSD behaviour we again set a vendor specific bit. This custom Read request then informs our analyst side toolset that the implanted toolset is requesting a command from the analyst. The analyst end of the channel then responds with the next available datagram. As results of the analyst’s commands become available from the implanted toolset they are transmitted to the analyst with the use of Write requests. In a similar manner a vendor specific bit is set in order to identify our communications as part of the covert channel.

4 Validation Activities

Validation of the USBcat toolset was carried out to determine if its operation would be detectable by an adversary. Based on our results, we argue that our toolset permits an investigation of malicious code on a compromised to be carried out remotely and with a high degree of stealth. Our validation also considered the extensible nature of our toolset and its versatility for enabling investigations against the broader context of malware compromises.

Our performance testing considered the performance impact on the compromised machine from the perspective of both internal and external time sources. That is, would an attacker notice or could he observe changes in performance that would alert him to the defender’s activities. From the internal time source perspective we considered the scenario where the adversary is attempting to detect the presence of our toolset from a vantage point within the compromised machine. Alternatively, for the external time source scenario we evaluate the potential for the adversary to detect the performance impact of our toolset from their attacking machine. Figure 7 depicts the validation environment.

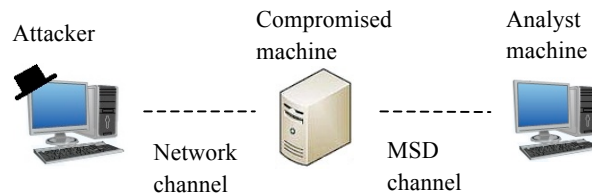


Figure 7: Validation Environment

4.1 Performance Measurements - Internal Time Source

To conduct the internal time source measurements we made use of Microsoft performance [12] counters which monitor running applications and system resources. Our motivation for the selection of such counters was to assess the impact of our toolset on system performance. These counters capture I/O activity in terms of file system reads and writes carried out by our toolset, in addition to measuring processor and memory usage. As our implanted toolset is designed to execute within the context of an existing process on the compromised machine, we must first select a target process. The target process for our validation was the explorer.exe process. Explorer.exe was selected given that it is both a native and privileged process which executes within the Microsoft OS and is therefore also the likely target of an adversary (for the injection of malicious code). A total of six measurement scenarios were performed:

- Baseline 1 (idle)
- Baseline 2 (end-user activity)

- Toolset scenario 1 (USBcat injected but idle)
- Toolset scenario 2 (processing "dir C:\WINDOWS" at 3 second intervals)
- Toolset scenario 3 (executing file transfers of 34 MB file)
- Toolset scenario 4 (executing Userdump.exe)

The baseline scenarios provide us with a normal picture of the compromised machine's performance without our toolset installed. The first baseline represents the scenario where the compromised machine is otherwise idle, while the second baseline incorporates end-user activity with events such as document editing and web browsing traffic. Our intent is to better understand how typical end-user activity may further conceal the presence of our toolset.

In addition to the two baseline scenarios, four toolset scenarios were evaluated. These scenarios represent typical activities that would be expected to take place over the course of an investigation of a compromised machine. Additionally, these scenarios represent an increasing load on system resources of the compromised machine and therefore provide insight into the impact of toolset activity and intensity on system resources.

Upon comparing baseline 1 with toolset scenario 1 (Table 1) there exists a number of metrics which fall outside of two standard deviations and are therefore potentially suspicious to an attacker concerned with identifying anomalous behaviour on the compromised machine. However, as indicated in baseline 2 as end-user activity is added to the machine, toolset activities cease to be anomalous and very quickly become hidden in the noise of the system.

Performance Counters	Baseline 1		Baseline 2		Toolset Scenario 1	
	Avg	Std Dev	Avg	Std Dev	Avg	Std Dev
IODataBytesPersec	0	0	201.19	1395.96	0.21	5.06
IODataOpsPersec	0	0	1.45	9.3	0	0.04
IOOtherBytesPersec	1067.57	1702.07	1647.43	9558.95	526.21	372.77
IOOtherOpsPersec	2.66	2.75	25.28	100.67	19.62	3.34
IOReadBytesPersec	0	0	188.63	1341.61	0.21	5.06
IOReadOpsPersec	0	0	1.42	9.24	0	0.04
IOWriteBytesPersec	0	0	12.56	211.02	0	0
IOWriteOpsPersec	0	0	0.02	0.2	0	0
ThreadCount	14.33	0.47	16.03	1.34	17.98	1.14
PageFaultsPersec	4.88	6.31	21.84	69.59	2.65	11.45
VirtualBytes	75809403	123315	82379066	403520	72446102	297756
PercentProcTime	0.3	0.55	1.48	6.47	0.14	0.5

Table 1: Internal Time Source Metrics – Baselines & Toolset Scenario 1

Toolset scenarios 2 and 3 (Table 2) represent an increasing use of resources on the compromised machine. Where these activities begin to stand out as anomalous the analyst's actions should be scaled down such that metrics fall more in line with the rates identified in baseline 2 (simulated end-user activity).

Toolset scenario 4 considered the impact of executing Microsoft's Userdump executable as a payload in the compromised machine. During the course of this scenario Userdump was observed temporarily locking access to the process it is inspecting and therefore suspending all other interaction with that process. Therefore diagnostic tools which may significantly impact their target process must be used with care in order to not disclose our toolset's presence.

Performance Counters	Toolset Scenario 2		Toolset Scenario 3		Toolset Scenario 4	
	Avg	Std Dev	Avg	Std Dev	Avg	Std Dev
IODataBytesPersec	1940.38	2825.94	3014767	804280	12.66	90.07
IODataOpsPersec	2.43	3.51	2.07	0.87	0.14	2.59
IOOtherBytesPersec	6102.45	6737.81	3017220	521228	124.93	636.26
IOOtherOpsPersec	24.06	6.18	62.65	6.94	2.59	13.29
IOReadBytesPersec	1935.75	2819.41	3014767	804280	12.66	90.07
IOReadOpsPersec	2.12	3.08	2.07	0.87	0.14	2.59
IOWriteBytesPersec	4.59	6.85	0	0	0	0
IOWriteOpsPersec	0.27	0.44	0	0	0	0
ThreadCount	19.6	0.51	17.81	0.94	18.13	1.45
PageFaultsPersec	4.73	23.84	35.78	107	14.18	130.09
VirtualBytes	73439696	133493.4	82608914	421407	72016989	392604
PercentProcTime	0.28	0.65	3.49	2.05	0.55	1.89

Table 2: Internal Time Source – Toolset Scenarios 2, 3 and 4

The internal performance metrics gathered during this portion of the validation support our argument that our toolset is sufficiently stealthy and covert.

4.2 Performance Measurements - External Time Source

Performance metrics were also captured from an external time source. This scenario is less intrusive and requires much less complexity to execute from an attacker's perspective as it can be conducted remotely. This test involves repeated issuing of identical commands from the attacker's workstation to the compromised machine. This then permits measurements of the response time of each such command in order to determine if the execution of our toolset is potentially visible to an outside attacker.

To carry out this test we made use of the network depicted in Figure 7. Making use of tcpdump [13] (on the attacker's machine) we measured the round-trip time for the "dir C:\WINDOWS" command issued on the attacker's machine and for the results of the command to be received. Test scenarios incorporated the same toolset scenarios as those of the internal performance measurements although during these tests we did not use a baseline with end-user activity. Test results with no end-user activity proved to be sufficiently stealthy in concealing the presence of our toolset. For all scenarios "dir C:\WINDOWS" was issued 100 times from the attacker's computer at 3 second intervals. Although, in toolset scenario 4 where Userdump was executing concurrently our sample size was much smaller at just 14 samples. Again, this was due to the fact that Userdump locks its target process and therefore our target process explorer.exe was unable to respond in a timely manner to the attacker's requests. The results of these tests are listed in Table 3.

Toolset scenarios 1, 2 and 3 indicate only minor deviations from the baseline in which no toolset is running. As these scenarios are well within a single standard deviation of the baseline we are confident that this method of instrumentation does not reveal the presence of our toolset. By relying on measurements that are effectively measuring round-trip times of individual commands the attacker will also be impacted by fluctuations in response times resulting from other traffic on the network. The combination of this network noise factor in conjunction with the already minute timing variances depicted in Table 3 would make it very difficult for external performance testing to identify the presence of our toolset.

Scenarios	Avg (sec)	Std Dev (sec)
Baseline 1	0.8459	0.1038
Toolset Scenario 1	0.9187	0.1889
Toolset Scenario 2	0.9077	0.1810
Toolset Scenario 3	0.8777	0.0821
Toolset Scenario 4	28.8034	10.1764

Table 3: External Time Source Metrics

Alternatively, we see that in Scenario 4 response times to the attacker's commands have increased greatly and are reminded that care must be taken to ensure intrusive diagnostic tools are used discretely.

4.3 Validation Against the Broader Research Context

Once an attacker gains a foothold on a compromised machine, investigation of his actions will require standard tools and capabilities such as those indicated in our design. By spawning a command shell on the compromised machine and redirecting input and output to the remote end of the toolset the analyst is able to launch commands and carry out his investigation as if he were seated at the compromised machine. The analyst can then use tools such as tasklist and netstat to identify anomalous processes and network connections.

Following this initial assessment of a compromised machine often finer grained and specialized toolsets will be needed to conduct a more thorough investigation. Our toolset provides the capability to transfer analysis tools to the compromised machine in a covert manner. Of particular significance is that the use of console based analysis tools require no modifications in order to be supported within our toolset framework.

5 Future Work

Current research opportunities will now be proposed. There are several ways in which this research can be extended.

5.1 Payload to Capture Stdin and Stdout

The ability to see commands issued by the attacker to malware is a very valuable capability towards identifying the attacker's overall motivations and intent. Hooking stdin and stdout has commonly been accomplished through filtering ReadFile and WriteFile system calls within kernel space [14]. While effective, a potentially more novel technique might make use of APCs to filter system calls, and the incorporation of this capability as a payload within our USBcat framework. Given that APCs run at a higher Interrupt Request Level (IRQL) than normal code [15] they could be used to both detect and filter ReadFile and WriteFile system calls in order to intercept malicious command and control signals.

5.2 Improved Covert Channel

Our covert channel relies on polling behaviour in order to implement our command and control channel. The implanted toolset polls for commands by leveraging the Test Unit Ready signal. Rather than carrying out polling activity a potentially more novel solution would be to effectively leave the channel

open allowing the analyst's end of the channel to respond with command signals once they are ready [16]. Although, the serial nature of MSD communications may prove to be a limiting factor to such a technique.

5.3 Alternate Implanted Toolset Format

Alexander identifies several types of code formats which the Dark Knight rootkit is capable of injecting into user-mode threads [2]. When injecting code into a foreign process, code remapping is required to correctly insert the code into the virtual memory address space of this process. DLLs natively incorporate code remapping capabilities in their executable, whereas the injection of shellcode into a process requires the manual calculation of offsets. The trade off is that DLLs provide a larger distinguishable footprint in memory. Therefore implementation of the implanted toolset with the use of shellcode would enhance its stealth.

6 Conclusion

In our introduction we identified the strategic importance of monitoring cyber espionage being conducted against government and corporate infrastructure. During such attacks it is often of greater strategic advantage to observe an intruder in order to gain enhanced insight into their identity, objectives, strategy and infiltration than to break contact and remove the attacker, effectively alerting them of their detection. We therefore developed a framework to provide such a stealthy investigative capability. The extensible nature of our framework permits a wide variety of diagnostic tools to be seamlessly executed on the compromised machine. Additionally, to maintain the stealth of our investigation a novel covert USB MSD channel was developed to permit remote stealthy command and control of our toolset.

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