CommSec

HITBSECCONF AMSTERDAM - 2021

Playing hide-n-seek with AWS GuardDuty: Post-DNS era covert channel for C&C and data exfiltration

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Who am I?

- Developer
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Agenda

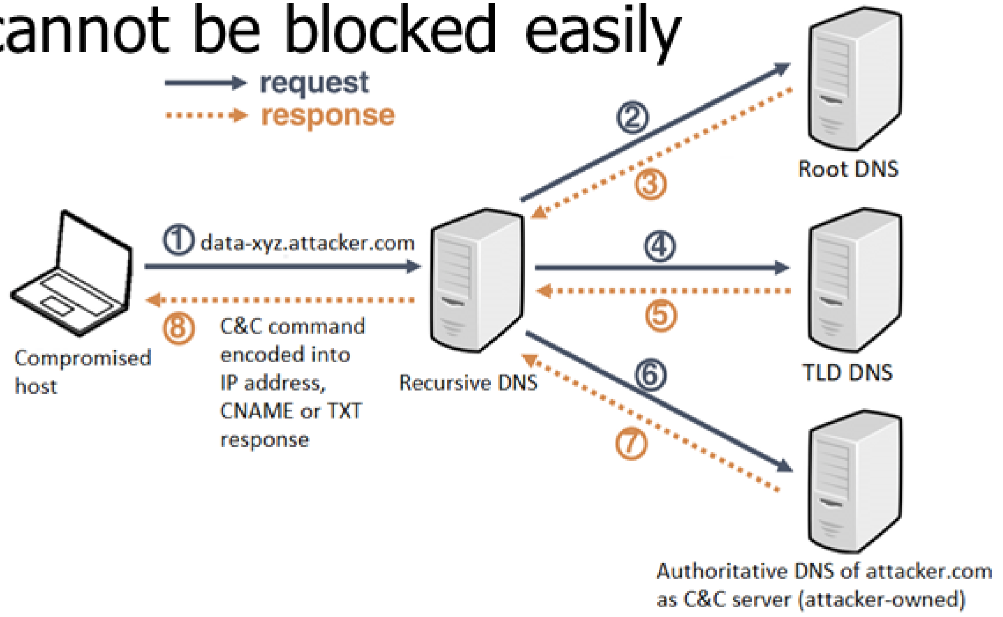
- DNS tunneling, NIDS, HIDS and SIEM
- Covert channel using SaaS or CDN
- Amazon GuardDuty evasion
- Proof-of-Concept and demo
- Common fallacy of AWS & mitigation tips

DNS Tunneling

- Direct TCP & IRC – Perl & C code, NetBus, BackOrifice, Sub7 (1990s)
- DNS Tunneling - Bugtraq by Oskar Pearson (April 1998)
- Attacker's web server – Malware/backdoor programs (2000s)
- Reddit posts – iWorm botnet (2014)
- GitHub commits - Black Hat Python by Justin Seitz (2015)
- Twitter tweets and GitHub – Hammertoss by APT29 (2015)
- Instagram comments – Trojan horse by Turla Group (2017)

DNS Tunneling

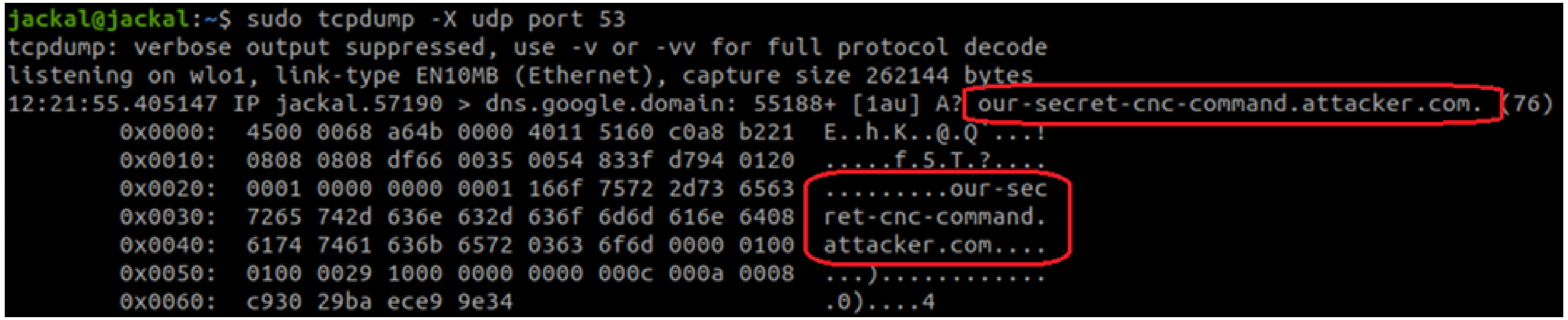
- DNS traffic cannot be blocked easily



request
response
②
③
Root DNS
① data-xyz.attacker.com
④
⑤
TLD DNS
⑧ C&C command encoded into IP address, CNAME or TXT response
Compromised host
Recursive DNS
⑥
⑦
Authoritative DNS of attacker.com as C&C server (attacker-owned)

DNS Tunneling

- But… DNS queries are not encrypted



```
jackal@jackal:~$ sudo tcpdump -X udp port 53
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on wlo1, link-type EN10MB (Ethernet), capture size 262144 bytes
12:21:55.405147 IP jackal.57190 > dns.google.domain: 55188+ [1au] A? our-secret-cnc-command.attacker.com. (76)
        0x0000:  4500 0068 a64b 0000 4011 5160 c0a8 b221  E..h.K..@.Q`...!
        0x0010:  0808 0808 df66 0035 0054 833f d794 0120  .....f.5.T.?....
        0x0020:  0001 0000 0000 0001 166f 7572 2d73 6563  .........our-sec
        0x0030:  7265 742d 636e 632d 636f 6d6d 616e 6408  ret-cnc-command.
        0x0040:  6174 7461 636b 6572 0363 6f6d 0000 0100  attacker.com....
        0x0050:  0100 0029 1000 0000 0000 000c 000a 0008  ...)............
        0x0060:  c930 29ba ece9 9e34                      .0)....4
```

- What about DNS over HTTPS (DoH) and DNS over TLS (DoT)?

Network-based IDS (NIDS)

- Network-based IDS (E.g. Snort, Zeek, Suricata, etc.)
  - Able to detect DNS tunneling, but not 100%
  - Inspect packet header and unencrypted packet data (DPI)
  - Limited insight on encrypted channels like HTTPS
  - DPI does not scale well for high throughput networks

Host-based IDS (HIDS)

- Host-based IDS (E.g. OSSEC, Wazuh, ThreatStack, etc.)
  - Monitor filesystem integrity, processes, network and analyzes logs
  - Performance & stability concerns (Some use kernel-mode hooks)
  - Not very platform/distro agnostic (due to kernel module)
  - Can be noisy, might end up as a crying wolf

Security info and event management (SIEM)

- SIEM (E.g. ELK stack, Datadog, Splunk, AlienVault, etc.)
  - Ingest logs from various sources
  - Aggregate logs to gain traffic insights
  - Alerts and reactive actions can be triggered
  - Event search and investigation capability

Covert channel using SaaS or CDN

- Examples of popular enterprise SaaS
  - Source control – GitHub, GitLab, Bitbucket, etc.
  - APM tools - NewRelic, Dynatrace, AppDynamics, etc.
  - Monitoring tools – Datadog, Grafana, LogicMonitor, etc.
- Examples of popular CDN/WAF services
  - CloudFlare, Fastly, Imperva, etc.

Covert channel using SaaS or CDN

- Assume that the target server for data exfiltration
    - No ingress traffic from Internet, private network, no public IP
    - Only egress traffic to the Internet is through a NAT gateway
    - Uses Internet to fetch GitHub repos and get OS updates
    - Compromise it through supply chain attack (malware)

Covert channel using SaaS or CDN

- Setup for C&C/data exfiltration channel
  1. Gather the IP range of top 10 (or more) cloud services that
     - are widely used by many organizations
     - have publicly documented API
     - have ability to store and retrieve data
  2. Gather the IP range of top 5 CDN services
  3. Create SaaS accounts for API keys and setup C&C server behind CDNs
  4. Embed API keys and IP range data into the malware

Covert channel using SaaS or CDN

- Malware monitors OS connection table for at least 24 hours
  - Look for remote IP that matches any embedded IP range data
    - Linux - **/proc/net/tcp (IPv4), /proc/net/tcp6 (IPv6)**
    - Windows – **GetTcpTable (IPv4), GetTcp6Table (IPv6)**
- Or… find repo host with IP that matches any embedded IP range data
  - **/etc/apt/sources.list.d/***
  - **/etc/yum.repos.d/***

Covert channel using SaaS or CDN

1. Found a matching SaaS IP? Use it to blend in the C&C traffic
   - Malware 🡐 store/retrieve data 🡒 SaaS's storage as data exchange medium
   - C&C Server 🡐 store/retrieve data 🡒 SaaS's storage as data exchange medium
2. Found a matching CDN IP? Use it to blend in the C&C traffic
   - Malware 🡒 request 🡒 CDN as proxy for C&C 🡒 request 🡒 C&C Server
   - Malware 🡐 response 🡐 CDN as proxy for C&C 🡐 response 🡐 C&C Server
3. No matching IP? Pick a CDN, still less suspicious than directly to C&C Server
   - Malware 🡒 request 🡒 CDN as proxy for C&C 🡒 request 🡒 C&C Server
   - Malware 🡐 response 🡐 CDN as proxy for C&C 🡐 response 🡐 C&C Server

Amazon GuardDuty evasion

- Amazon GuardDuty data sources
  - **CloudTrail** – logs all AWS API call and S3 data events
  - **VPC Flow Logs** - logs VPC traffic's packet header without content
  - **Threat intel feed** – Known malicious IP addresses, etc.
  - **DNS logs** - logs all DNS requests to AWS DNS resolver

Note: IAM is the core service of AWS, all AWS API calls use it

Amazon GuardDuty evasion

- Evasion criteria, the C&C traffic **must not**
  - Call AWS API with compromised host's IAM access (~~CloudTrail~~)
  - Communicate with any unknown IP address (~~VPC Flow Logs~~)
  - Communicate with any malicious IP (~~Threat intel feed~~)
  - Use DNS tunneling (~~VPC Flow Logs and DNS Logs~~)

Amazon GuardDuty evasion

- How the ideal **"solution"** looks like?
  - A medium for data exchange without leaving trace in CloudTrail
  - The medium for data exchange must be trusted by AWS
  - Simple to implement in malware without additional dependency
  - Uses standard HTTPS traffic for communication

Amazon GuardDuty evasion

Option #1 - Embed the IAM user access key of the attacker

- Can use any AWS resource of the attacker (E.g. S3, SQS, DynamoDB) 👍
- **STS::GetCallerIdentity()** reveals AWS account ID and IAM username 👎
- Need HMAC/SHA256 library to sign AWS API call at the compromised host 👎

Note: This method only generates CloudTrail logs in the attacker's AWS account

Amazon GuardDuty evasion

Option #2 – Setup C&C server behind AWS CloudFront (CDN)

- No API call signing is required (i.e. Embed API key and URL of C&C in malware) 👍
- EC2 initiated outbound connection to CloudFront may appear suspicious 👎

Note: Amazon Linux 2's package repository uses S3 without CloudFront

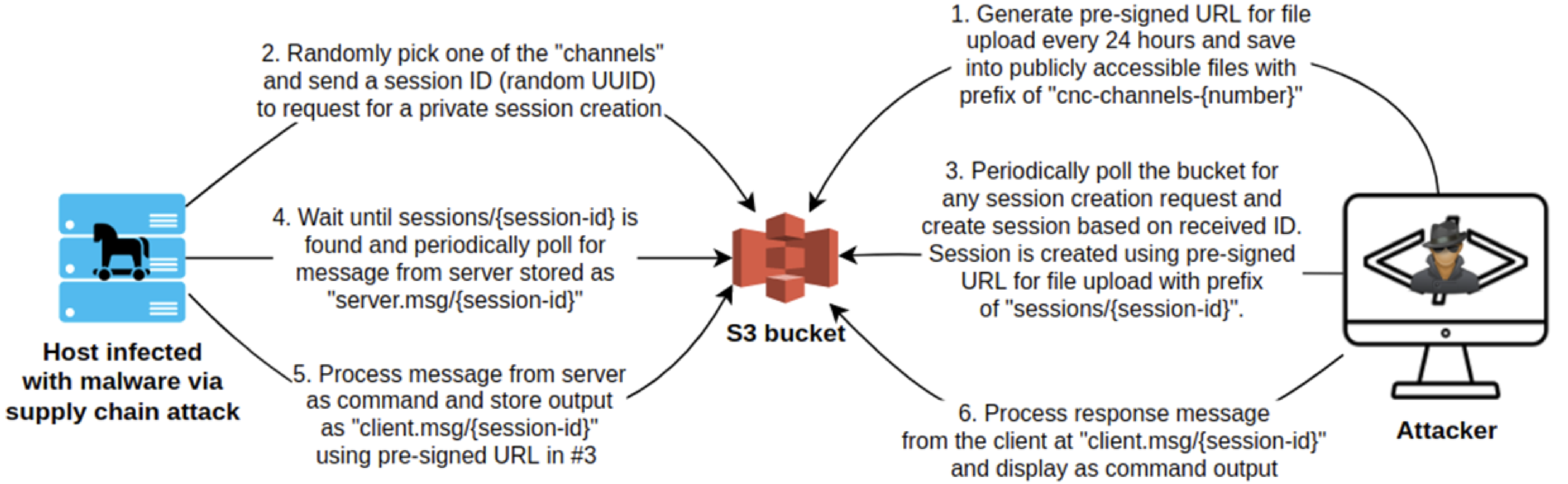
(i.e. https://amazonlinux-2-repos-[region].s3.[region].amazonaws.com)

Amazon GuardDuty evasion

Option #3 – Use attacker's S3 bucket via pre-signed URL

- No API call signing is required, URL already has signature 👍
- S3 is preferred over CloudFront due to AL2's package repository using it 👍
- Limited validity of 7 days, but workaround is possible 👌

Proof-of-Concept and demo


2. Randomly pick one of the "channels" and send a session ID (random UUID) to request for a private session creation
1. Generate pre-signed URL for file upload every 24 hours and save into publicly accessible files with prefix of "cnc-channels-{number}"
3. Periodically poll the bucket for any session creation request and create session based on received ID. Session is created using pre-signed URL for file upload with prefix of "sessions/{session-id}".
4. Wait until sessions/{session-id} is found and periodically poll for message from server stored as "server.msg/{session-id}"
S3 bucket
Host infected with malware via supply chain attack
Attacker
5. Process message from server as command and store output as "client.msg/{session-id}" using pre-signed URL in #3
6. Process response message from the client at "client.msg/{session-id}" and display as command output

PoC code at https://github.com/ssteo/hitbsecconf2021ams-poc

Common fallacy of AWS & mitigation tips

1. Allowing all egress traffic to AWS services is safe
   - 💡 Use PrivateLink endpoint policy to restrict traffic to a specific S3 bucket
2. Using iptables in EC2 is the same as using security groups
   - 💡 It is recommended to use security groups over iptables
3. GuardDuty is good enough for overall security monitoring
   - 💡 Continuous tweaking of SIEM is the key to improve security visibility

Thank You

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