CompTIA Security+ Exam SY0-701

Lesson 11

Enhance Application Security Capabilities

Lesson 11

Topic 11A

Application Protocol Security Baselines

Secure Protocols

- Many of the protocols used today were developed many decades ago
  - Functionality was primary focus
  - Trustworthiness was assumed
  - Cybersecurity was less of an issue than it is today
- Insecure Protocols
  - Transmit data in clear text format
  - Generally, cannot be secured
  - Must be avoided
- Secure Protocols
  - Same functionality and secure
  - More complex to configure

Insecure	Secure Alternative
Telnet	SSH
HTTP	HTTPS
FTP	FTPS/SFTP

Transport Layer Security

- Most Common Uses
  - Secure HTTP communications
  - Virtual Private Networking (VPN)
- SSL/TLS Versions
  - SSL 2.0, 3.0
  - TLS 1.0, 1.1, 1.2, 1.3
  - Only use TLS version 1.2 or newer
  - Disable all others
    - Downgrade attack

Transport Layer Security

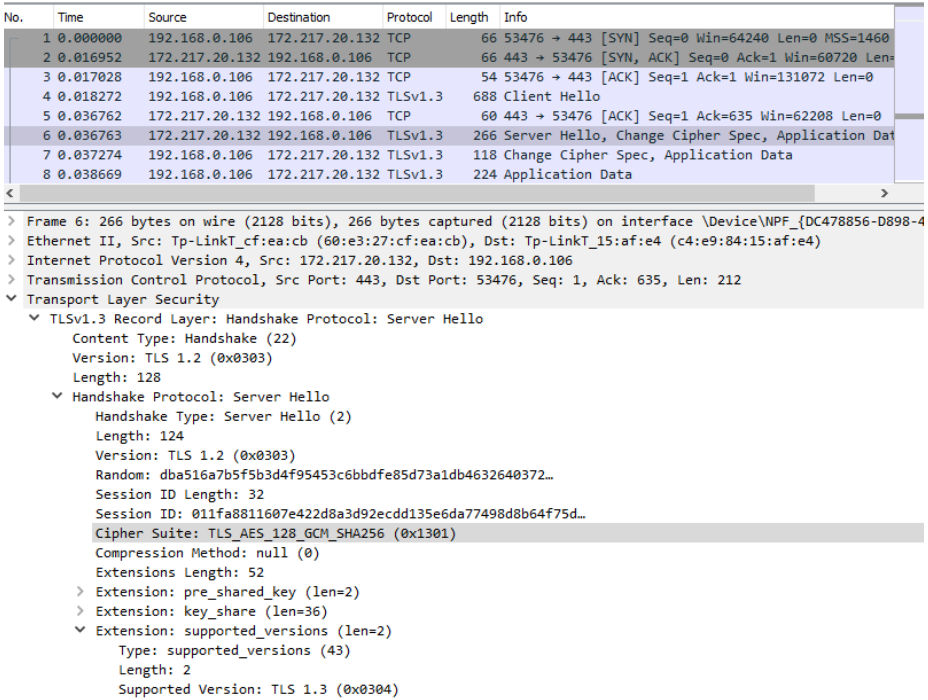
- Cipher Suites
  - Describe the mix of algorithms used to implement TLS protections
- Prior to TLS 1.3

  `ECDHE-RSA-AES128-GCM-SHA256`

- TLS 1.3 uses shortened suites

  `TLS_AES_256_GCM_SHA384`

- Only lists bulk encryption key strength, mode of operation and hash type



```
No. Time     Source         Destination    Protocol Length Info
  1 0.000000 192.168.0.106  172.217.20.132 TCP          66 53476 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460
  2 0.016952 172.217.20.132 192.168.0.106  TCP          66 443 → 53476 [SYN, ACK] Seq=0 Ack=1 Win=60720 Len=
  3 0.017028 192.168.0.106  172.217.20.132 TCP          54 53476 → 443 [ACK] Seq=1 Ack=1 Win=131072 Len=0
  4 0.018272 192.168.0.106  172.217.20.132 TLSv1.3     688 Client Hello
  5 0.036762 172.217.20.132 192.168.0.106  TCP          60 443 → 53476 [ACK] Seq=1 Ack=635 Win=62208 Len=0
  6 0.036763 172.217.20.132 192.168.0.106  TLSv1.3     266 Server Hello, Change Cipher Spec, Application Dat
  7 0.037274 192.168.0.106  172.217.20.132 TLSv1.3     118 Change Cipher Spec, Application Data
  8 0.038669 192.168.0.106  172.217.20.132 TLSv1.3     224 Application Data

> Frame 6: 266 bytes on wire (2128 bits), 266 bytes captured (2128 bits) on interface \Device\NPF_{DC478856-D898-4
> Ethernet II, Src: Tp-LinkT_cf:ea:cb (60:e3:27:cf:ea:cb), Dst: Tp-LinkT_15:af:e4 (c4:e9:84:15:af:e4)
> Internet Protocol Version 4, Src: 172.217.20.132, Dst: 192.168.0.106
> Transmission Control Protocol, Src Port: 443, Dst Port: 53476, Seq: 1, Ack: 635, Len: 212
v Transport Layer Security
  v TLSv1.3 Record Layer: Handshake Protocol: Server Hello
      Content Type: Handshake (22)
      Version: TLS 1.2 (0x0303)
      Length: 128
    v Handshake Protocol: Server Hello
        Handshake Type: Server Hello (2)
        Length: 124
        Version: TLS 1.2 (0x0303)
        Random: dba516a7b5f5b3d4f95453c6bbdfe85d73a1db4632640372…
        Session ID Length: 32
        Session ID: 011fa8811607e422d8a3d92ecdd135e6da77498d8b64f75d…
        Cipher Suite: TLS_AES_128_GCM_SHA256 (0x1301)
        Compression Method: null (0)
        Extensions Length: 52
      > Extension: pre_shared_key (len=2)
      > Extension: key_share (len=36)
      v Extension: supported_versions (len=2)
          Type: supported_versions (43)
          Length: 2
          Supported Version: TLS 1.3 (0x0304)
```

Viewing the TLS handshake in a Wireshark packet capture. Note that the connection is using TLS 1.3 and one of the shortened cipher suites (TLS_AES_128_GCM_SHA256).

Secure Directory Services

- A Network directory contains
  - Subjects (users, computers, and services)
  - Objects (directories and files) available in the environment
  - Permissions that subjects have over objects
  - High-value attack target

- Lightweight Directory Access Protocol (LDAP)
  - Default is cleartext communication

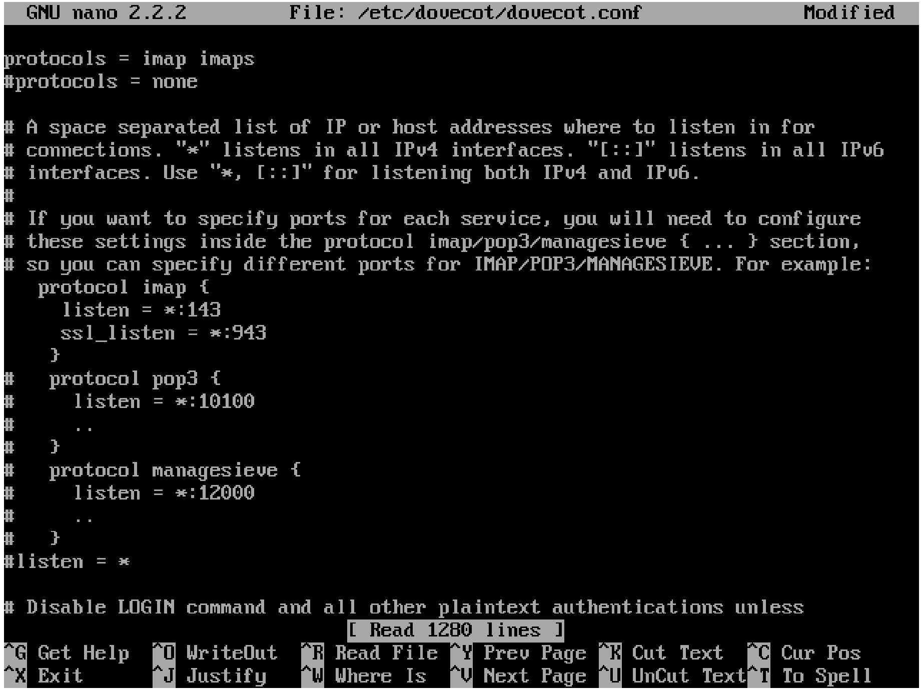
Simple Network Management Protocol Security

- Simple Network Management Protocol (SNMP)
- Management and monitoring
- SNMP monitor + agents
- Provides very detailed information about systems
- Uses “Community Strings” default “Public” and “Private”
- Can be used to issue commands
- SNMPv3 has secure features, other versions should be avoided

File Transfer Services

- File Transfer Protocol
  - Cleartext
  - Used to host and share files
- SSH
  - Primarily used to access a shell remotely
  - Very versatile protocol
  - Can be used as a tunnel for other protocols
- FTP (SFTP) and FTP Over SSL (FTPS)
  - SFTP is FTP tunneled through SSH
  - FTPS is FTP secured using TLS

Email Services



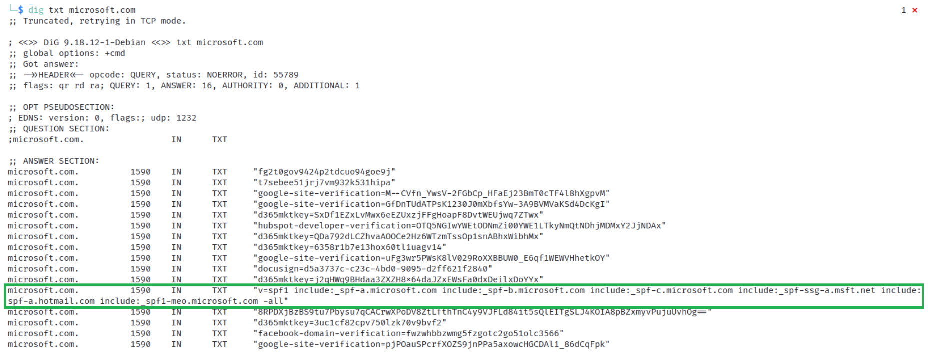
```
  GNU nano 2.2.2          File: /etc/dovecot/dovecot.conf               Modified

protocols = imap imaps
#protocols = none

# A space separated list of IP or host addresses where to listen in for
# connections. "*" listens in all IPv4 interfaces. "[::]" listens in all IPv6
# interfaces. Use "*, [::]" for listening both IPv4 and IPv6.
#
# If you want to specify ports for each service, you will need to configure
# these settings inside the protocol imap/pop3/managesieve { ... } section,
# so you can specify different ports for IMAP/POP3/MANAGESIEVE. For example:
   protocol imap {
     listen = *:143
     ssl_listen = *:943
    }
#   protocol pop3 {
#     listen = *:10100
#     ..
#   }
#   protocol managesieve {
#     listen = *:12000
#     ..
#   }
#listen = *

# Disable LOGIN command and all other plaintext authentications unless
                               [ Read 1280 lines ]
^G Get Help  ^O WriteOut  ^R Read File ^Y Prev Page ^K Cut Text  ^C Cur Pos
^X Exit      ^J Justify   ^W Where Is  ^V Next Page ^U UnCut Text^T To Spell
```

Configuring mailbox access protocols on a server.

- SMTP
  - Cleartext by default
  - Transmit email between systems
  - SMTPS is secure configuration
- Open Relay
  - Improperly configured SMTP server
  - Used to send SPAM
- POP & IMAP
  - Used to access mailboxes
  - Cleartext by default
  - POPS & IMAPS are secure

Email Security (1 of 3)

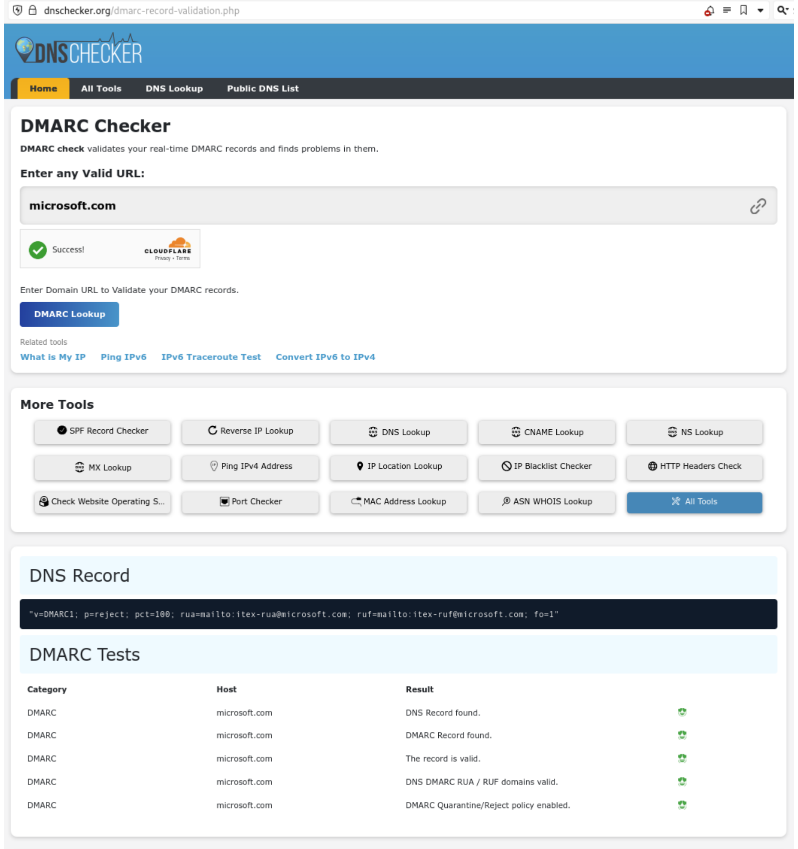
- Sender Policy Framework (SPF)
  - Email validation method that helps detect and prevent sender address forgery
  - Uses data saved in DNS TXT Records
  - Can use to identify “authorized senders”
    - Hosted email
    - Marketing campaigns, etc.



```
└─$ dig txt microsoft.com                                                                                          1 ×
;; Truncated, retrying in TCP mode.

; <<>> DiG 9.18.12-1-Debian <<>> txt microsoft.com
;; global options: +cmd
;; Got answer:
;; —»HEADER«— opcode: QUERY, status: NOERROR, id: 55789
;; flags: qr rd ra; QUERY: 1, ANSWER: 16, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1232
;; QUESTION SECTION:
;microsoft.com.                 IN      TXT

;; ANSWER SECTION:
microsoft.com.          1590    IN      TXT     "fg2t0gov9424p2tdcuo94goe9j"
microsoft.com.          1590    IN      TXT     "t7sebee51jrj7vm932k531hipa"
microsoft.com.          1590    IN      TXT     "google-site-verification=M--CVfn_YwsV-2FGbCp_HFaEj23BmT0cTF4l8hXgpvM"
microsoft.com.          1590    IN      TXT     "google-site-verification=GfDnTUdATPsK1230J0mXbfsYw-3A9BVMVaKSd4DcKgI"
microsoft.com.          1590    IN      TXT     "d365mktkey=SxDf1EZxLvMwx6eEZUxzjFFgHoapF8DvtWEUjwq7ZTwx"
microsoft.com.          1590    IN      TXT     "hubspot-developer-verification=OTQ5NGIwYWEtODNmZi00YWE1LTkyNmQtNDhjMDMxY2JjNDAx"
microsoft.com.          1590    IN      TXT     "d365mktkey=QDa792dLCZhvaAOOCe2Hz6WTzmTssOp1snABhxWibhMx"
microsoft.com.          1590    IN      TXT     "d365mktkey=6358r1b7e13hox60tl1uagv14"
microsoft.com.          1590    IN      TXT     "google-site-verification=uFg3wr5PWsK8lV029RoXXBBUW0_E6qf1WEWVHhetkOY"
microsoft.com.          1590    IN      TXT     "docusign=d5a3737c-c23c-4bd0-9095-d2ff621f2840"
microsoft.com.          1590    IN      TXT     "d365mktkey=j2qHWq9BHdaa3ZXZH8×64daJZxEWsFa0dxDeilxDoYYx"
microsoft.com.          1590    IN      TXT     "v=spf1 include:_spf-a.microsoft.com include:_spf-b.microsoft.com include:_spf-c.microsoft.com include:_spf-ssg-a.msft.net include:
spf-a.hotmail.com include:_spf1-meo.microsoft.com -all"
microsoft.com.          1590    IN      TXT     "8RPDXjBzBS9tu7Pbysu7qCACrwXPoDV8ZtLfthTnC4y9VJFLd84it5sQlEITgSLJ4KOIA8pBZxmyvPujuUvhOg=="
microsoft.com.          1590    IN      TXT     "d365mktkey=3uc1cf82cpv750lzk70v9bvf2"
microsoft.com.          1590    IN      TXT     "facebook-domain-verification=fwzwhbbzwmg5fzgotc2go51olc3566"
microsoft.com.          1590    IN      TXT     "google-site-verification=pjPOauSPcrfXOZS9jnPPa5axowcHGCDAl1_86dCqFpk"
```

Displaying the TXT records for microsoft.com using the dig tool. (Screenshot used with permission from Microsoft.)

Email Security (2 of 3)



DMARC Checker

DMARC check validates your real-time DMARC records and finds problems in them.

Enter any Valid URL:

microsoft.com

Enter Domain URL to Validate your DMARC records.

DNS Record

```
"v=DMARC1; p=reject; pct=100; rua=mailto:itex-rua@microsoft.com; ruf=mailto:itex-ruf@microsoft.com; fo=1"
```

DMARC Tests

Category	Host	Result	
DMARC	microsoft.com	DNS Record found.	✓
DMARC	microsoft.com	DMARC Record found.	✓
DMARC	microsoft.com	The record is valid.	✓
DMARC	microsoft.com	DNS DMARC RUA / RUF domains valid.	✓
DMARC	microsoft.com	DMARC Quarantine/Reject policy enabled.	✓

Performing a DMARC lookup using the DNSChecker website https://dnschecker.org.

- DomainKeys Identified Mail (DKIM)
  - Sender signs emails using a digital signature
  - Receiver uses a DKIM record in the sender's DNS to verify the signature
- Domain-based Message Authentication, Reporting & Conformance (DMARC)
  - Uses the results of SPF and DKIM checks to define rules for handling messages
  - Provides reporting capabilities
    - Email activity
    - Identify systems sending emails
    - Identify unauthorized activity

Email Security (3 of 3)

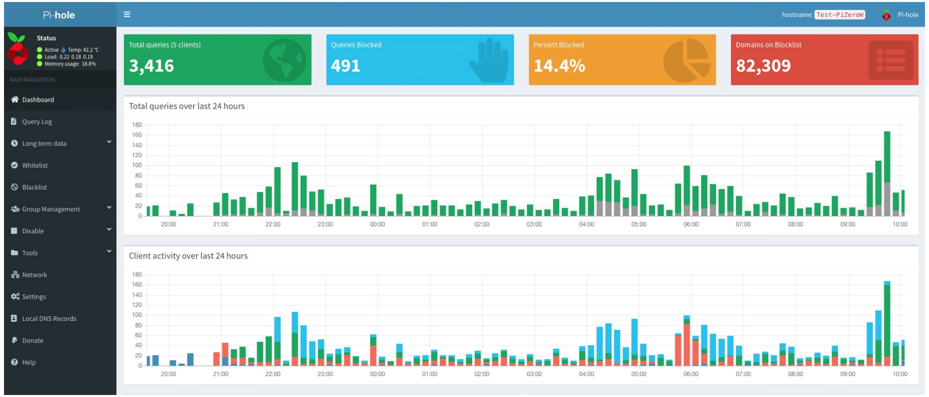
- Email Gateway
  - Control point for all incoming and outgoing email
  - Anti-spam filters and antivirus scanners
  - Sophisticated threat detection algorithms
    - Identify phishing attempts, Business Email Compromise (BEC) Attack
  - Harmful attachments and malicious URLs
    - URL Sanitization/Link Anonymization/Safe Linking/Web Link Transformation
- Secure/Multipurpose Internet Mail Extensions (S/MIME)
  - Encrypts emails to provide the confidentiality and integrity protections
  - Requires Public Key Infrastructure (PKI)

Email Data Loss Prevention

- Email is one of the most frequently used communication channels within organizations
  - Conduit for sensitive data
  - Encourages careless handling of sensitive data (ease of use) and prone to human error
  - Common channel for data loss
  - GDPR, HIPAA, and PCI DSS, (and others) have requirements for protecting data
- DLP scans emails and attachments for certain types of sensitive information
  - Prevents unauthorized sharing of sensitive information
  - Create organization-wide DLP policies
  - Actions are based on predefined rules, such as
    - Blocking the email, alerting the sender, automatically encrypting it

DNS Filtering

- Block or allow access to specific websites
  - DNS filter checks requests against a database of domain names
  - Block access to malicious sites
  - Content/Site Restrictions
  - Ad-blocking (Pi-Hole, AdGuard)
- OpenDNS opendns.com
- Quad9 quad9.net
- CleanBrowsing cleanbrowsing.org
- Cisco Umbrella umbrella.cisco.com/products/dns-layer-network-security
- CloudFlare DNS cloudflare.com/application-services/products/dns/



hostname: Test-PiZeroW

Status
Active Temp: 42.2 °C
Load: 0.22 0.18 0.19
Memory usage: 18.8%

Total queries (5 clients) 3,416

Queries Blocked 491

Percent Blocked 14.4%

Domains on Blocklist 82,309

The Pi-hole administrative dashboard showing DNS resolution statistics. (Screenshot courtesy of Pi-hole.)

DNS Security

- DNS Contains valuable information about hosts on a network
- Internal records should not be accessible from the Internet
- DNS protocol is often exploited to perform data exfiltration
- DNS can be exploited to provide malicious data (ex. Attacker IP instead of real IP)

- DNS Security Extensions (DNSSEC)
  - Mitigate spoofing and poisoning attacks
  - Provides a validation process for DNS responses
  - Authoritative server for the zone creates a "package" of resource records (RRset)

Review Activity: Application Protocol Security Baselines

- Secure Protocols
- Transport Layer Security
- Secure Directory Services
- Simple Network Management Protocol Security
- File Transfer Services
- Email Services
- Email Security
- Email Data Loss Prevention
- DNS Filtering

Lab Activity

- Assisted Lab: Performing DNS Filtering

Lesson 11

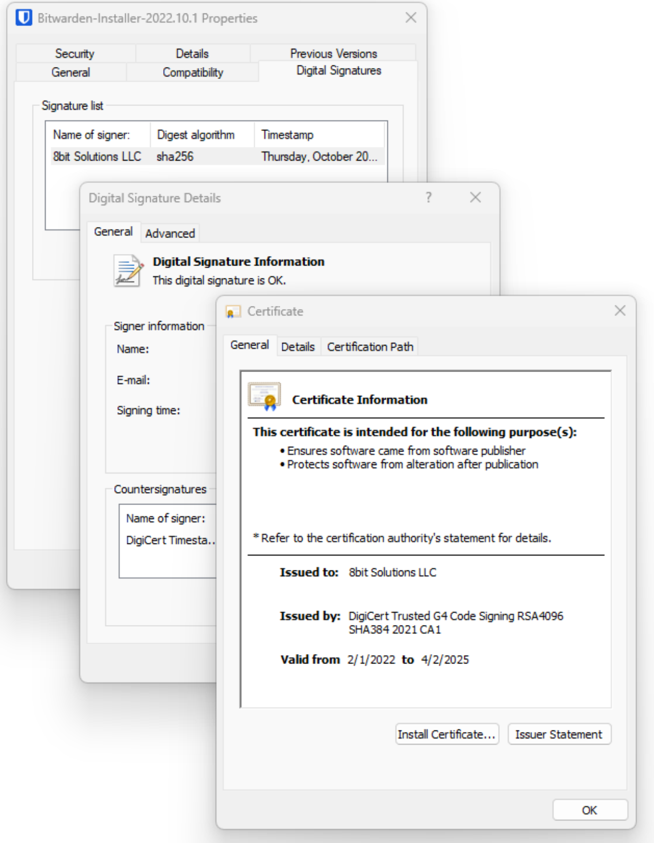
Topic 11B

Cloud and Web Application Security Concepts

Secure Coding Techniques (1 of 2)

- Pressure to release an application often overshadows the requirement to ensure it is secure

- Coding practices must implement secure development practices
- Code Signing
- Secure Cookies
- Static/Dynamic Code Analysis
- Peer Review



Bitwarden-Installer-2022.10.1 Properties

Signature list

Name of signer:	Digest algorithm	Timestamp
8bit Solutions LLC	sha256	Thursday, October 20...

Digital Signature Details

Digital Signature Information
This digital signature is OK.

Signer information
Name:
E-mail:
Signing time:

Countersignatures
Name of signer:
DigiCert Timesta..

Certificate

Certificate Information

This certificate is intended for the following purpose(s):
- Ensures software came from software publisher
- Protects software from alteration after publication

*Refer to the certification authority's statement for details.

Issued to: 8bit Solutions LLC

Issued by: DigiCert Trusted G4 Code Signing RSA4096 SHA384 2021 CA1

Valid from 2/1/2022 **to** 4/2/2025

Reviewing the digital signature contained within the Bitwarden Password Management app installer.

Secure Coding Techniques (2 of 2)

- Input Validation
- Attacker provides specially crafted data to an application to manipulate its behavior
- Injection Attack
- Methods used to perform input validation:
    - Allow/Block Lists
    - Data Type checks
    - Range checks
    - Regular Expressions
    - Encoding

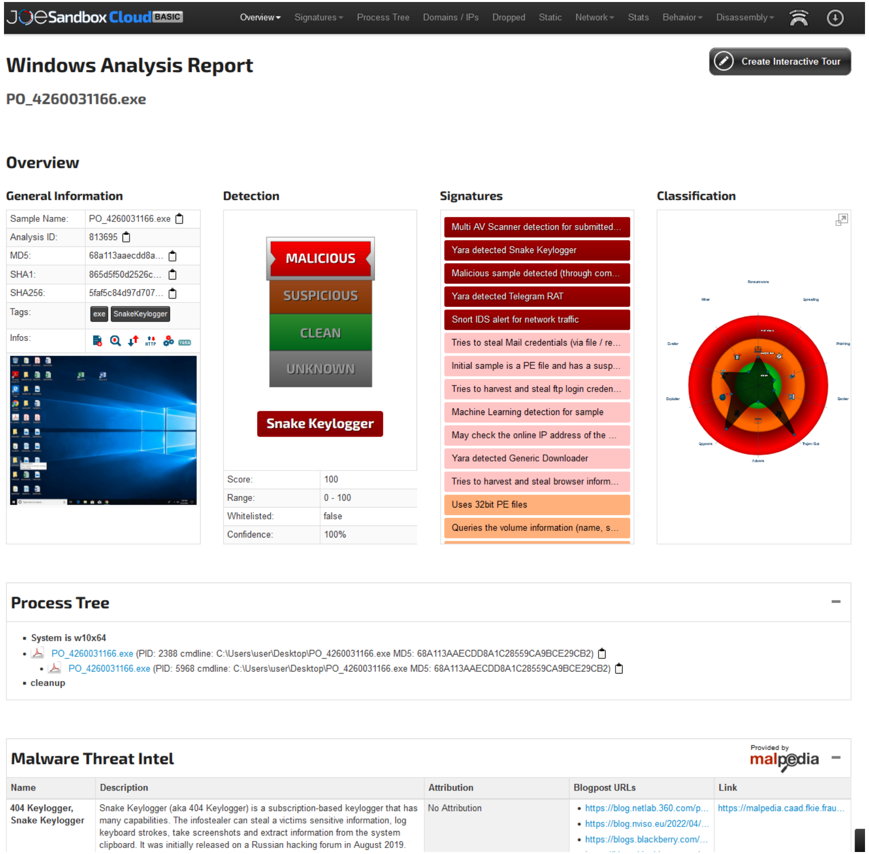
Application Protections (1 of 2)

- Data exposure
- Allows privileged information to be read by unauthorized user
  - Access token
  - Password
  - Personal data
- Error Handling
  - Safely handle and control errors
  - Report errors to logs instead of user interface
- Application Security in the Cloud
  - Application security supports the shared responsibility model
  - Secure applications running on a secure cloud platform

Application Protections (2 of 2)

- Memory Management
  - Buffer overflow attacks are a decades-old problem
  - Input validation is an important defense
- Client-Side vs. Server-Side Validation
  - Security checks should be performed server-side
  - Developers often use client-side checks to improve application performance
  - Client-side checks can be bypassed

Software Sandboxing



Windows Analysis Report

PO_4260031166.exe

Overview

General Information

Sample Name:	PO_4260031166.exe
Analysis ID:	813695
MD5:	68a113aaecdd8a...
SHA1:	865d5f50d2526c...
SHA256:	5faf5c84d97d707...
Tags:	exe SnakeKeylogger
Infos:	

Detection

MALICIOUS

SUSPICIOUS

CLEAN

UNKNOWN

Snake Keylogger

Score:	100
Range:	0 - 100
Whitelisted:	false
Confidence:	100%

Signatures

- Multi AV Scanner detection for submitted...
- Yara detected Snake Keylogger
- Malicious sample detected (through com...
- Yara detected Telegram RAT
- Snort IDS alert for network traffic
- Tries to steal Mail credentials (via file / re...
- Initial sample is a PE file and has a susp...
- Tries to harvest and steal ftp login creden...
- Machine Learning detection for sample
- May check the online IP address of the ...
- Yara detected Generic Downloader
- Tries to harvest and steal browser inform...
- Uses 32bit PE files
- Queries the volume information (name, s...

Classification

Process Tree

- System is w10x64
- PO_4260031166.exe (PID: 2388 cmdline: C:\Users\user\Desktop\PO_4260031166.exe MD5: 68A113AAECDD8A1C28559CA9BCE29CB2)
  - PO_4260031166.exe (PID: 5968 cmdline: C:\Users\user\Desktop\PO_4260031166.exe MD5: 68A113AAECDD8A1C28559CA9BCE29CB2)
- cleanup

Malware Threat Intel

Provided by malpedia

Name	Description	Attribution	Blogpost URLs	Link
404 Keylogger, Snake Keylogger	Snake Keylogger (aka 404 Keylogger) is a subscription-based keylogger that has many capabilities. The infostealer can steal a victims sensitive information, log keyboard strokes, take screenshots and extract information from the system clipboard. It was initially released on a Russian hacking forum in August 2019.	No Attribution	https://blog.netlab.360.com/p... https://blog.nviso.eu/2022/04/... https://blogs.blackberry.com/...	https://malpedia.caad.fkie.frau...

Joe Sandbox analysis of a malicious executable file. (Screenshot courtesy of Joe Security, LLC.)

- A security mechanism used to isolate software
- Prevent it from accessing operating system features
- Isolate is from other processes/software
- Prevent access to network
- “Safe Detonation”

Review Activity:

- Secure Coding Techniques
- Application Protections
- Software Sandboxing

Lab Activity

- Assisted Lab: Configuring System Monitoring

CompTIA Security+ Exam SY0-701

Lesson 11

Summary