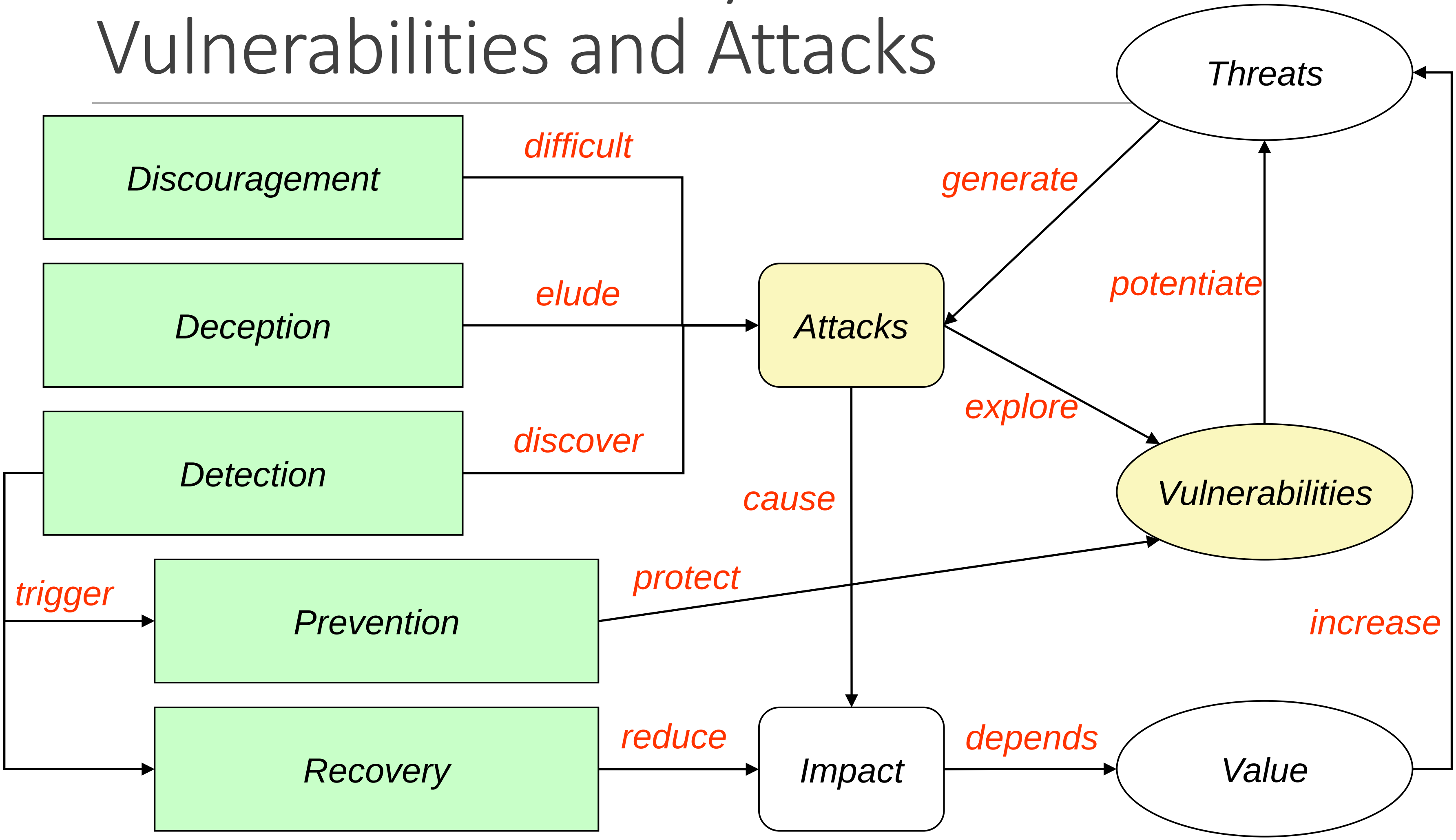
Vulnerabilities

Information Security
Vulnerabilities and Attacks



Measures (and some tools)

Discouragement

- Punishment
  - Legal restrictions
  - Forensic evidences
- Security barriers
  - *Firewalls*
  - Autentication
  - Secure communication
  - *Sandboxing*

Detection

- Intrusion detection system
  - e.g. Seek, Bro, Suricata
- Auditing
- Forensic break-in analysis

Deception

- *Honeypots / honeynets*
- Forensic follow-up

Prevention

- Restrictive policies
  - e.g. least privilege principle
- Vulnerability scanning
  - e.g. OpenVAS, metasploit
- Vulnerability patching
  - e.g. regular updates

Recovery

- Backups
- Redundant systems
- Forensic recovery

Security readiness (1/3)

Discouragement, Deception and Detection measures mainly tackle known issues

- Reconnaissance attempts (e.g. port scanning)
- Generic attacks (e.g. network eavesdropping)
- Specific attacks (e.g. buffer overflows)

Prevention measures tackle well-known and unknown vulnerabilities

- Generic vulnerabilities
  - e.g. reaction to malformed messages (protocol scrubbers)
  - e.g. stealth attacks (normalization to canonical formats)
- Specific vulnerabilities (e.g. a particular software bug)

Security readiness (2/3)

Measure enforcement requires specific knowledge

Known vulnerabilities

- Problem, exploitation mode, impact, etc.

Activity patterns used in attacks

- Modus operandi
- Attacks’ signatures

Abnormal activity patterns

- Abnormal is the opposite of normal ...
  - ...but what’s normal?
- Hard to define in heterogeneous environments

source: flickr

Security readiness (3/3)

Computer network threats are not like other threats

- They can be launched anytime, anywhere
- They can be easily coordinated, and chain multiple attacks
  - e.g. Distributed Denial of Service attacks (DDoS)
- They are cheap to deploy
- They can be automated
- They are fast

Thus, they require a permanent, 24x7 capacity to react to attacks:

- Teams of security experts
- Just-in-time attack alerts
- Security measurement and evaluation
- Immediate reaction procedures

Zero Day (or Zero Hour) Attack/Threat

Attack using vulnerabilities which are:

- Unknown to others
- Undisclosed to the software vendor

Occurs at the day zero of the knowledge about those vulnerabilities

- For which no security fix is available

A single "day zero" may exist for months/years

- Known to attackers, unknown to others
- Frequently part of attack arsenal
- Traded around in specific markets

Case Study: ShadowBrokers

Background: State actors have exploits to publicly unknown vulnerabilities

- For many years, used for state level warfare, and never revealed

August 2016: Shadowbrokers publish large stash of tools from state actors

- Use standard public channels: Twitter, Github, PasteBin, Medium
- Then several other stashes, make an auction, black friday sales, etc...
- Objective: sell tools exploiting 0 days to the highest bidder

March 2017: Microsoft releases patch to most Windows systems

- but not to W7, W8, WXP and Server 2003
- Possibly tipped by state actor or researcher

Case Study: ShadowBrokers

April 2017: ETERNALBLUE leaked by ShadowBrokers to the public

- Exploit to MS Windows SMB v1, allowing Remote Code Execution

May 2017: WannaCry Ransomware

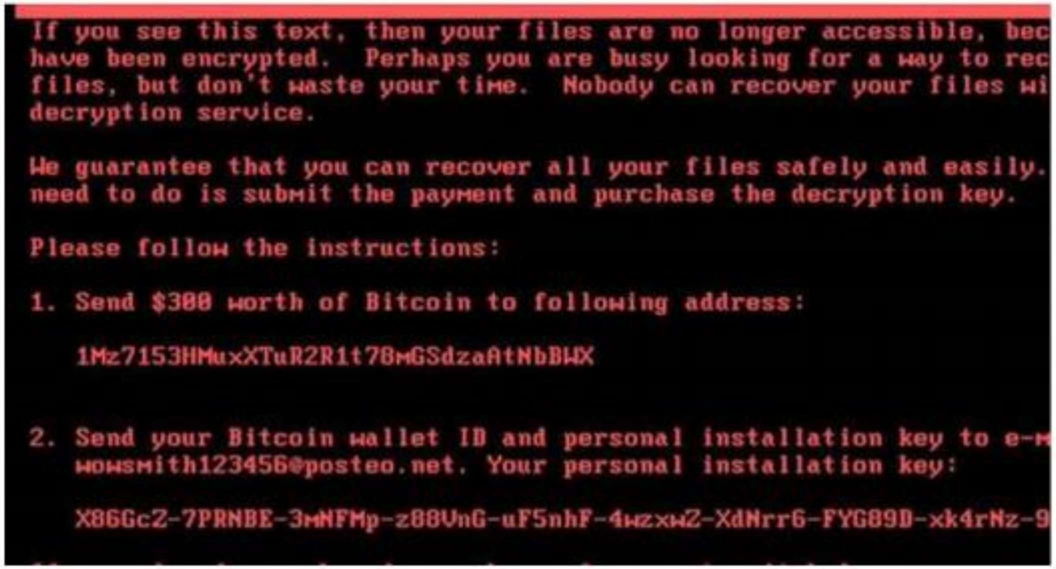
- Uses 2 exploits from ShadowBrokers leak (ETERNALBLUE as entry point)
- Asks for $300-600 ransom to obtain the key
- Impact: Files are encrypted in >300.000 devices

May 2017: EternalRocks Ransomware

- Uses 7 exploits from ShadowBrokers leak (ETERNALBLUE as entry point)
- Impact: Panic only. Author disables worm

June 2017: NotPetya Ransomware

- Variant using ETERNALBLUE and infects the Master Book Record
- Asks for $300 ransom (but decryption key is never provided)
- Targets mostly Ukraine companies and utilities (Russia and others affected too)
- Impact: Files are lost. >$10B of damage



```
If you see this text, then your files are no longer accessible, bec
have been encrypted.  Perhaps you are busy looking for a way to rec
files, but don't waste your time.  Nobody can recover your files wi
decryption service.

We guarantee that you can recover all your files safely and easily.
need to do is submit the payment and purchase the decryption key.

Please follow the instructions:

1. Send $300 worth of Bitcoin to following address:

   1Mz7153HMuxXTuR2R1t78mGSdzaAtNbBWX


2. Send your Bitcoin wallet ID and personal installation key to e-m
   wowsmith123456@posteo.net. Your personal installation key:

   X86GcZ-7PRNBE-3mNFMp-z88VnG-uF5nhF-4wzxwZ-XdNrr6-FYG89D-xk4rNz-9
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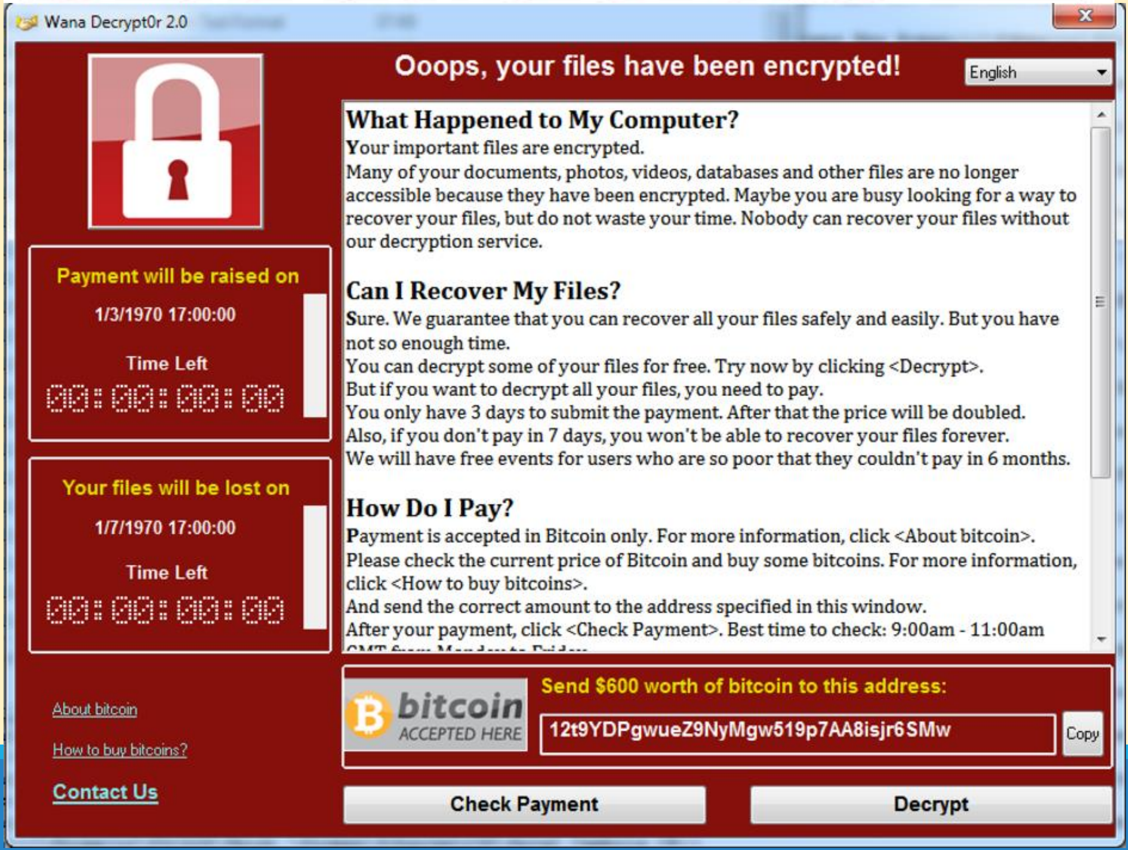


Ooops, your files have been encrypted!

What Happened to My Computer?

Your important files are encrypted.
Many of your documents, photos, videos, databases and other files are no longer accessible because they have been encrypted. Maybe you are busy looking for a way to recover your files, but do not waste your time. Nobody can recover your files without our decryption service.

Can I Recover My Files?

Sure. We guarantee that you can recover all your files safely and easily. But you have not so enough time.
You can decrypt some of your files for free. Try now by clicking <Decrypt>.
But if you want to decrypt all your files, you need to pay.
You only have 3 days to submit the payment. After that the price will be doubled.
Also, if you don't pay in 7 days, you won't be able to recover your files forever.
We will have free events for users who are so poor that they couldn't pay in 6 months.

How Do I Pay?

Payment is accepted in Bitcoin only. For more information, click <About bitcoin>.
Please check the current price of Bitcoin and buy some bitcoins. For more information, click <How to buy bitcoins>.
And send the correct amount to the address specified in this window.
After your payment, click <Check Payment>. Best time to check: 9:00am - 11:00am GMT from Monday to Friday.

Send $600 worth of bitcoin to this address:

12t9YDPgwueZ9NyMgw519p7AA8isjr6SMw

Vulnerability detection

Specific tools can detect vulnerabilities

- Exploiting known vulnerabilities
- Testing known vulnerability patterns
  - e.g. buffer overflow, SQL injection, XSS, etc.

Specific tools can replicate known attacks

- Use known exploits for known vulnerabilities
  - e.g.: MS Samba v1 exploit used by WannaCry
- Can be used to implement countermeasures

Vital to assert the robustness of production systems and applications

- Service often provided by third-party companies

Vulnerability detection

Can be applied to:

- Source code (static analysis)
  - OWASP LAPSE+, RIPS, Veracode, …
- Running application (dynamic analysis)
  - Valgrind, Rational, AppScan, GCC, …
- Externally as a remote client:
  - OpenVAS, Metasploit, …

Should not be <u>blindly</u> applied to production systems!

- Potential data loss/corruption
- Potential DoS
- Potential ilegal activity

Survivability

How can we survive a zero-day attack?

How can we react to a massive zero-day attack?

Diversity is one answer (as a policy) …

- but software production, distribution and update goes on the opposite direction!
  - And the same happens with hardware architectures
- Why is MS Windows such an interesting target?
  - And Apple macOS not so much?
- Are you using an Android cell phone?
  - What are the odds of being in the battlefront? (you are)
  - iOS landscape may be worst as it is more homogeneous

CVE
Common Vulnerabilities and Exposures

Dictionary of publicly known information security vulnerabilities and exposures

- For vulnerability management
- For patch management
- For vulnerability alerting
- For intrusion detection

Uses common identifiers for the same CVE's

- Enable data exchange between security products
- Provide a baseline index point for evaluating coverage of tools and services.

Details about a vulnerability can be kept private

- Part of responsible disclosure: Until owner provides a fix

CVE Vulnerability

A mistake in software that can be directly used by an attacker to gain access to a system or network

A mistake is a vulnerability if it allows an attacker to use it to violate a reasonable security policy for that system

- This excludes entirely "open" security policies in which all users are trusted, or where there is no consideration of risk to the system

A CVE vulnerability is a state in a computing system (or set of systems) that either:

- Allows an attacker to execute commands as another user
- Allows an attacker to access data that is contrary to the specified access restrictions for that data
- Allows an attacker to pose as another entity
- Allows an attacker to conduct a denial of service

CVE Exposure

A configuration issue or a mistake in software allowing access to information or capabilities used as a stepping-stone into a system or network

A configuration issue or a mistake is an exposure if it does not directly allow compromise

- But could be an important component of a successful attack, and is a violation of a reasonable security policy

An exposure describes a state in a computing system (or set of systems) that is not a vulnerability, but either:

- Allows an attacker to conduct information gathering activities
- Allows an attacker to hide activities
- Includes a capability that behaves as expected, but can be easily compromised
- Is a primary point of entry that an attacker may attempt to use to gain access to the system or data
- Is considered a problem by some reasonable security policy

CVE benefits

Provides common language for referring to problems

- Facilitates data sharing among
- Intrusion detection systems
- Assessment tools
- Vulnerability databases
- Researchers
- Incident response teams

Will lead to improved security tools

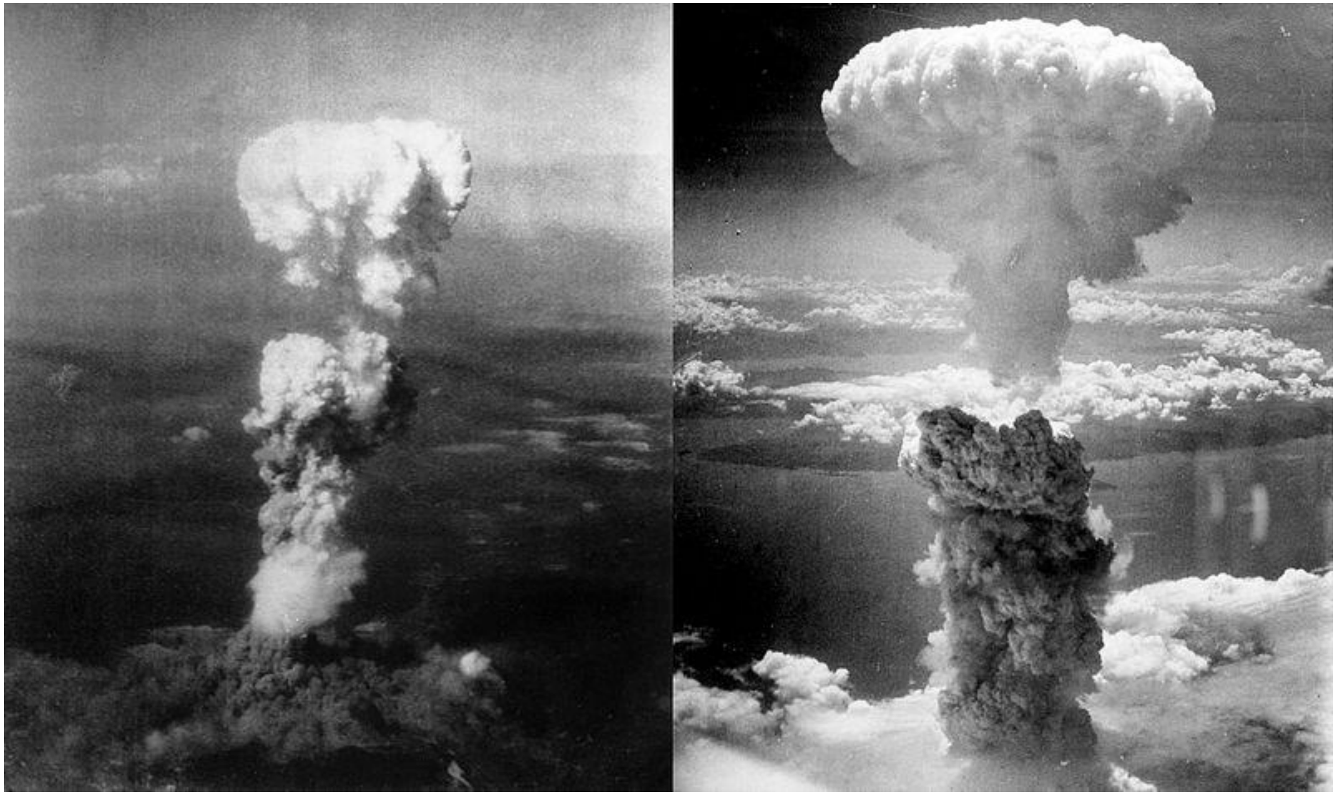
- More comprehensive, better comparisons, interoperable
- Indications and warning systems

Will spark further innovations

- Focal point for discussing critical database content issues

CVE limitations

Worthless Against 0-day attacks



CVE identifiers

Aka CVE names, CVE numbers, CVE-IDs, CVEs

Unique, common identifiers for publicly known information security vulnerabilities

- Have "candidate" or "entry" status
- Candidate: under review for inclusion in the list
- Entry: accepted to the CVE List

Format

- CVE identifier number (CVE-Year-Order)
- Status (Candidate or Entry)
- Brief description of the vulnerability or exposure
- References to extra information

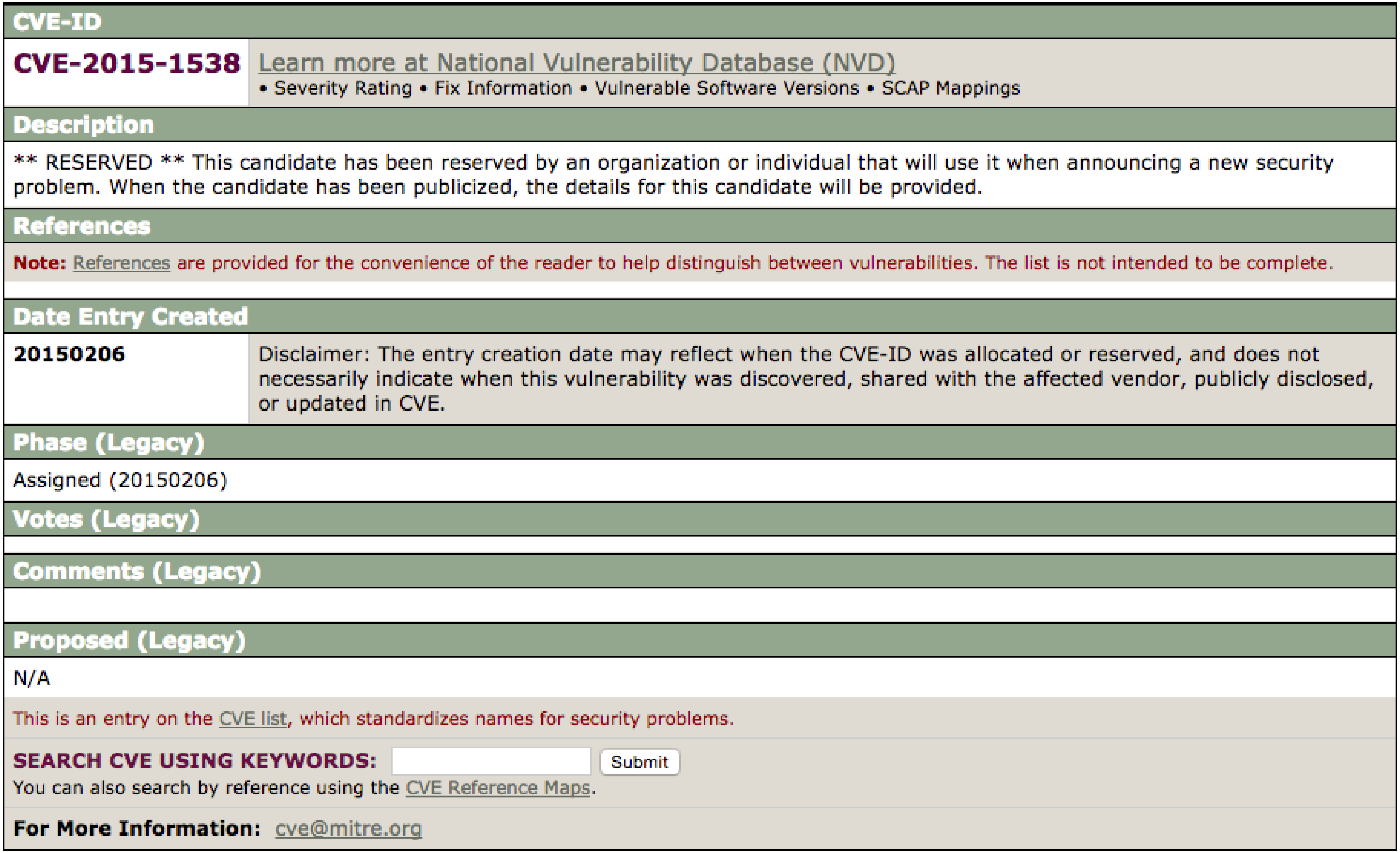
CVE and Attacks

Attacks can be made possible through multiple vulnerabilities

- One CVE for each vulnerability

Example: Stagefright (Android, video in MMS messages)

- CVE-2015-1538, P0006, Google Stagefright ‘stsc’ MP4 Atom Integer Overflow Remote Code Execution
- CVE-2015-1538, P0004, Google Stagefright ‘ctts’ MP4 Atom Integer Overflow Remote Code Execution
- CVE-2015-1538, P0004, Google Stagefright ‘stts’ MP4 Atom Integer Overflow Remote Code Execution
- CVE-2015-1538, P0004, Google Stagefright ‘stss’ MP4 Atom Integer Overflow Remote Code Execution
- CVE-2015-1539, P0007, Google Stagefright ‘esds’ MP4 Atom Integer Underflow Remote Code Execution
- CVE-2015-3827, P0008, Google Stagefright ‘covr’ MP4 Atom Integer Underflow Remote Code Execution
- CVE-2015-3826, P0009, Google Stagefright 3GPP Metadata Buffer Overread
- CVE-2015-3828, P0010, Google Stagefright 3GPP Integer Underflow Remote Code Execution
- CVE-2015-3824, P0011, Google Stagefright ‘tx3g’ MP4 Atom Integer Overflow Remote Code Execution
- CVE-2015-3829, P0012, Google Stagefright ‘covr’ MP4 Atom Integer Overflow Remote Code Execution



CVE-ID

CVE-2015-1538 Learn more at National Vulnerability Database (NVD)
• Severity Rating • Fix Information • Vulnerable Software Versions • SCAP Mappings

Description

** RESERVED ** This candidate has been reserved by an organization or individual that will use it when announcing a new security problem. When the candidate has been publicized, the details for this candidate will be provided.

References

Note: References are provided for the convenience of the reader to help distinguish between vulnerabilities. The list is not intended to be complete.

Date Entry Created

20150206 Disclaimer: The entry creation date may reflect when the CVE-ID was allocated or reserved, and does not necessarily indicate when this vulnerability was discovered, shared with the affected vendor, publicly disclosed, or updated in CVE.

Phase (Legacy)

Assigned (20150206)

Votes (Legacy)

Comments (Legacy)

Proposed (Legacy)

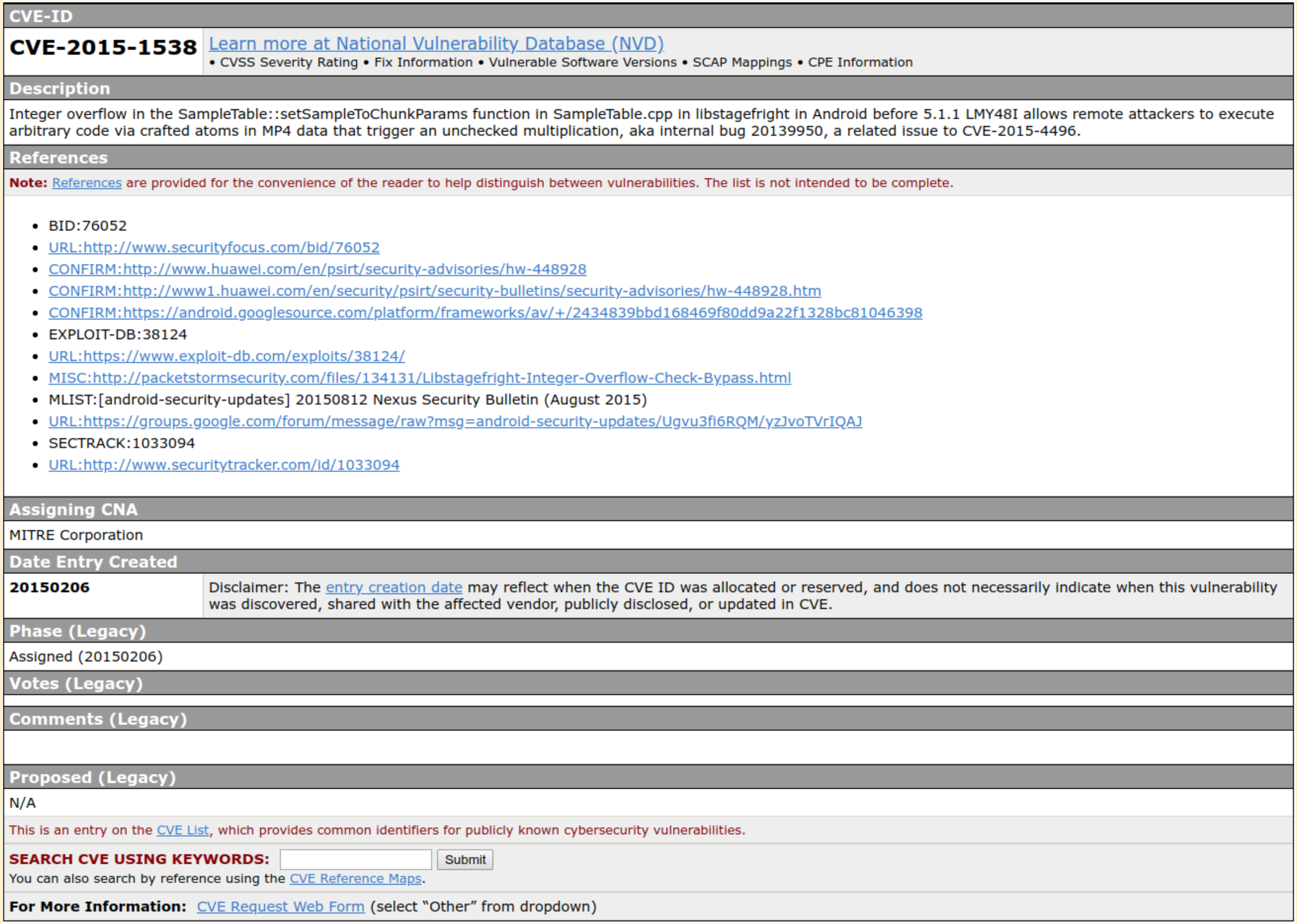
N/A

This is an entry on the CVE list, which standardizes names for security problems.

SEARCH CVE USING KEYWORDS:

You can also search by reference using the CVE Reference Maps.

For More Information: cve@mitre.org



CVE-ID

CVE-2015-1538

Learn more at National Vulnerability Database (NVD)
• CVSS Severity Rating • Fix Information • Vulnerable Software Versions • SCAP Mappings • CPE Information

Description

Integer overflow in the SampleTable::setSampleToChunkParams function in SampleTable.cpp in libstagefright in Android before 5.1.1 LMY48I allows remote attackers to execute arbitrary code via crafted atoms in MP4 data that trigger an unchecked multiplication, aka internal bug 20139950, a related issue to CVE-2015-4496.

References

Note: References are provided for the convenience of the reader to help distinguish between vulnerabilities. The list is not intended to be complete.

- BID:76052
- URL:http://www.securityfocus.com/bid/76052
- CONFIRM:http://www.huawei.com/en/psirt/security-advisories/hw-448928
- CONFIRM:http://www1.huawei.com/en/security/psirt/security-bulletins/security-advisories/hw-448928.htm
- CONFIRM:https://android.googlesource.com/platform/frameworks/av/+/2434839bbd168469f80dd9a22f1328bc81046398
- EXPLOIT-DB:38124
- URL:https://www.exploit-db.com/exploits/38124/
- MISC:http://packetstormsecurity.com/files/134131/Libstagefright-Integer-Overflow-Check-Bypass.html
- MLIST:[android-security-updates] 20150812 Nexus Security Bulletin (August 2015)
- URL:https://groups.google.com/forum/message/raw?msg=android-security-updates/Ugvu3fi6RQM/yzJvoTVrIQAJ
- SECTRACK:1033094
- URL:http://www.securitytracker.com/id/1033094

Assigning CNA

MITRE Corporation

Date Entry Created

20150206

Disclaimer: The entry creation date may reflect when the CVE ID was allocated or reserved, and does not necessarily indicate when this vulnerability was discovered, shared with the affected vendor, publicly disclosed, or updated in CVE.

Phase (Legacy)

Assigned (20150206)

Votes (Legacy)

Comments (Legacy)

Proposed (Legacy)

N/A

This is an entry on the CVE List, which provides common identifiers for publicly known cybersecurity vulnerabilities.

SEARCH CVE USING KEYWORDS: Submit

You can also search by reference using the CVE Reference Maps.

For More Information: CVE Request Web Form (select "Other" from dropdown)

CWE
Common Weakness Enumeration

Common language of discourse for discussing, finding and dealing with the causes of software security vulnerabilities

- Found in code, design, or system architecture
- Each individual CWE represents a single vulnerability type
- Currently maintained by the MITRE Corporation
  - A detailed CWE list is currently available at the MITRE website
- The list provides a detailed definition for each individual CWE

Individual CWEs are held within a hierarchical structure

- CWEs located at higher levels provide a broad overview of a vulnerability type
  - Can have many children CWEs associated with them
- CWEs at deeper levels in the structure provide a finer granularity
  - Usually have fewer or no children CWEs

CWE != CVE

Seven Pernicious Kingdoms

1. **Input validation and representation**
2. **API abuse**
3. **Security features**
4. **Time and state**
5. **Errors**
6. **Code quality**
7. **Encapsulation**

(*) Environment

K. Teipenyuk, B. Chess, & G. McGraw, Seven Pernicious Kingdoms: A Taxonomy of Software Security Errors, IEEE Security & Privacy, 2005

Vulnerability databases

NIST NVD (National Vulnerability Database)

CERT Vulnerability Card Catalog

US-CERT Vulnerability Notes Database

Other

- https://en.0day.today
- https://www.exploit-db.com/
- https://vuldb.com/

CERT
Computer Emergency Readiness Team

Organization ensuring that appropriate technology and systems’ management practices are used to

- Resist attacks on networked systems
- Limit damage, ensure continuity of critical services
  - In spite of successful attacks, accidents, or failures

CERT/CC (Coordination Center) @ CMU

- One component of the larger CERT Program
- A major center for internet security problems
  - Established in November 1988, after the "Morris Worm“
  - It demonstrated the growing Internet exposure to attacks

CSIRT
Computer Security Incident Response Team

A service organization responsible for receiving, reviewing, and responding to computer security incident reports and activity

- Provides 24x7 Computer Security Incident Response Services to users, companies, government agencies or organizations
- Provides a reliable and trusted single point of contact for reporting computer security incidents worldwide
- CSIRT provides the means for reporting incidents and for disseminating important incident-related information

Portuguese CSIRTs

- CERT.PT: https://www.facebook.com/CentroNacionalCibersegurancaPT
- National CSIRT Network : https://www.redecsirt.pt/
- CSIRT @ UA: https://csirt.ua.pt

Security alerts & activity trends

Vital to the fast dissemination of knowledge about new vulnerabilities

- US-CERT Technical Cyber Security Alerts
- US-CERT (non-technical) Cyber Security Alerts
- SANS Internet Storm Center
  - Aka DShield (Defense Shield)
- Microsoft Security Response Center
- Cisco Security Center

- And many others …

Important Rules

Address security with a broad scope

Consider existing frameworks (ISO 27001, 27002)

- best practices and recommendations

Consider normative requirements

- add risk verifications and resolution strategies

Consider the legal requirements

- Laws, regulations, and contractual aspects

Create controls and ensure they address the requirements

Evaluate the operation of the security program

Important Rules

Identify and Manage Risk

Consider the specific risk to the system/ business/ operations

- Consider operational aspects and technology used
- Consider the devices and interactions with third parties
  - E.g.: payments with credit cards

Identify risk in all areas of the organization

- Technology, relations with third parties, people

Define preventive measures to reduce risk

- Consider an attack and its impact to the organization

Periodically evaluate risk

Important Rules

Follow the Data

Data has value

- To attackers: will focus in areas with more value
- Regulatory: Data breaches can imply high penalties
- Business: Leaks/Manipulations can imply severe financial losses

Know where the data is at every moment

- Who manipulates it
- Where/how it is stored
- Through where it is transmitted

Classify data according to risk/visibility

- Confidential, private, public, personal information

Important Rules

Apply defense in depth mechanisms

The attack surface is wide

- External adversaries, or adversaries which gain internal access
- Collaborators

Ensure the existence of adequate and sufficient controls

- Reconcile leak detection, manipulation, corruption
- Consider collaborators, third-parties, general public

Also consider physical mechanisms

- Air Gaps, Doors, Buildings

Embed security requirements into the organization language

Important Rules

Align security with objectives, products and services

Mandatory to ensure that security follows the organization

- Still relevant, exists and has impact

Evolve from the simple protection of the critical assets

- Consider all data

Have knowledge of how the organization operates, how products are developed/sold/operated

- Know how to apply security concepts

Know about the profit generation processes

- Important to calculate the impact of an attack

Important Rules

Antecipar, Inovar e Adaptar

Attacks, business and vulnerabilities evolve

- Security must follow this evolution
- Follow CSIRTS, CERTs, etc...

Focus on where there is a larger return from the protection

- What is easier to protect
- What has a greater damage (and is reasonable to be exploited)

Consider Advanced Persistent Attacks (APT)

- They don’t always target the big players

Important Rules

Establish a culture based on security

Create training opportunities for collaborators

- To understand the risks, impact and mitigations
- To know the best practices, mechanisms and solutions
- Which is supported and applied to all levels of the organization

Build policies which are applied to the entire organization

- As an integrated aspect and not an “extra”
- Have policies which include security in the product design
  - Mandated by law if the product deals with personal data
- Have policies which include suppliers, collaborators and clients

Promote a periodicity to security activites (e.g. 1p/y)

- Review policies
- Train, exchange ideas, discuss use cases

Important Rules

Trust but verify

Deploy the adequate controls

- Both for external and internal activities
- Without exceptions

External audits are vital

- Ensure the mechanisms are effective
- Ensure the policies cover the correct aspects
- Ensure the lays are observed

Pentests are an important tool

- Evaluate the existence of weaknesses in the application and technologies
- Evaluate the existence of weaknesses in collaborator and processes

Important Rules

Share Experiences, Regulations, Incidents and Responses

Provide the capacity to analyze incidents

- About the entire stack of processes and applications
- Requires the existence of trusted records (logs)
- Discuss internally, in a broad manner

Commit to external influence

- Show how regulation is applied
- Show how incidents are handled
- Increate trust towards clients and suppliers