30th ANNUAL FIRST CONFERENCE
KUALA LUMPUR
June 24-29, 2018
30 YEARS OF INCIDENT HANDLING

# Using a Vulnerability Description Ontology for vulnerability coordination

## - Removing the pain of repetitive analysis of vulnerability reports -

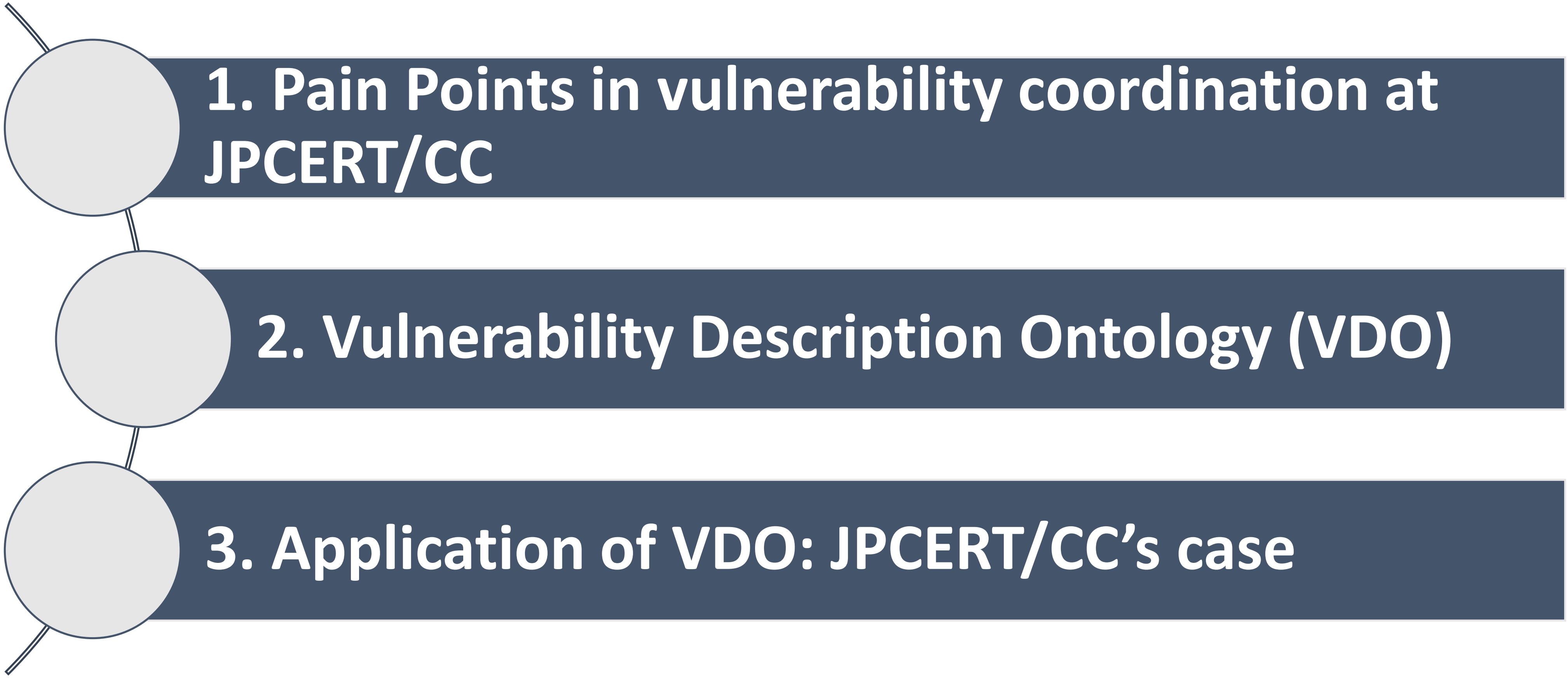
**Masanobu Katagi, Takayuki Uchiyama (JPCERT/CC, JP), and Masaki Kubo (NICT, JP)**

FIRST
Improving Security Together

# BIO

- **Masanobu Katagi (JPCERT/CC - Vulnerability Coordination Group)**
  - Responsible for vulnerability coordination at JPCERT/CC
- **Takayuki (Taki) Uchiyama (JPCERT/CC - Technical Committee Member, Panasonic PSIRT)**
  - Responsible for activities related to vulnerabilities (identification, analysis, coordination, disclosure)
- **Masaki KUBO (Cybersecurity Laboratory, NICT)**
  - Responsible for leading technical analysis of darknet monitoring of NICTER as well as NICT-CSIRT operation

# Today’s talk



1. Pain Points in vulnerability coordination at JPCERT/CC

2. Vulnerability Description Ontology (VDO)

3. Application of VDO: JPCERT/CC’s case

# About JPCERT/CC

## Prevent

-Vulnerability Coordination

- ➢ Coordinate with developers on unknown vulnerability information
- ➢ Secure Coding

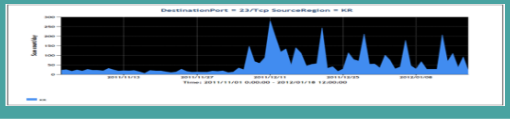
JVN Japan Vulnerability Notes

## Watch

-Information gathering / analysis / sharing

-Internet Traffic Monitoring

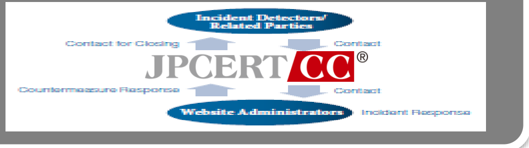
- ➢ Alerts / Advisories



## Respond

- Incident Handling

- ➢ Mitigating the damage through efficient incident handling
- ➢ Information sharing to prevent similar incidents



**Early Warning Information**
Information sharing with critical infrastructure enterprises, etc.

**CSIRT Establishment Support**
Capacity building for internal CSIRTs in enterprises / overseas national CSIRTs

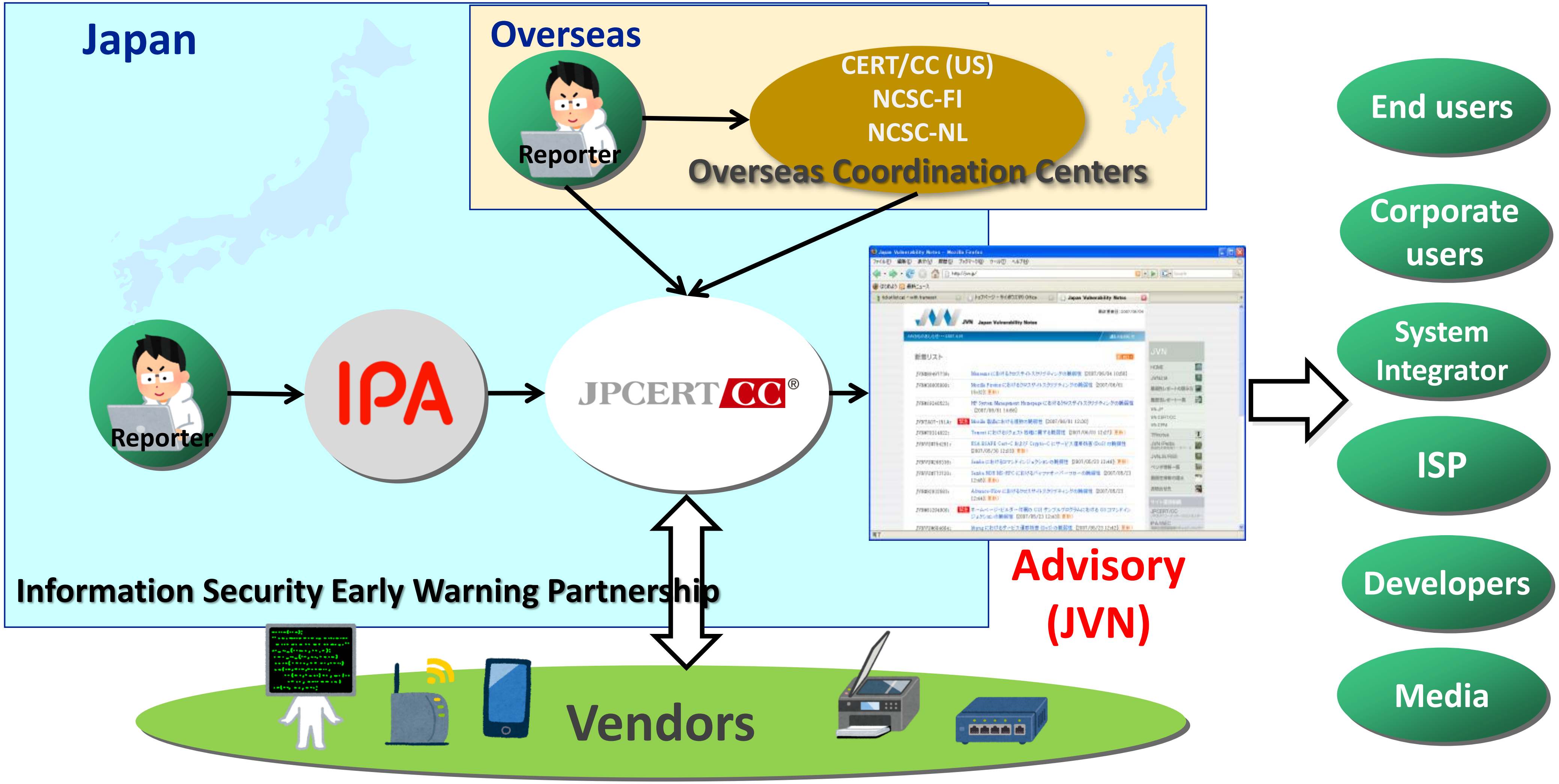
**Industrial Control System Security**
Activities to protect ICS, such as incident handling and information gathering/sharing

**Artifact Analysis**
Analysis on attack methods / behavior of malware (unauthorized program)

**Domestic Collaboration**
Collaboration with various security communities in Japan

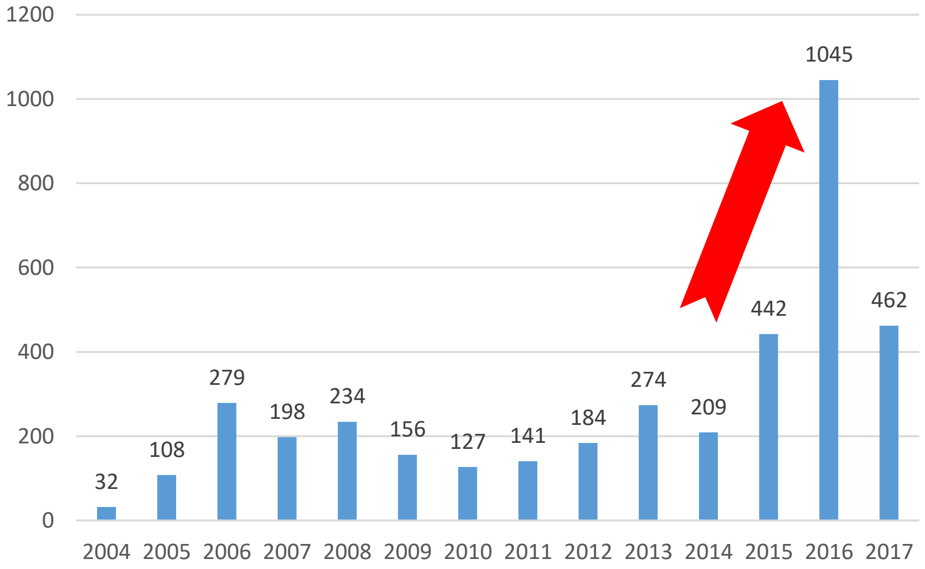
**International Collaboration**
Collaboration with overseas organizations for smoother handling of incidents and vulnerabilities

# JPCERT/CC - Vulnerability Coordination



# Bottlenecks in Coordination

- Sudden increase in vulnerability reports the last few years
  - 2.4 times more reports in 2016
  - Bottlenecks in JPCERT/CC coordination process
    - Delay of delivering reports to vendor
    - Increased risk for the vulnerable software
  - Urgent need to re-think coordination process

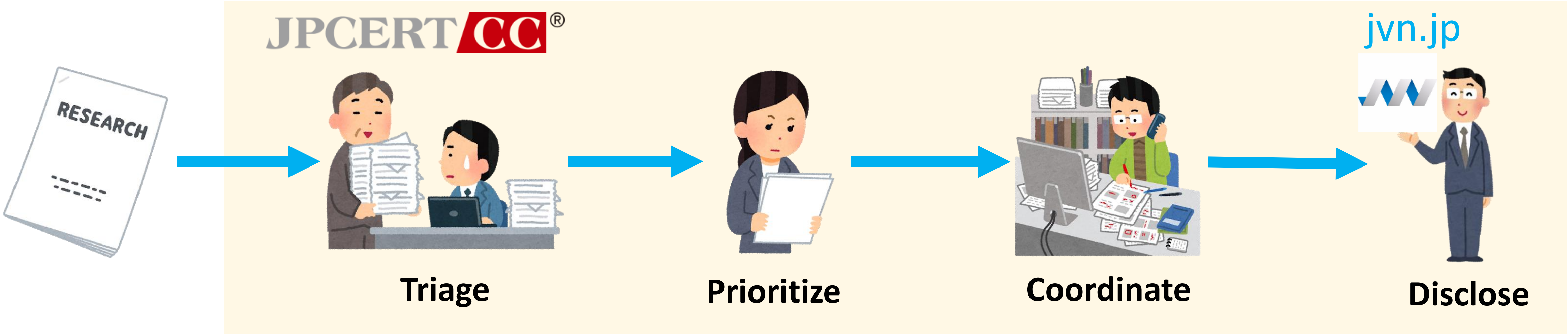


**Total number of reported vulnerabilities by year (as of 4/25/2018)**

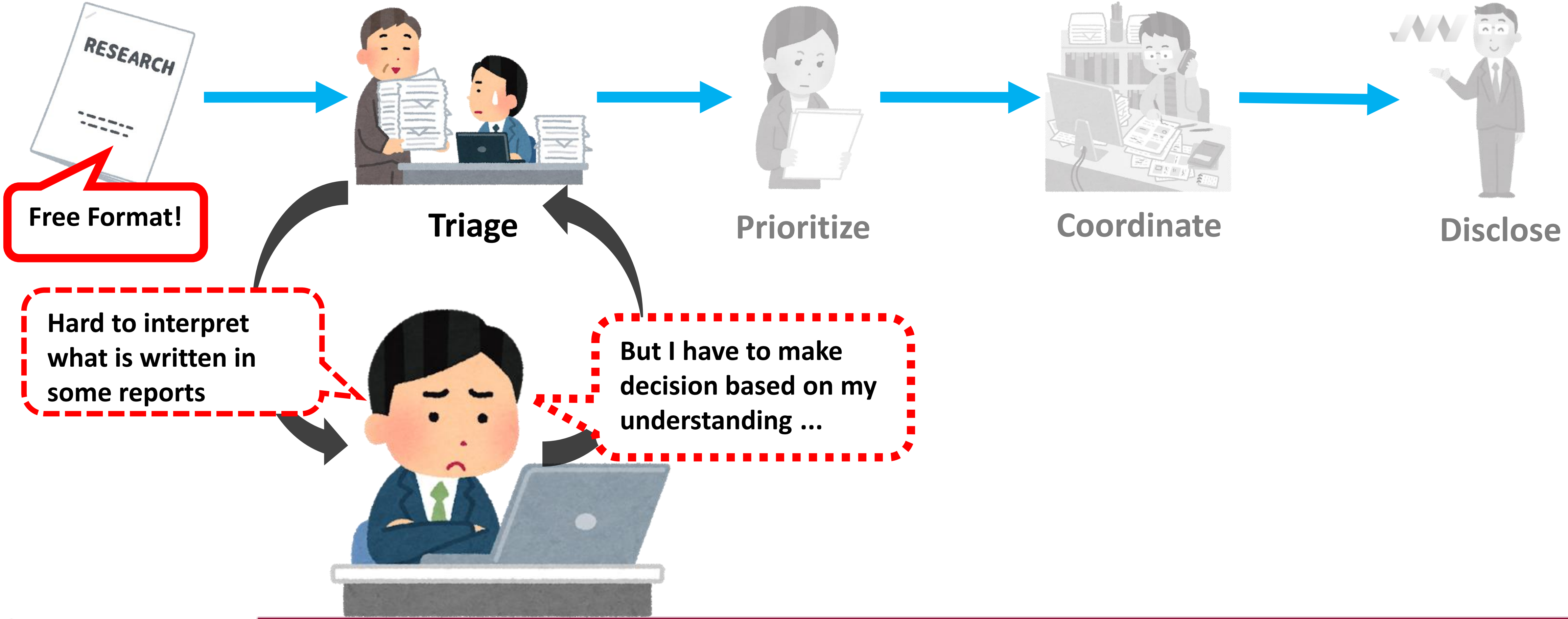
https://www.ipa.go.jp/security/english/quarterlyrep_vuln.html

# Reconsideration of Coordination Processes

## Lifecycle of Vulnerability Information at JPCERT/CC



# Pain Point #1: Understanding a vulnerability report written in free text format



Free Format!

Triage

Prioritize

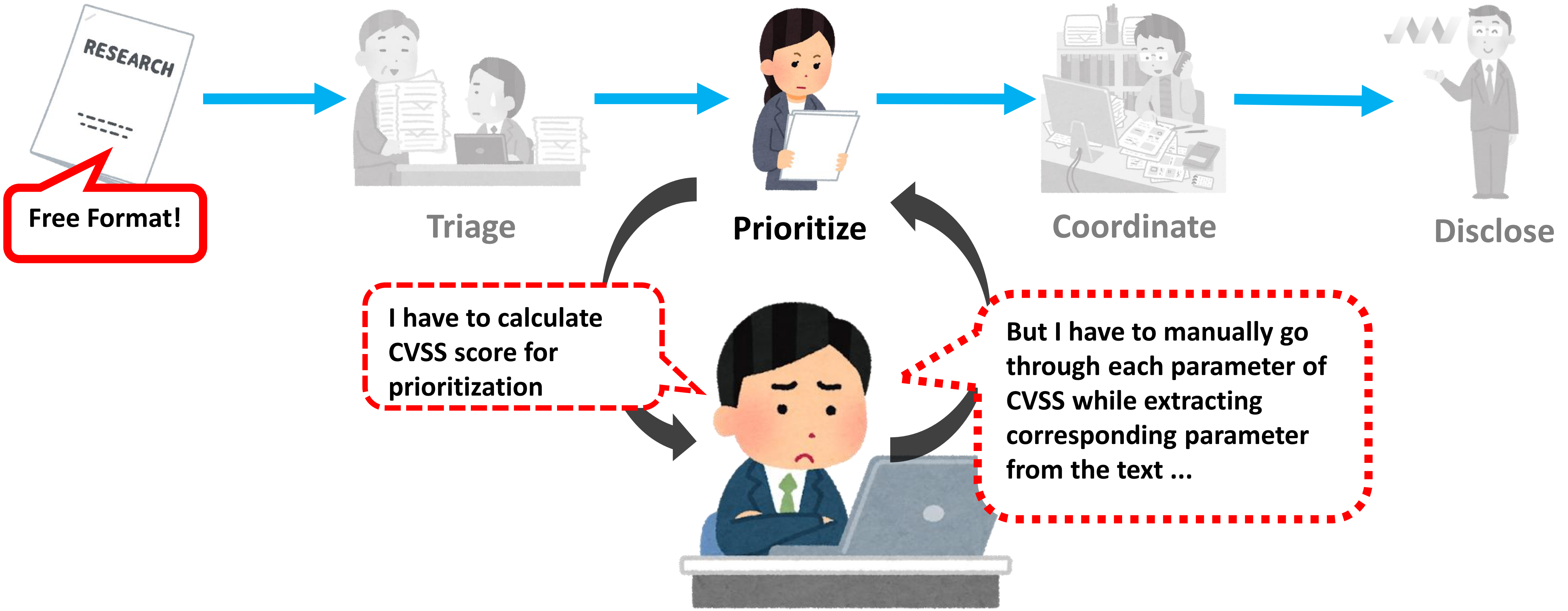
Coordinate

Disclose

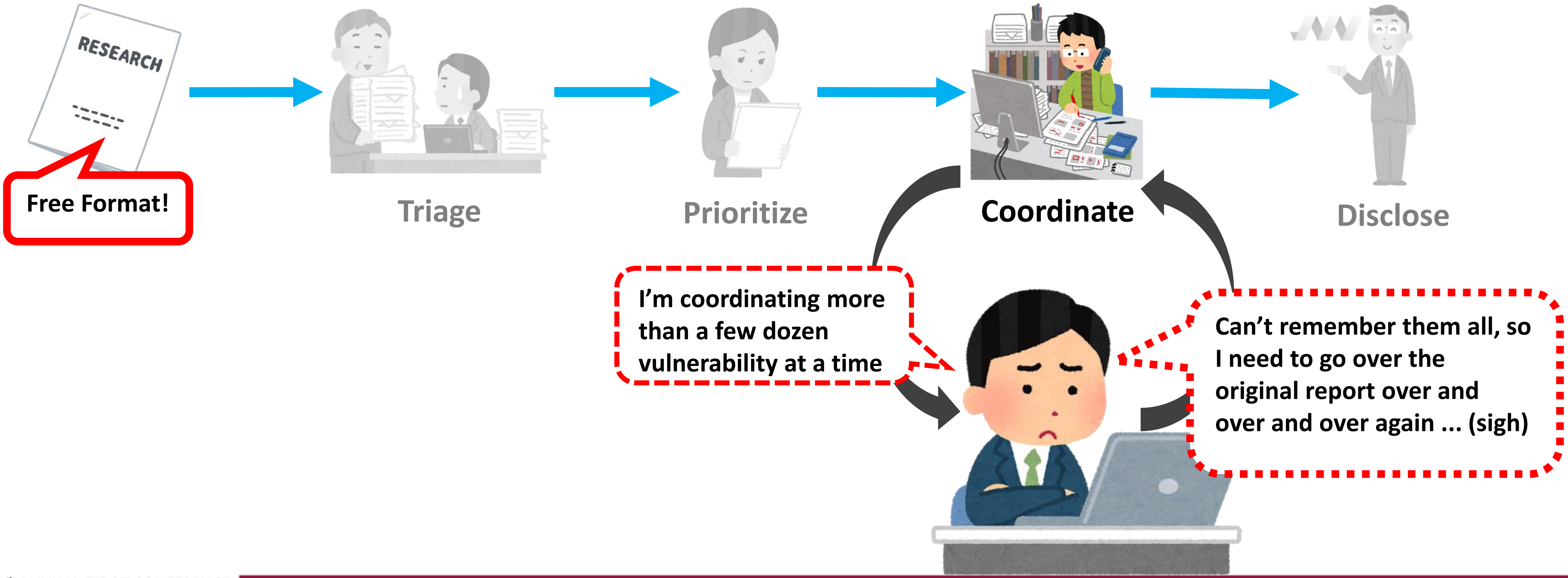
Hard to interpret what is written in some reports

But I have to make decision based on my understanding ...

# Pain Point #2: Extracting elements of information for scoring CVSS


RESEARCH
Free Format!
Triage
Prioritize
Coordinate
Disclose
I have to calculate CVSS score for prioritization
But I have to manually go through each parameter of CVSS while extracting corresponding parameter from the text ...

# Pain Point #3: Going back to Pain Point #1



Free Format!

Triage

Prioritize

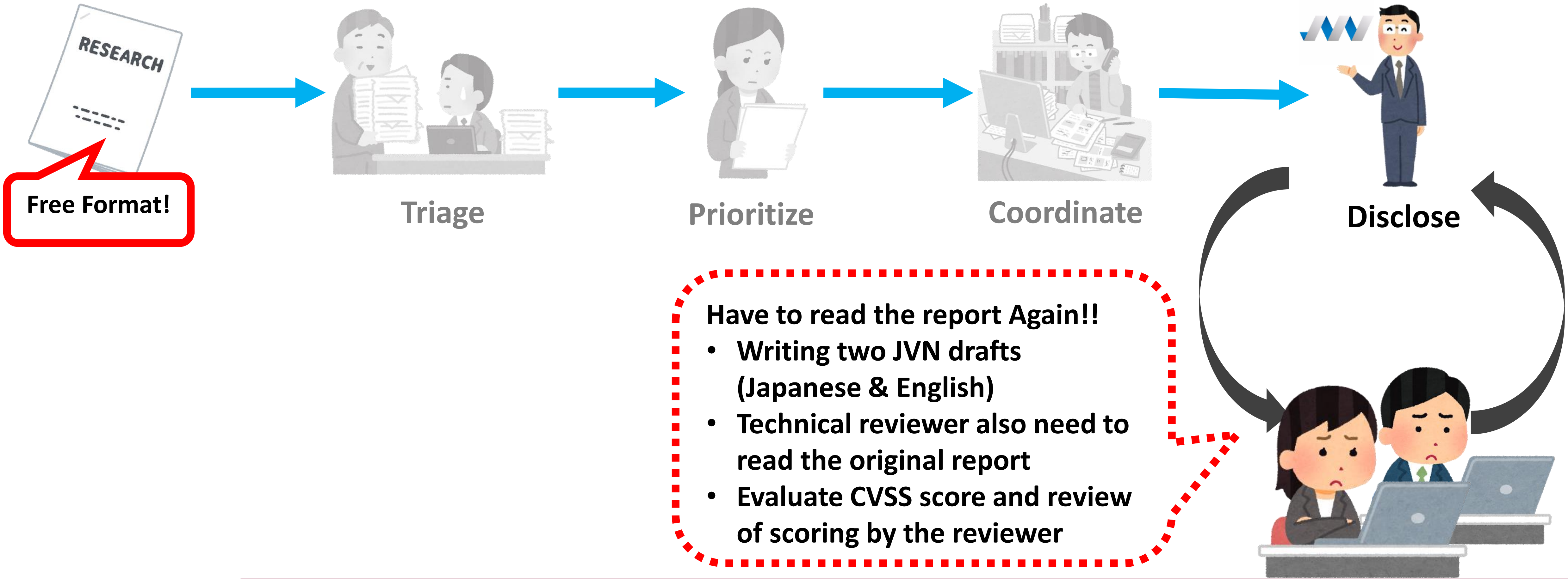
Coordinate

Disclose

I'm coordinating more than a few dozen vulnerability at a time

Can't remember them all, so I need to go over the original report over and over and over again ... (sigh)

# Pain Point #4: Writing an advisory



Free Format!

Triage

Prioritize

Coordinate

Disclose

Have to read the report Again!!

- Writing two JVN drafts (Japanese & English)
- Technical reviewer also need to read the original report
- Evaluate CVSS score and review of scoring by the reviewer

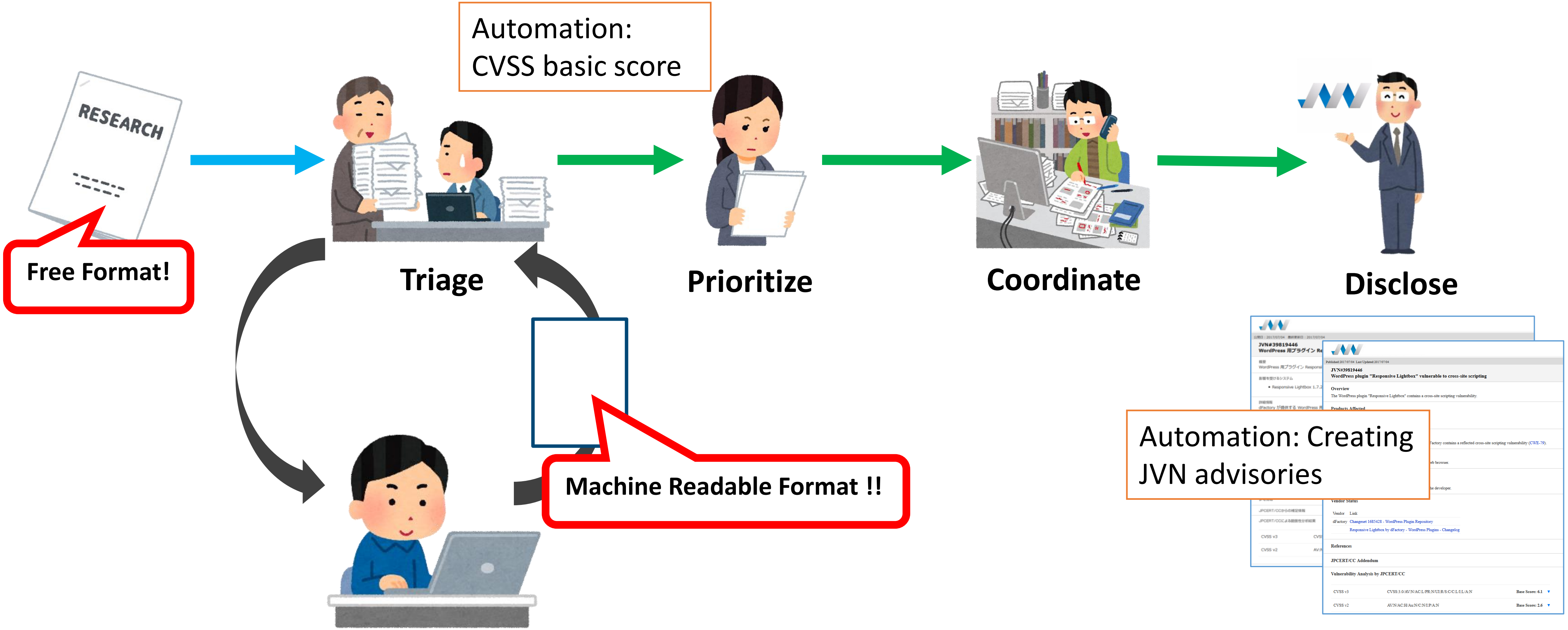
# Problem Statement (1)

- Redundancy in coordination process causing:
    - Analysis of the same report (at least) twice throughout the process
    - Since only the original report is stored, the second analysis takes the same amount of time as the first

# Problem Statement (2)

- Since vulnerability information is provided in a free format:
  - Technical aspects must be extracted
    - Affected products / versions
    - Vulnerability type / How to exploit / Effects / etc.
  - Requires interpretation of written language
    - What essentially means the same thing can be written in a million different ways
    - Language barriers can cause mis-interpretation of subtle nuances

# Solution: Convert Reports into a Machine Readable Format



公開日：2017/07/04 最終更新日：2017/07/04

JVN#39819446
WordPress 用プラグイン Re

概要
WordPress 用プラグイン Responsi

影響を受けるシステム
- Responsive Lightbox 1.7.2

詳細情報
dFactory が提供する WordPress 用

JPCERT/CCからの補足情報

JPCERT/CCによる脆弱性分析結果

CVSS v3 CVS

CVSS v2 AV:N

Published:2017/07/04 Last Updated:2017/07/04

**JVN#39819446**
**WordPress plugin "Responsive Lightbox" vulnerable to cross-site scripting**

**Overview**
The WordPress plugin "Responsive Lightbox" contains a cross-site scripting vulnerability.

**Products Affected**

Factory contains a reflected cross-site scripting vulnerability (CWE-79).

eb browser.

he developer.

**Vendor Status**

| Vendor | Link |
|---|---|
| dFactory | Changeset 1685428 - WordPress Plugin Repository |
| | Responsive Lightbox by dFactory - WordPress Plugins - Changelog |

**References**

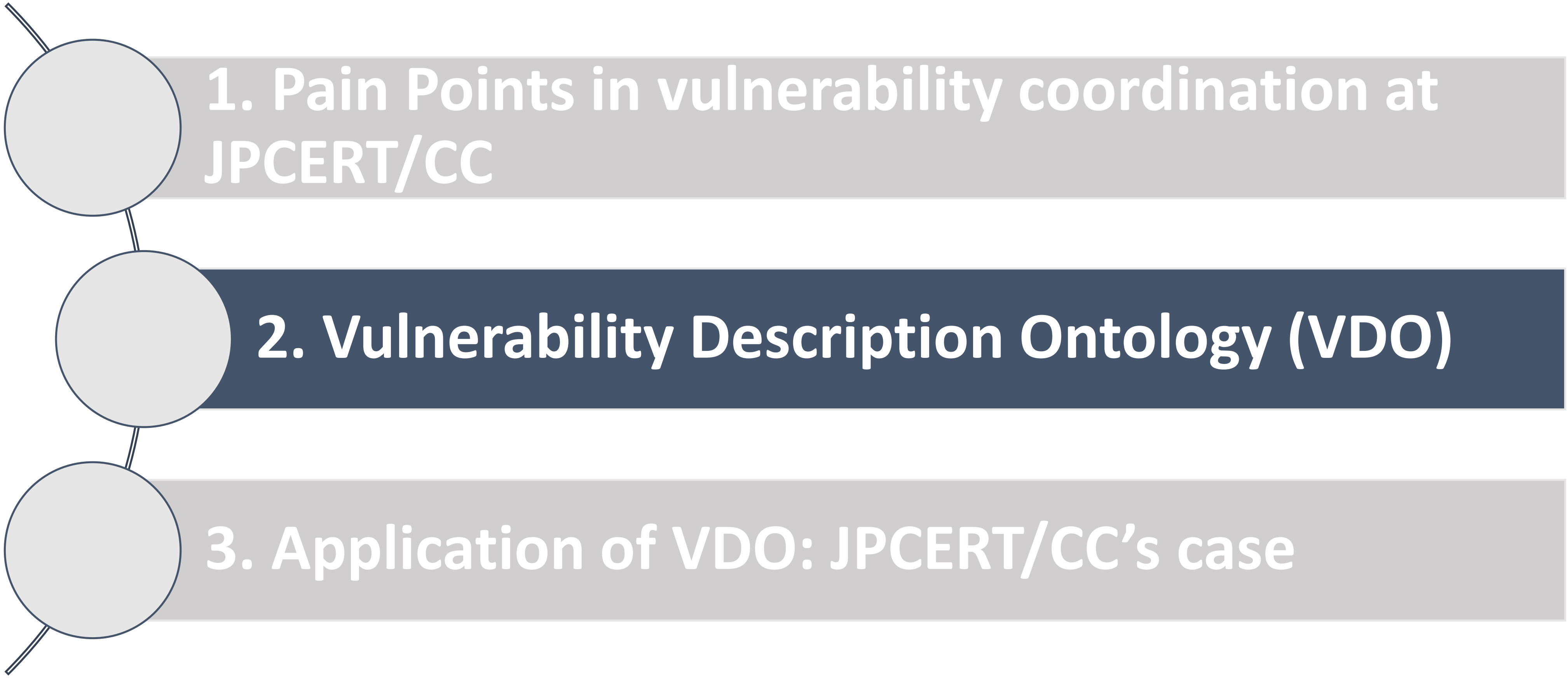
**JPCERT/CC Addendum**

**Vulnerability Analysis by JPCERT/CC**

| | | |
|---|---|---|
| CVSS v3 | CVSS:3.0/AV:N/AC:L/PR:N/UI:R/S:C/C:L/I:L/A:N | **Base Score: 6.1** ▼ |
| CVSS v2 | AV:N/AC:H/Au:N/C:N/I:P/A:N | **Base Score: 2.6** ▼ |

How to convert free formatted vulnerability information into a machine readable format?

# Today's talk



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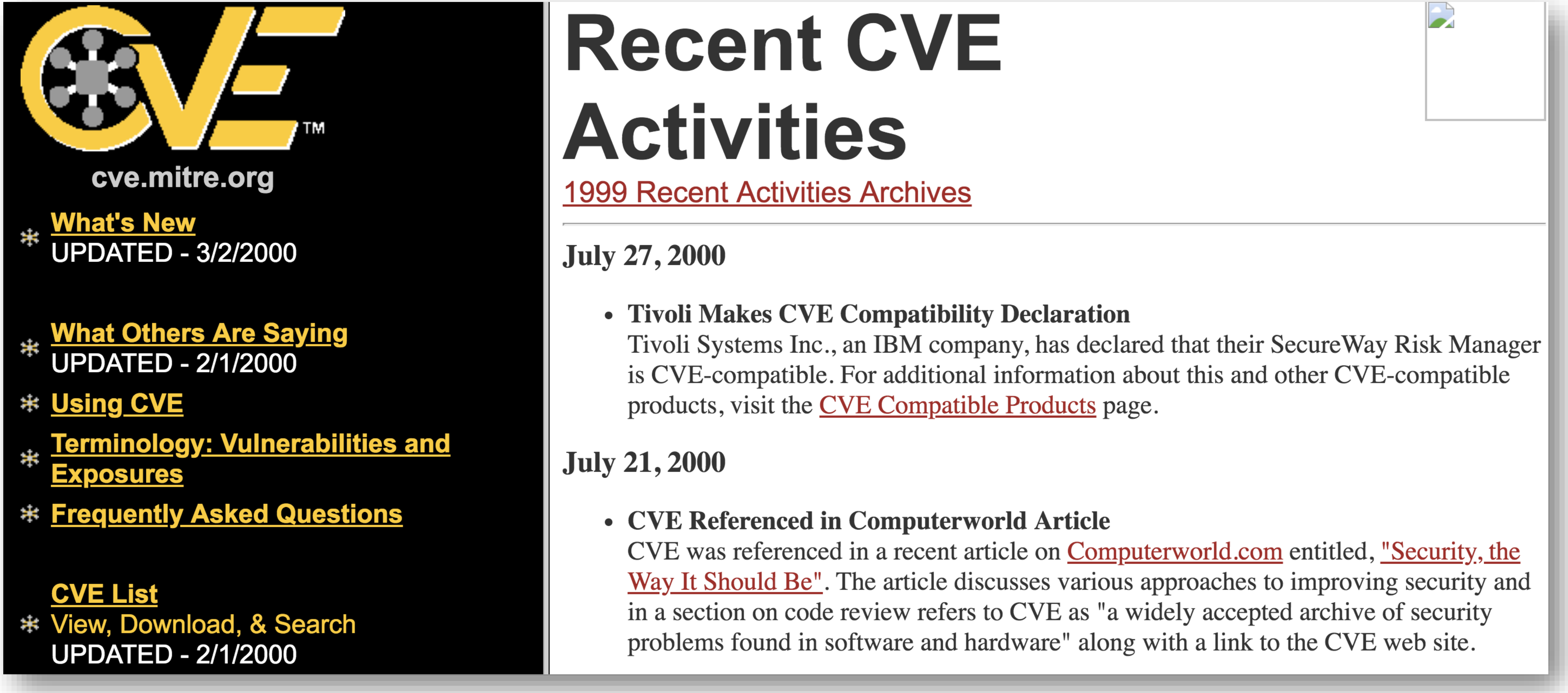


- What's New
  UPDATED - 3/2/2000
- What Others Are Saying
  UPDATED - 2/1/2000
- Using CVE
- Terminology: Vulnerabilities and Exposures
- Frequently Asked Questions
- CVE List
  View, Download, & Search
  UPDATED - 2/1/2000

# Recent CVE Activities

1999 Recent Activities Archives

## July 27, 2000

- **Tivoli Makes CVE Compatibility Declaration**
  Tivoli Systems Inc., an IBM company, has declared that their SecureWay Risk Manager is CVE-compatible. For additional information about this and other CVE-compatible products, visit the CVE Compatible Products page.

## July 21, 2000

- **CVE Referenced in Computerworld Article**
  CVE was referenced in a recent article on Computerworld.com entitled, "Security, the Way It Should Be". The article discusses various approaches to improving security and in a section on code review refers to CVE as "a widely accepted archive of security problems found in software and hardware" along with a link to the CVE web site.

https://web.archive.org/web/19991127120205/http://cve.mitre.org:80/

# How have we captured vulnerability information?

- almost 20 years industry experience in cataloging vulnerability
  - MITRE CVE project started in 1999
  - DoE/CIAC around 2000
  - CERT/CC Vulnerability started in 2000
  - JVN started around 2002
  - etc...

- Common elements of information
  - Title, summary, affected products, description, impact, patch, workaround...

# Existing standardization efforts about describing vulnerability

- **Common Security Advisory Framework (CSAF) Version 1.2 (2017)**
  https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=csaf

- **Application Vulnerability Description Language (AVDL) v1.0 (2004)**
  https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=avdl

- **Vulnerability Data Model (2013)**

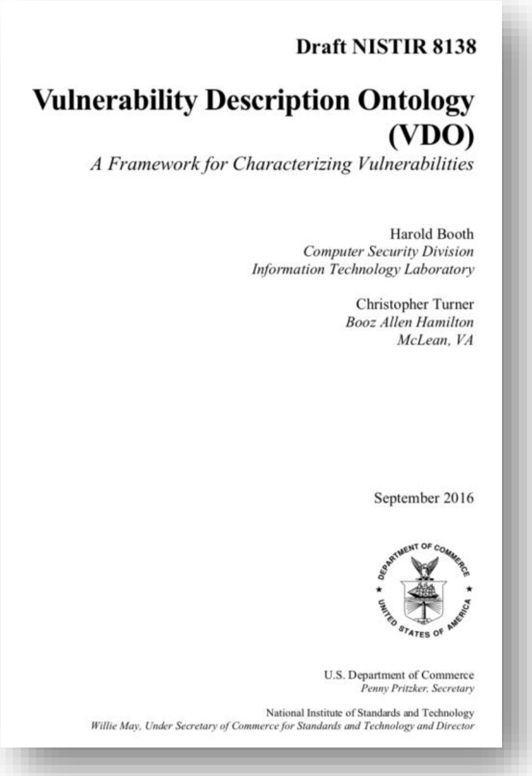
  https://www.ietf.org/archive/id/draft-booth-sacm-vuln-model-02.txt

# VDO – Vulnerability Description Ontology

- Draft NISTIR 8138

  **Vulnerability Description Ontology (VDO):**
  **a Framework for Characterizing Vulnerabilities** (2016)

- Goals of VDO
  - to **enable automated analysis** using metrics like CVSS
  - provide a **baseline of the minimum information** needed for a **vulnerability management process**



**Draft NISTIR 8138**

**Vulnerability Description Ontology (VDO)**
*A Framework for Characterizing Vulnerabilities*

Harold Booth
*Computer Security Division*
*Information Technology Laboratory*

Christopher Turner
*Booz Allen Hamilton*
*McLean, VA*

September 2016

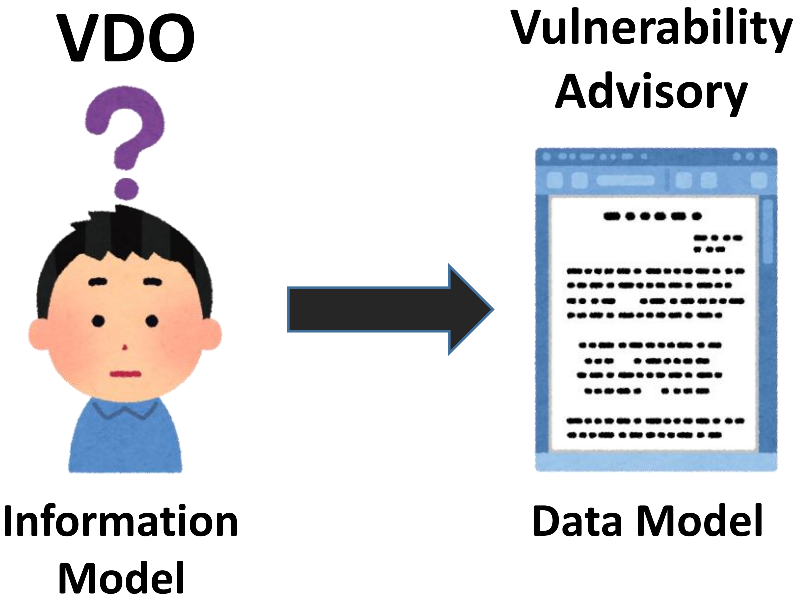
U.S. Department of Commerce
*Penny Pritzker, Secretary*

National Institute of Standards and Technology
*Willie May, Under Secretary of Commerce for Standards and Technology and Director*

# What is VDO?

- **Conceptual model** of vulnerability
  - Defines a **set of fundamental building blocks** of a vulnerability as well as their definitions, relationships and constrains
  - Helps you represent **semantics** of a vulnerability
  - Forces you to look at vulnerability in a VDO way

- **Information model** of vulnerability
  - VDO is **NOT**
    - a data model
    - advisory format
    - reporting format



**VDO**

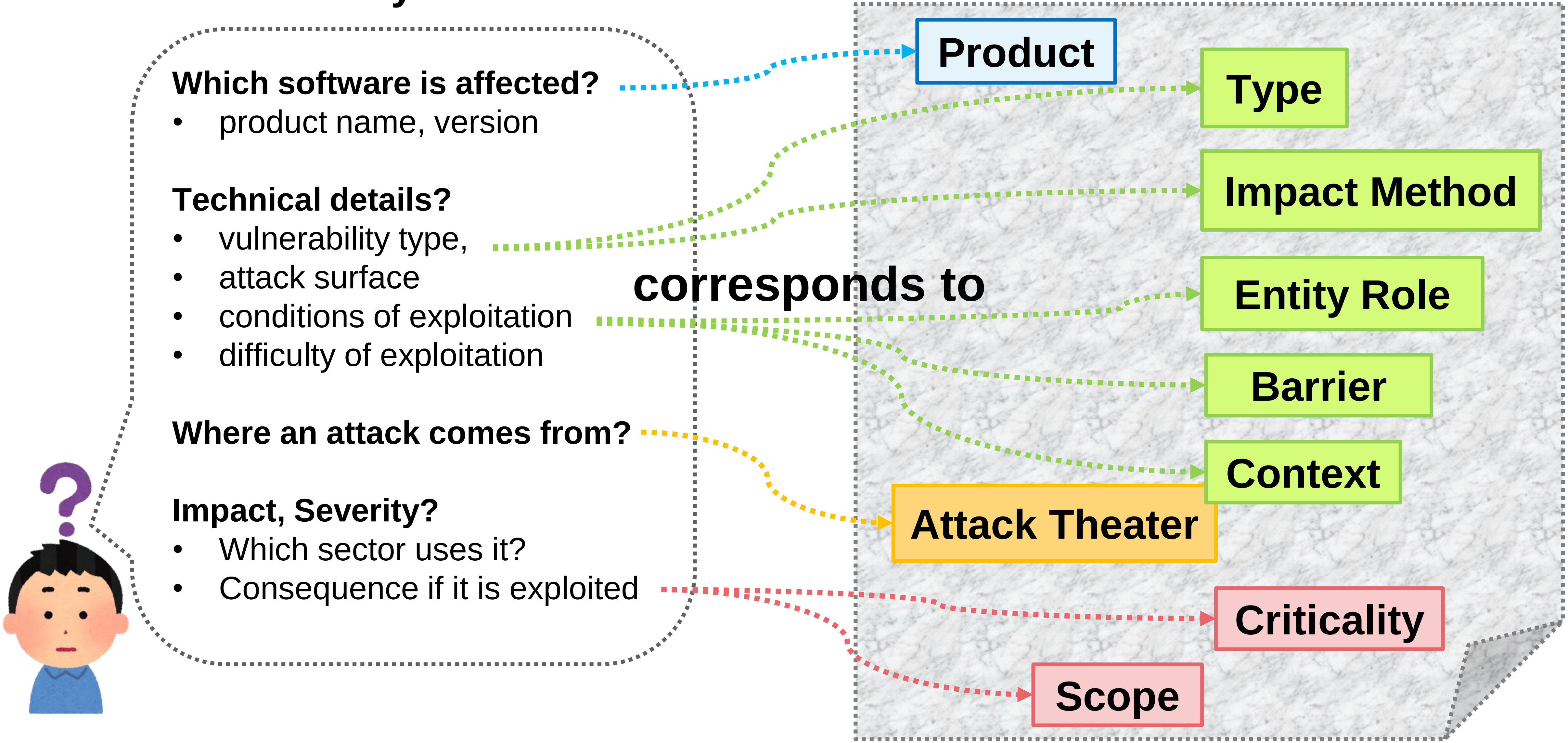
**Vulnerability Advisory**

**Information Model**

**Data Model**

## Understanding of vulnerability information

## Building blocks (noun groups) of VDO



**Which software is affected?**
- product name, version

**Technical details?**
- vulnerability type,
- attack surface
- conditions of exploitation
- difficulty of exploitation

**Where an attack comes from?**

**Impact, Severity?**
- Which sector uses it?
- Consequence if it is exploited

**corresponds to**

Product

Type

Impact Method

Entity Role

Barrier

Context

Attack Theater

Criticality

Scope

# Building blocks of VDO

- VDO is composed of
  - **noun groups** ... key elements of vulnerability
    - noun group definitions
    - usage (mandatory, recommended, optional)
  - **noun group values** ... valid values are enumerated and values are chosen from them
    - noun group value definitions
  - **relationships** ... how each noun groups are related to each other
- Let’s take a look at the example...

# Example of noun group - Context

- **Definition of Context**
  - the entity where the impacts are realized from successful exploitation
- **Possible Values**
  - **Hypervisor**
  - **Firmware**
  - **Host OS**
  - **…**
  - **Hardware**

- **Relationships:** *Entity Role, Impact Method, Mitigation, Privilege Required, Victim Type*
  - *Zero or many Entity Role values should be associated with Context.*
  - *One or many Impact Method values shall be associated with Context.*
  - *Zero or many Mitigation values may be associated with Context.*
  - *…*

# Description of a vulnerability

Directory traversal vulnerability in the XCloner plugin 3.1.1 for WordPress and 3.5.1 for Joomla! allows remote administrators to read arbitrary files via a .. (dot dot) in the file parameter in a json_return action in the xcloner_show page to wp-admin/admin-ajax.php.

# Mapping description to VDO

Directory traversal vulnerability in the XCloner plugin 3.1.1 for

Type Product

WordPress and 3.5.1 for Joomla! allows remote administrators

Entity Role Context Scope Attack Theater Barrier

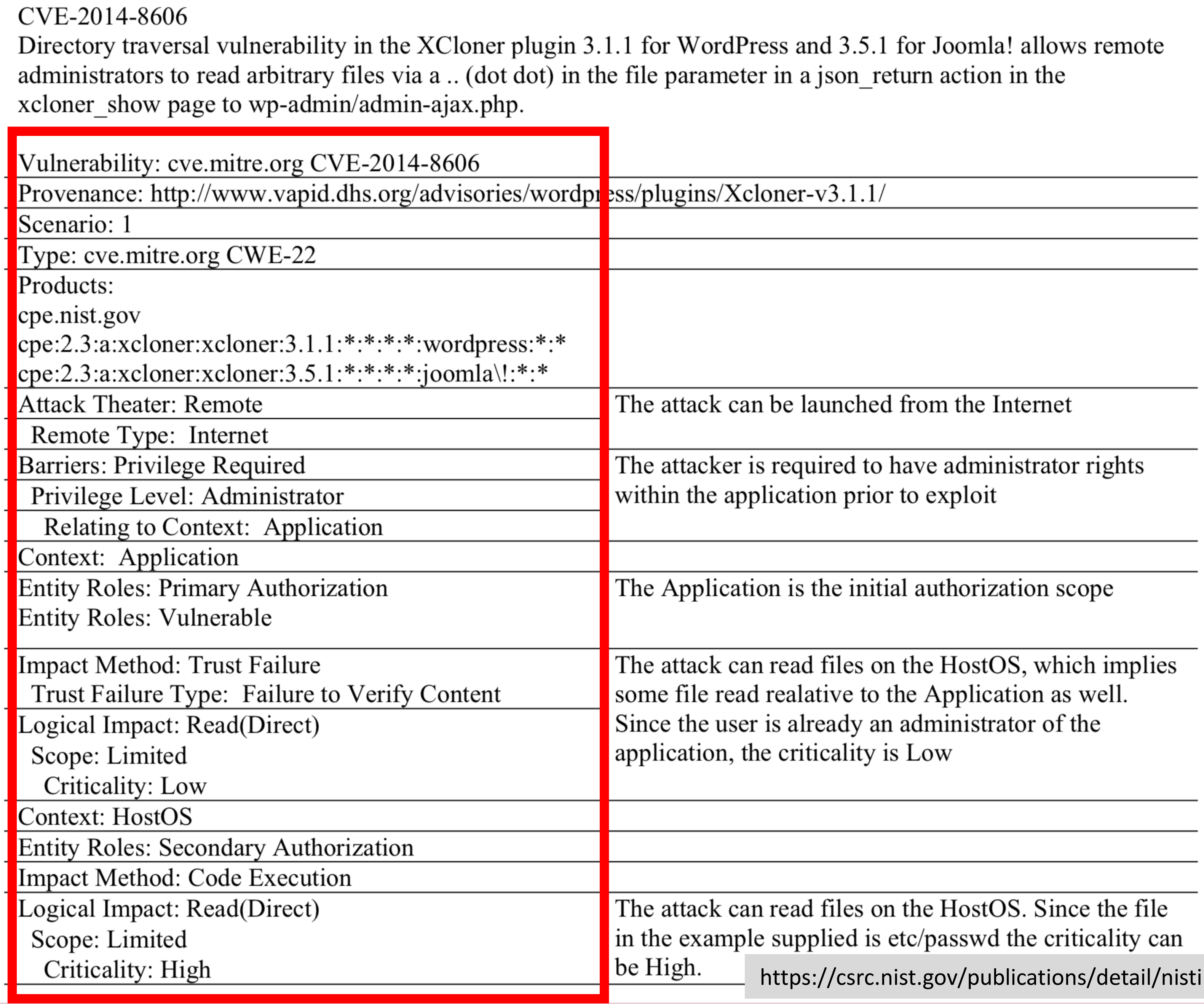
to read arbitrary files via a .. (dot dot) in the file parameter in a

Impact Method

json_return action in the xcloner_show page to wp-admin/admin-ajax.php.

**Technical details (specific to this case) necessary to create PoC code will be lost in VDO :-(**

Raw VDO data

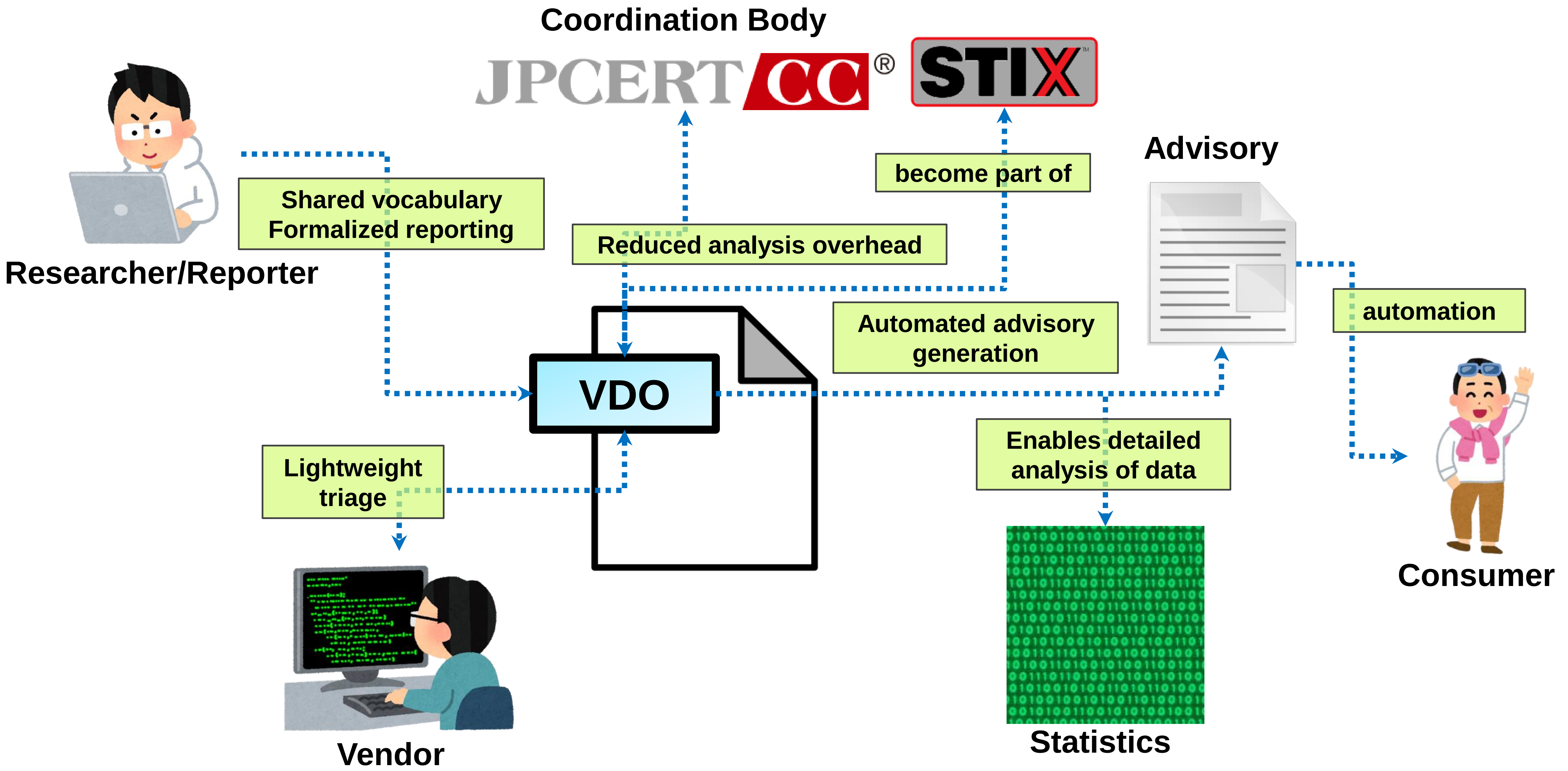


CVE-2014-8606
Directory traversal vulnerability in the XCloner plugin 3.1.1 for WordPress and 3.5.1 for Joomla! allows remote administrators to read arbitrary files via a .. (dot dot) in the file parameter in a json_return action in the xcloner_show page to wp-admin/admin-ajax.php.

| | |
|---|---|
| Vulnerability: cve.mitre.org CVE-2014-8606 | |
| Provenance: http://www.vapid.dhs.org/advisories/wordpress/plugins/Xcloner-v3.1.1/ | |
| Scenario: 1 | |
| Type: cve.mitre.org CWE-22 | |
| Products:<br>cpe.nist.gov<br>cpe:2.3:a:xcloner:xcloner:3.1.1:*:*:*:*:wordpress:*:*<br>cpe:2.3:a:xcloner:xcloner:3.5.1:*:*:*:*:joomla\!:*:* | |
| Attack Theater: Remote | The attack can be launched from the Internet |
| Remote Type: Internet | |
| Barriers: Privilege Required | The attacker is required to have administrator rights within the application prior to exploit |
| Privilege Level: Administrator | |
| Relating to Context: Application | |
| Context: Application | |
| Entity Roles: Primary Authorization<br>Entity Roles: Vulnerable | The Application is the initial authorization scope |
| Impact Method: Trust Failure<br>Trust Failure Type: Failure to Verify Content | The attack can read files on the HostOS, which implies some file read realative to the Application as well. Since the user is already an administrator of the application, the criticality is Low |
| Logical Impact: Read(Direct)<br>Scope: Limited<br>Criticality: Low | |
| Context: HostOS | |
| Entity Roles: Secondary Authorization | |
| Impact Method: Code Execution | |
| Logical Impact: Read(Direct)<br>Scope: Limited<br>Criticality: High | The attack can read files on the HostOS. Since the file in the example supplied is etc/passwd the criticality can be High. |

https://csrc.nist.gov/publications/detail/nistir/8138/draft

# Goals of VDO


Coordination Body

Researcher/Reporter

Shared vocabulary
Formalized reporting

Reduced analysis overhead

become part of

Advisory

VDO

Automated advisory generation

automation

Lightweight triage

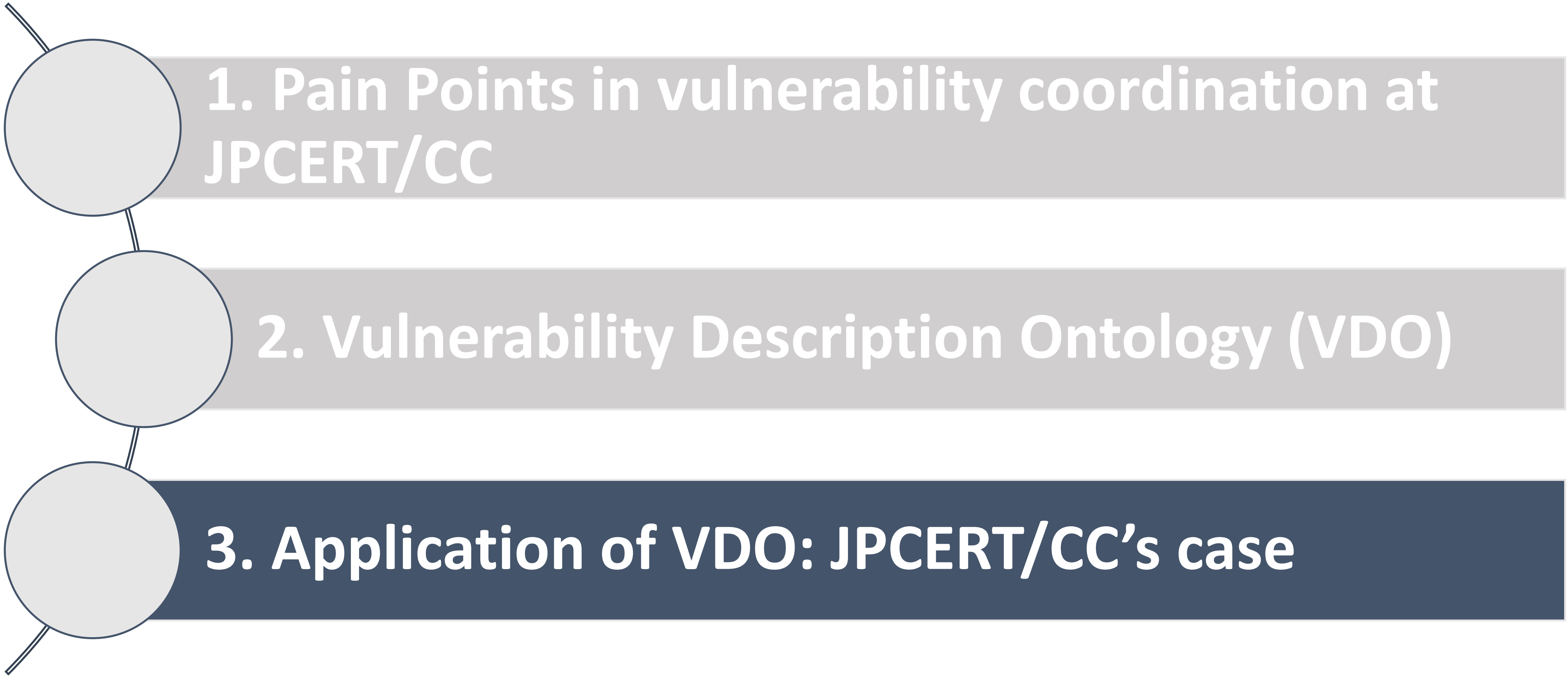
Enables detailed analysis of data

Vendor

Statistics

Consumer

# Today’s talk



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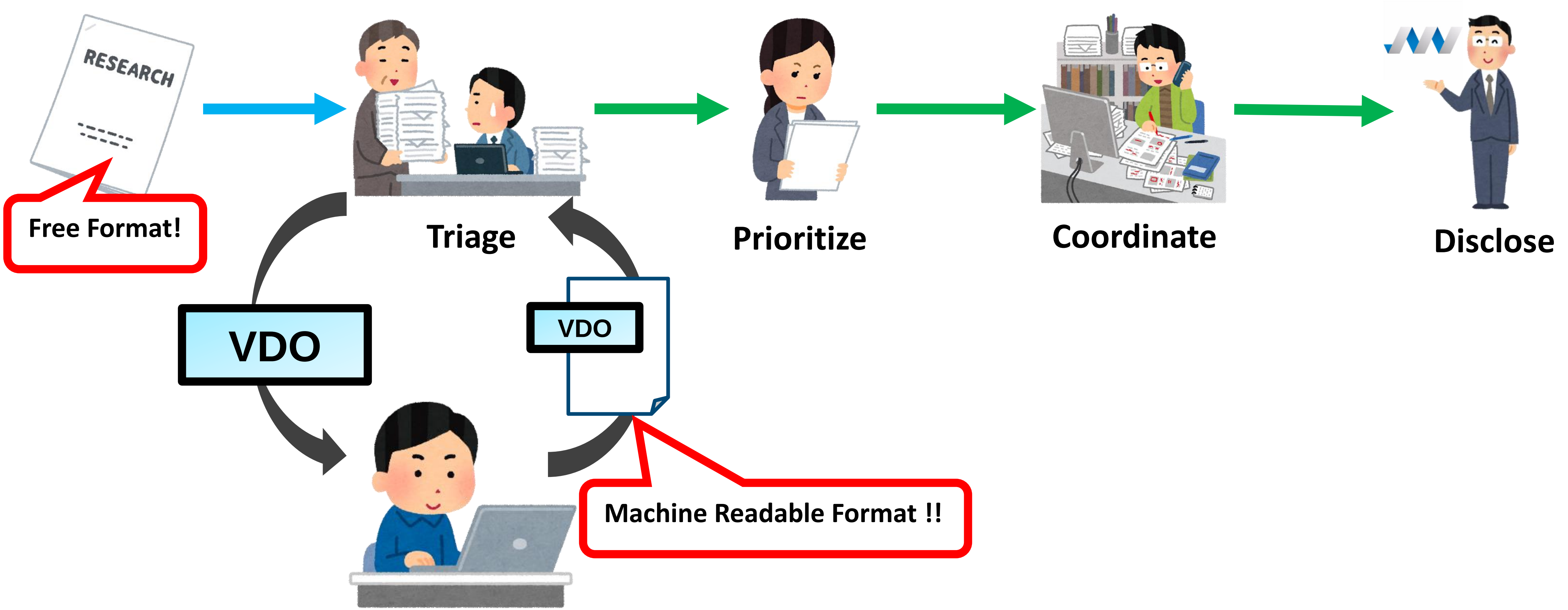
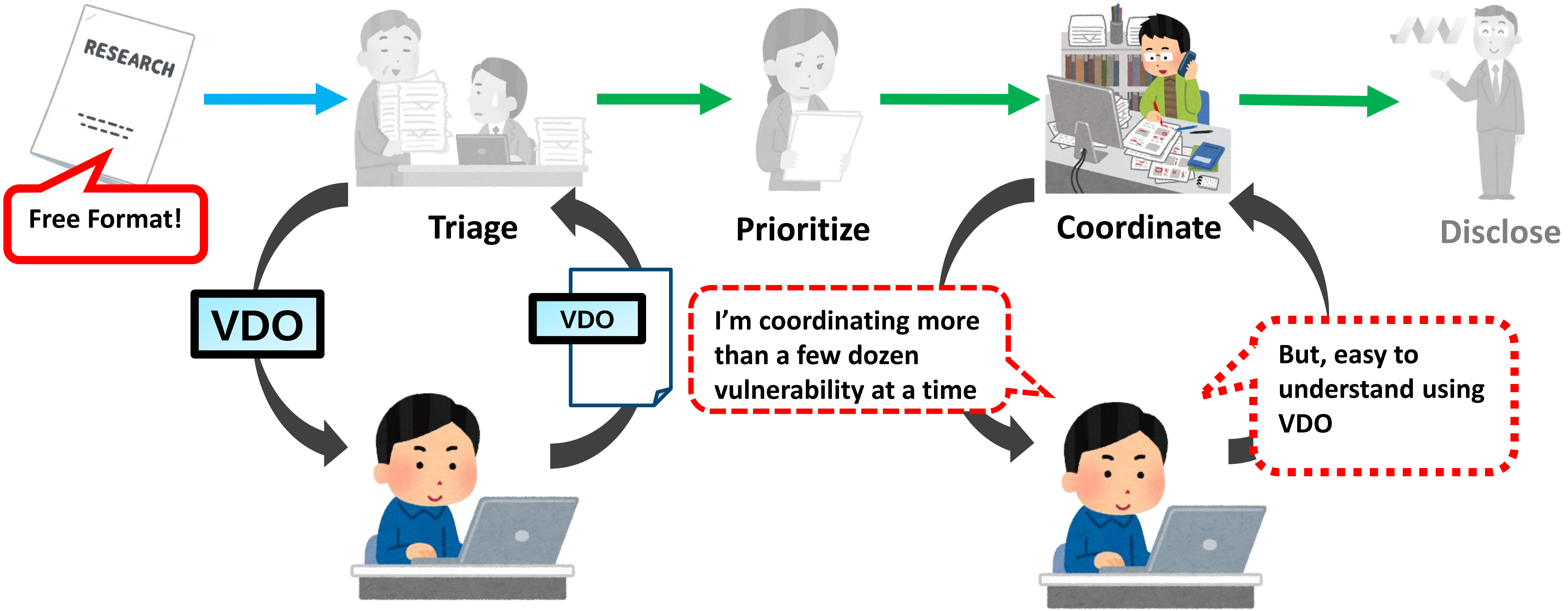
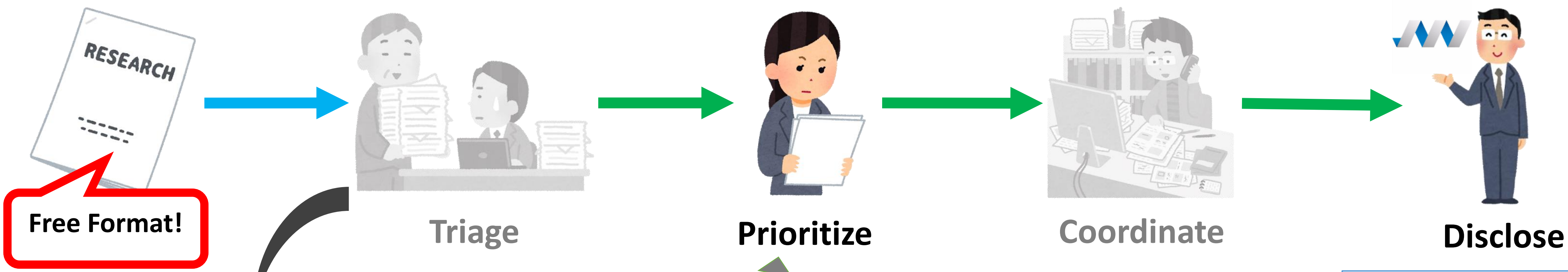
# Solution: Convert Reports into a Machine Readable Format using VDO

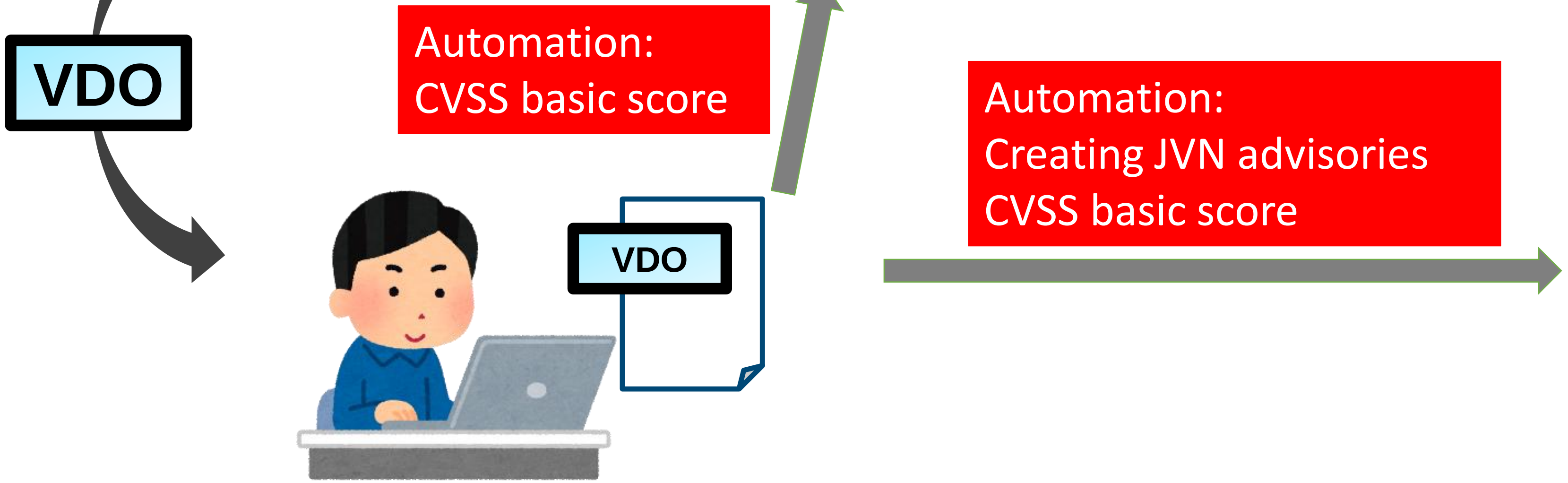


# Benefit #1: Time saving in Coordinate Phase


RESEARCH
Free Format!
Triage
Prioritize
Coordinate
Disclose
VDO
VDO
I'm coordinating more than a few dozen vulnerability at a time
But, easy to understand using VDO

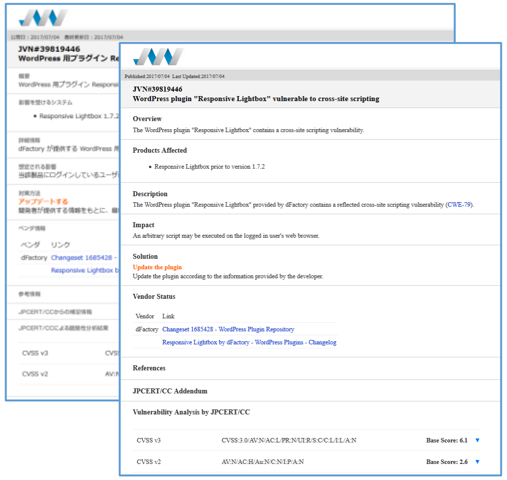
# Benefit #2: More Efficient Coordination Process





Automation:
CVSS basic score

Automation:
Creating JVN advisories
CVSS basic score



公開日：2017/07/04　最終更新日：2017/07/04
JVN#39819446
WordPress 用プラグイン Re

概要
WordPress 用プラグイン Responsi

影響を受けるシステム

- Responsive Lightbox 1.7.2

詳細情報
dFactory が提供する WordPress 用

想定される影響
当該製品にログインしているユーザ

対策方法
アップデートする
開発者が提供する情報をもとに、最

ベンダ情報

| ベンダ | リンク |
|---|---|
| dFactory | Changeset 1685428 - |
| | Responsive Lightbox b |

参考情報

JPCERT/CCからの補足情報

JPCERT/CCによる脆弱性分析結果

| | |
|---|---|
| CVSS v3 | CVS |
| CVSS v2 | AV:N |

Published:2017/07/04 Last Updated:2017/07/04

JVN#39819446
WordPress plugin "Responsive Lightbox" vulnerable to cross-site scripting

Overview
The WordPress plugin "Responsive Lightbox" contains a cross-site scripting vulnerability.

Products Affected

- Responsive Lightbox prior to version 1.7.2

Description
The WordPress plugin "Responsive Lightbox" provided by dFactory contains a reflected cross-site scripting vulnerability (CWE-79).

Impact
An arbitrary script may be executed on the logged in user's web browser.

Solution
Update the plugin
Update the plugin according to the information provided by the developer.

Vendor Status

| Vendor | Link |
|---|---|
| dFactory | Changeset 1685428 - WordPress Plugin Repository |
| | Responsive Lightbox by dFactory - WordPress Plugins - Changelog |

References

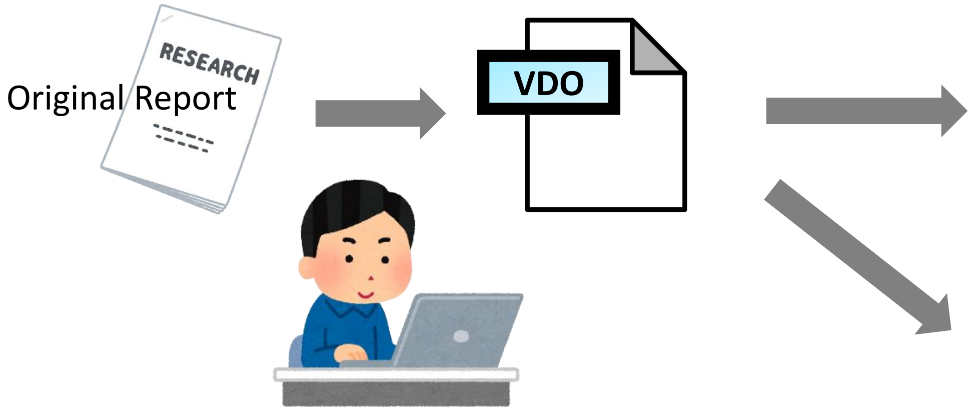
JPCERT/CC Addendum

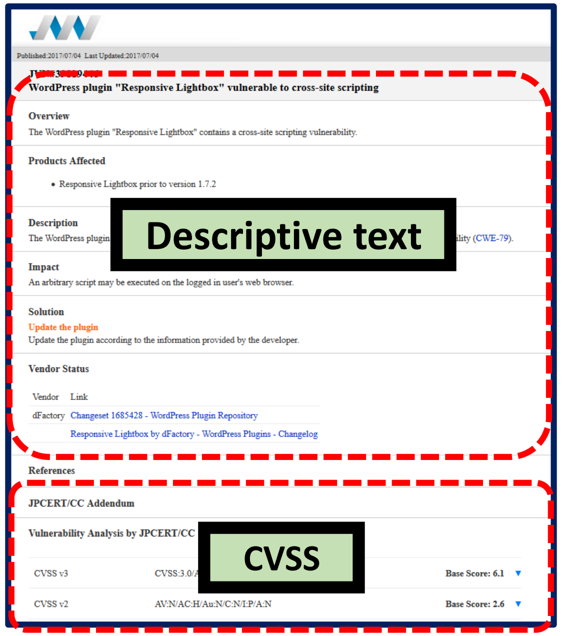
Vulnerability Analysis by JPCERT/CC

| | | |
|---|---|---|
| CVSS v3 | CVSS:3.0/AV:N/AC:L/PR:N/UI:R/S:C/C:L/I:L/A:N | Base Score: 6.1 ▼ |
| CVSS v2 | AV:N/AC:H/Au:N/C:N/I:P/A:N | Base Score: 2.6 ▼ |

# JPCERT's case: Toward Automating Advisory Generation

- Define Data representation of VDO
- Implement tools
  - VDO to CVSS basic score
  - VDO to JVN advisory





Published:2017/07/04 Last Updated:2017/07/04

JV[illegible]

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**References**

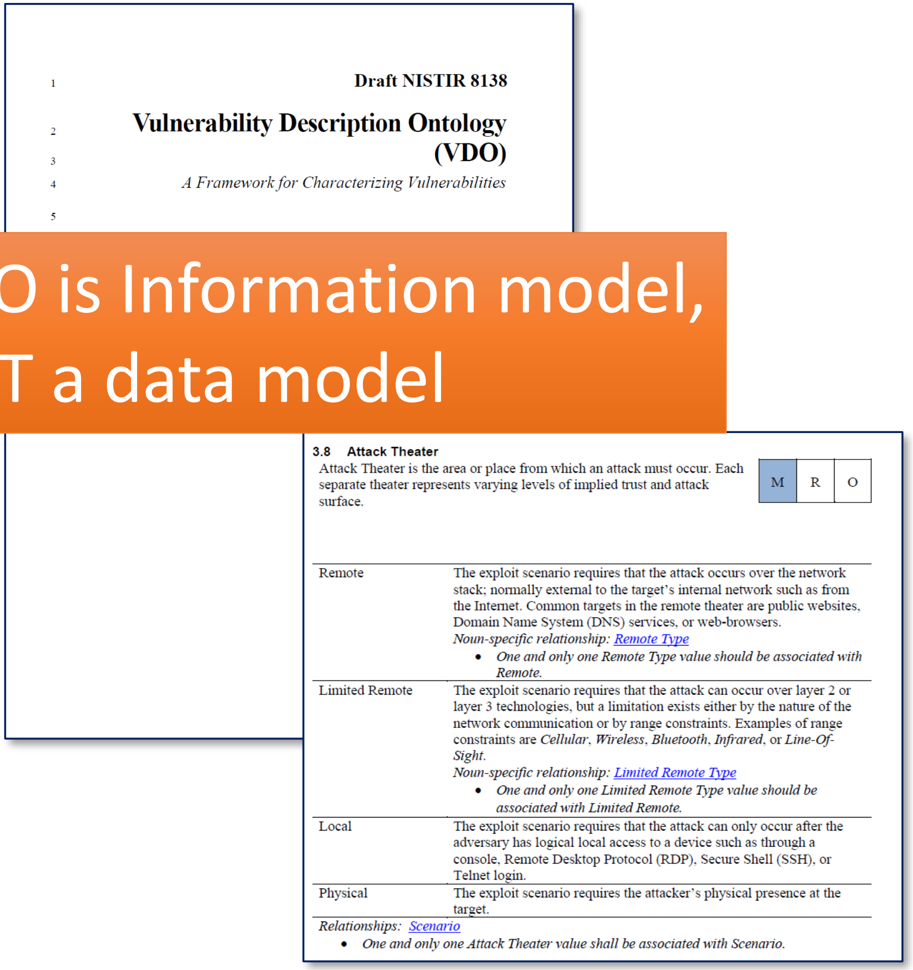
**JPCERT/CC Addendum**

**Vulnerability Analysis by JPCERT/CC**

| | | |
|---|---|---|
| CVSS v3 | CVSS:3.0/A | **Base Score: 6.1** ▼ |
| CVSS v2 | AV:N/AC:H/Au:N/C:N/I:P/A:N | **Base Score: 2.6** ▼ |

# Define Data representation of VDO

Original Report



Draft NISTIR 8138

Vulnerability Description Ontology (VDO)

*A Framework for Characterizing Vulnerabilities*

**3.8 Attack Theater**

Attack Theater is the area or place from which an attack must occur. Each separate theater represents varying levels of implied trust and attack surface.

| M | R | O |
|---|---|---|

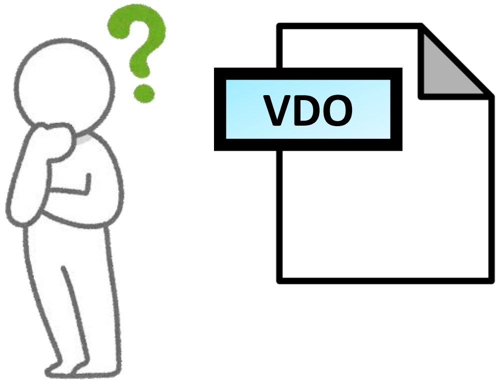
| | |
|---|---|
| Remote | The exploit scenario requires that the attack occurs over the network stack; normally external to the target's internal network such as from the Internet. Common targets in the remote theater are public websites, Domain Name System (DNS) services, or web-browsers.<br>*Noun-specific relationship: Remote Type*<br>• *One and only one Remote Type value should be associated with Remote.* |
| Limited Remote | The exploit scenario requires that the attack can occur over layer 2 or layer 3 technologies, but a limitation exists either by the nature of the network communication or by range constraints. Examples of range constraints are *Cellular*, *Wireless*, *Bluetooth*, *Infrared*, or *Line-Of-Sight*.<br>*Noun-specific relationship: Limited Remote Type*<br>• *One and only one Limited Remote Type value should be associated with Limited Remote.* |
| Local | The exploit scenario requires that the attack can only occur after the adversary has logical local access to a device such as through a console, Remote Desktop Protocol (RDP), Secure Shell (SSH), or Telnet login. |
| Physical | The exploit scenario requires the attacker's physical presence at the target. |

*Relationships: Scenario*

- *One and only one Attack Theater value shall be associated with Scenario.*

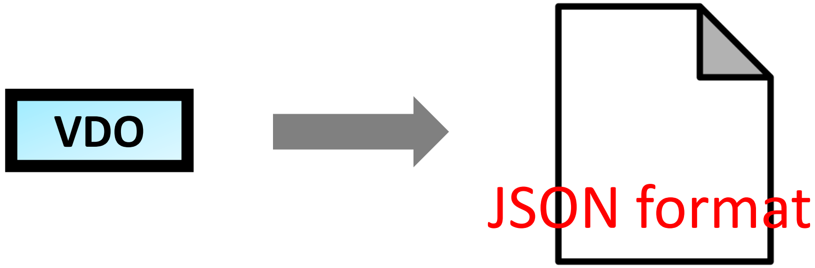
VDO is Information model, NOT a data model

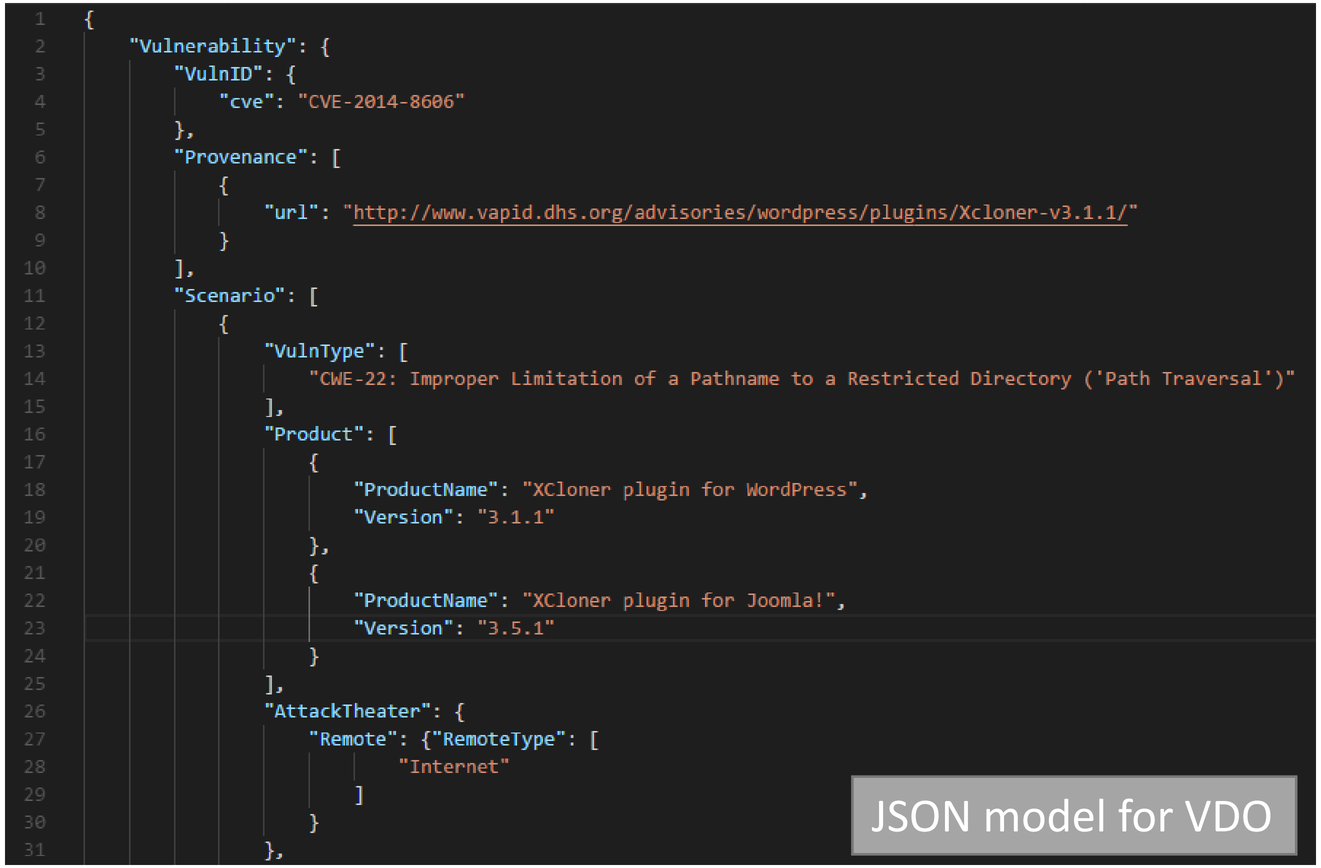
A format to encode VDO



# VDO data in a JSON format

- Choose JSON format
    - Why? A lot of scripts/tools are utilized





```
{
    "Vulnerability": {
        "VulnID": {
            "cve": "CVE-2014-8606"
        },
        "Provenance": [
            {
                "url": "http://www.vapid.dhs.org/advisories/wordpress/plugins/Xcloner-v3.1.1/"
            }
        ],
        "Scenario": [
            {
                "VulnType": [
                    "CWE-22: Improper Limitation of a Pathname to a Restricted Directory ('Path Traversal')"
                ],
                "Product": [
                    {
                        "ProductName": "XCloner plugin for WordPress",
                        "Version": "3.1.1"
                    },
                    {
                        "ProductName": "XCloner plugin for Joomla!",
                        "Version": "3.5.1"
                    }
                ],
                "AttackTheater": {
                    "Remote": {"RemoteType": [
                            "Internet"
                        ]
                    }
                },
```

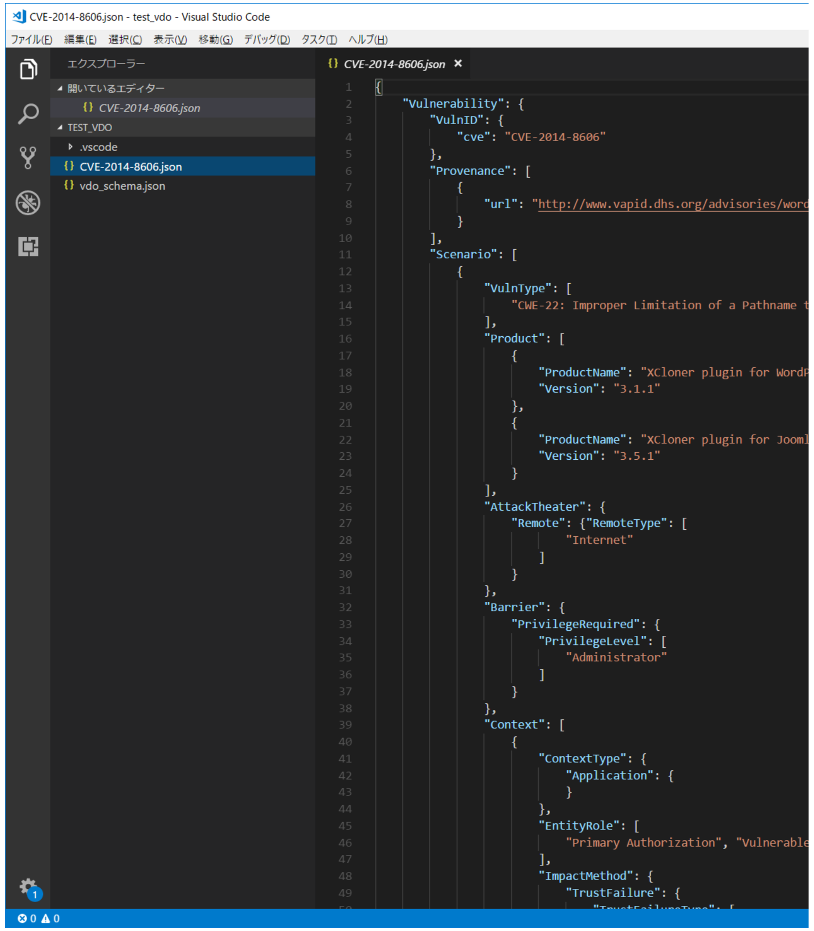
JSON model for VDO

# Writing a VDO instance

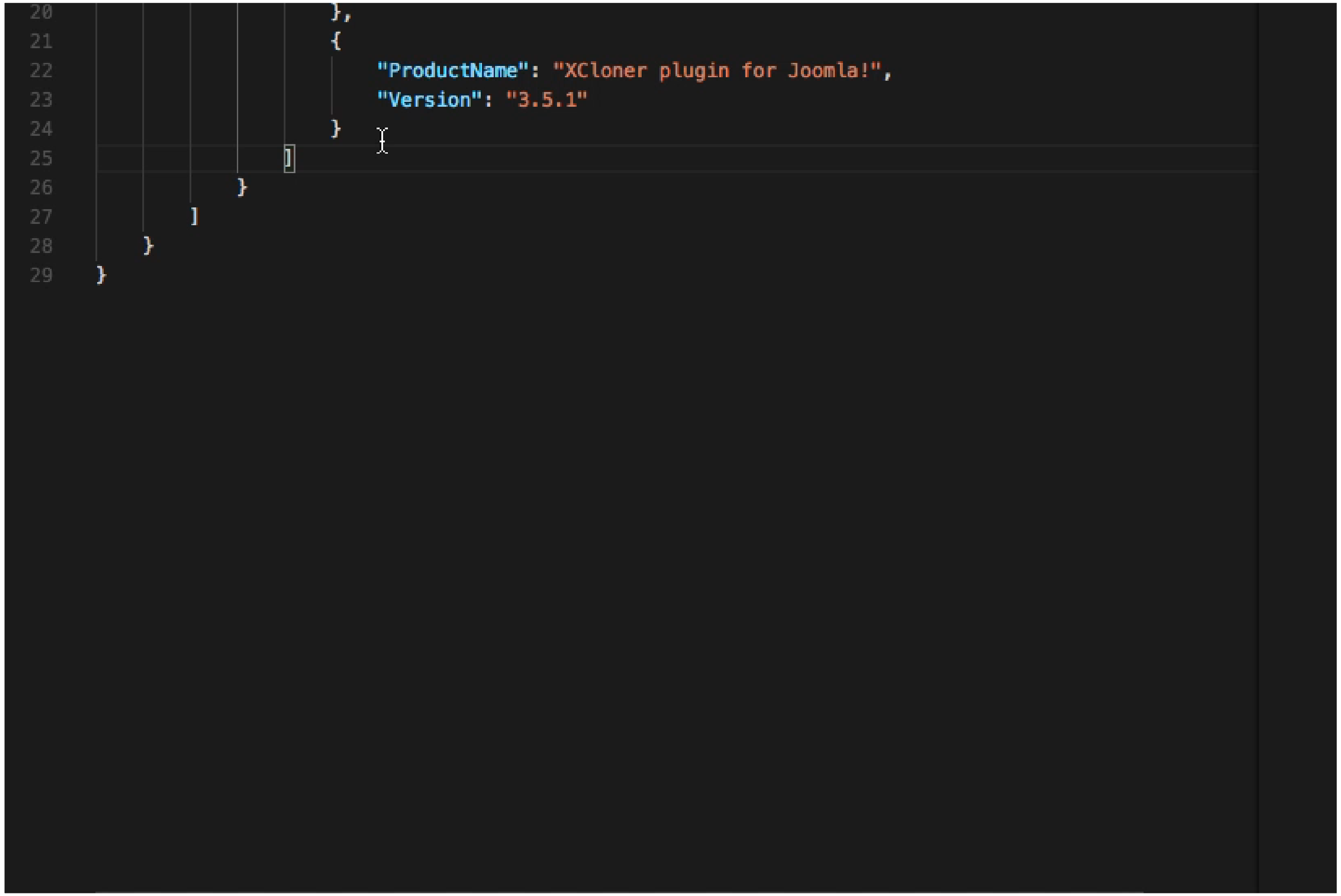
- How to Write a VDO instance ?
  - Some editors support autocompletion using a JSON Schema
    - Visual Studio Code, Atom
  - Generating an HTML form from a JSON Schema
    - JSON Editor
      - https://github.com/json-editor/json-editor

- Defined & Implemented **JSON Schema for VDO**

# Writing a VDO instance with autocompletion



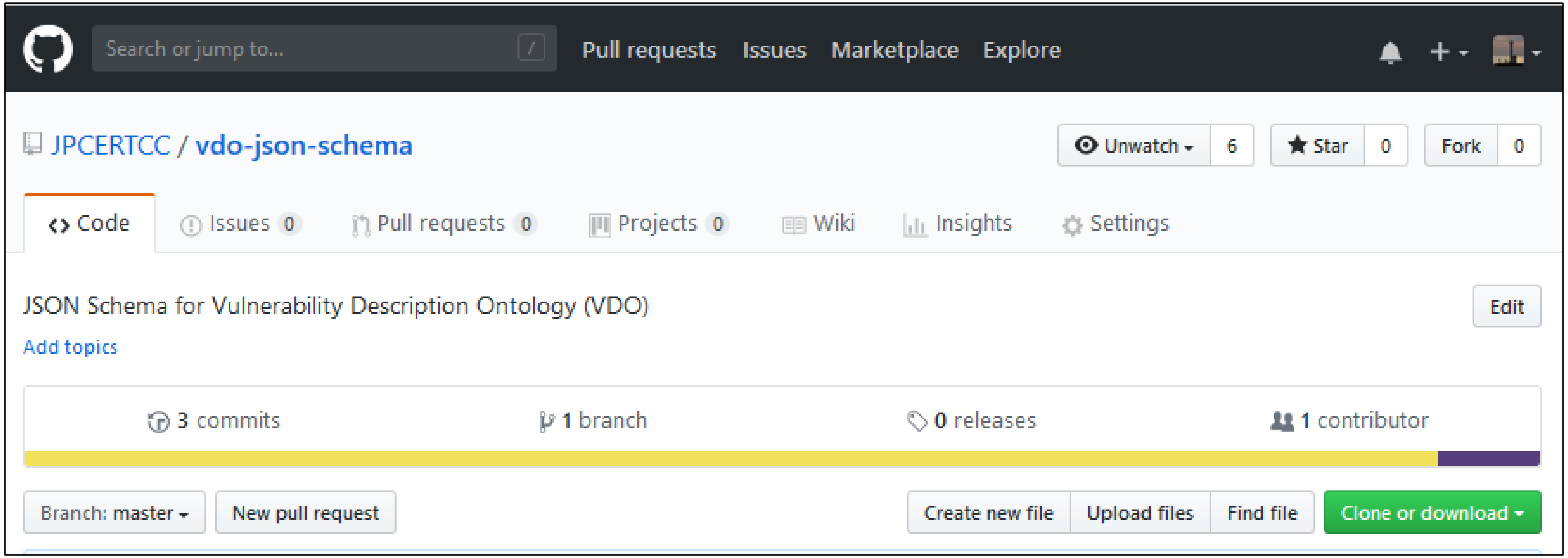
```
{
    "Vulnerability": {
        "VulnID": {
            "cve": "CVE-2014-8606"
        },
        "Provenance": [
            {
                "url": "http://www.vapid.dhs.org/advisories/word
            }
        ],
        "Scenario": [
            {
                "VulnType": [
                    "CWE-22: Improper Limitation of a Pathname t
                ],
                "Product": [
                    {
                        "ProductName": "XCloner plugin for WordP
                        "Version": "3.1.1"
                    },
                    {
                        "ProductName": "XCloner plugin for Jooml
                        "Version": "3.5.1"
                    }
                ],
                "AttackTheater": {
                    "Remote": {"RemoteType": [
                            "Internet"
                        ]
                    }
                },
                "Barrier": {
                    "PrivilegeRequired": {
                        "PrivilegeLevel": [
                            "Administrator"
                        ]
                    }
                },
                "Context": [
                    {
                        "ContextType": {
                            "Application": {
                            }
                        },
                        "EntityRole": [
                            "Primary Authorization", "Vulnerable
                        ],
                        "ImpactMethod": {
                            "TrustFailure": {
                                "TrustFailureType": [
```



```
                    },
                    {
                        "ProductName": "XCloner plugin for Joomla!",
                        "Version": "3.5.1"
                    }
                ]
            }
        ]
    }
}
```

# JSON Schema for VDO

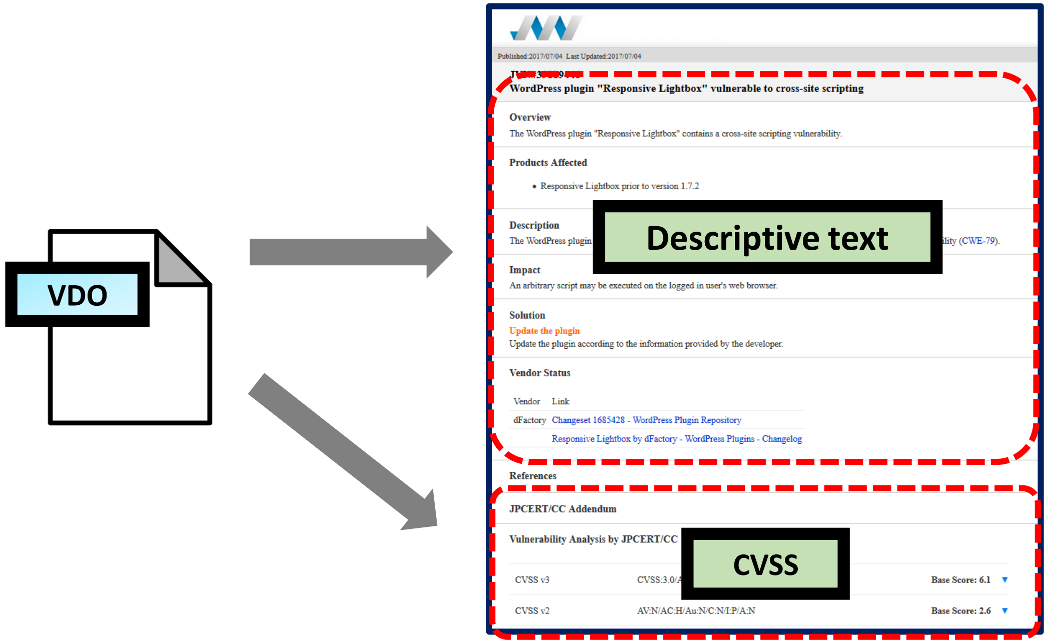
- VDO JSON Schema
  - https://github.com/JPCERTCC/vdo-json-schema



JSON Schema for Vulnerability Description Ontology (VDO)

# On-going projects (1/2)

- Tools for automatic advisory generation
  - Mapping VDO data to CVSS base score
    - VDO includes CVSS v2/v3 concept
      - NISTIR 8138 in Appendix shows partial mapping logic
    - The “entire” mapping logic needs to be developed
  - Conversion VDO data to descriptive text (JVN advisory)
    - Our idea
      - Use templates of advisory depended on CWE
      - “Fill in the blanks” of templates from VDO data



Published:2017/07/04 Last Updated:2017/07/04

JV[illegible]9[illegible]
WordPress plugin "Responsive Lightbox" vulnerable to cross-site scripting

Overview
The WordPress plugin "Responsive Lightbox" contains a cross-site scripting vulnerability.

Products Affected

- Responsive Lightbox prior to version 1.7.2

Description
The WordPress plugin [illegible] ility (CWE-79).

Impact
An arbitrary script may be executed on the logged in user's web browser.

Solution
Update the plugin
Update the plugin according to the information provided by the developer.

Vendor Status

| Vendor | Link |
|---|---|
| dFactory | Changeset 1685428 - WordPress Plugin Repository |
| | Responsive Lightbox by dFactory - WordPress Plugins - Changelog |

References

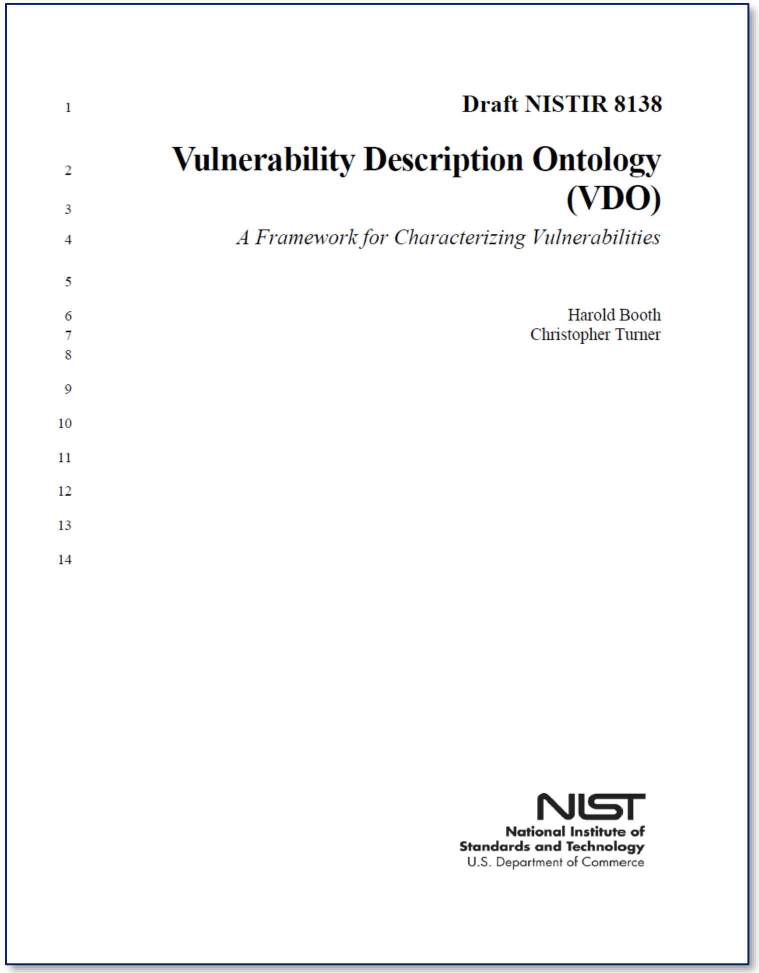
JPCERT/CC Addendum

Vulnerability Analysis by JPCERT/CC

| | | |
|---|---|---|
| CVSS v3 | CVSS:3.0/A[illegible] | Base Score: 6.1 ▼ |
| CVSS v2 | AV:N/AC:H/Au:N/C:N/I:P/A:N | Base Score: 2.6 ▼ |

# On-going projects (2/2)

- Refine NISTIR 8138
  - The framework of VDO is not mature
    - Some noun groups should be discussed
  - 1st round of comments sent to NIST and VRDX SIG
    - Our findings from the feasibility study in JPCERT/CC
    - Discussions on comments to follow



**Draft NISTIR 8138**

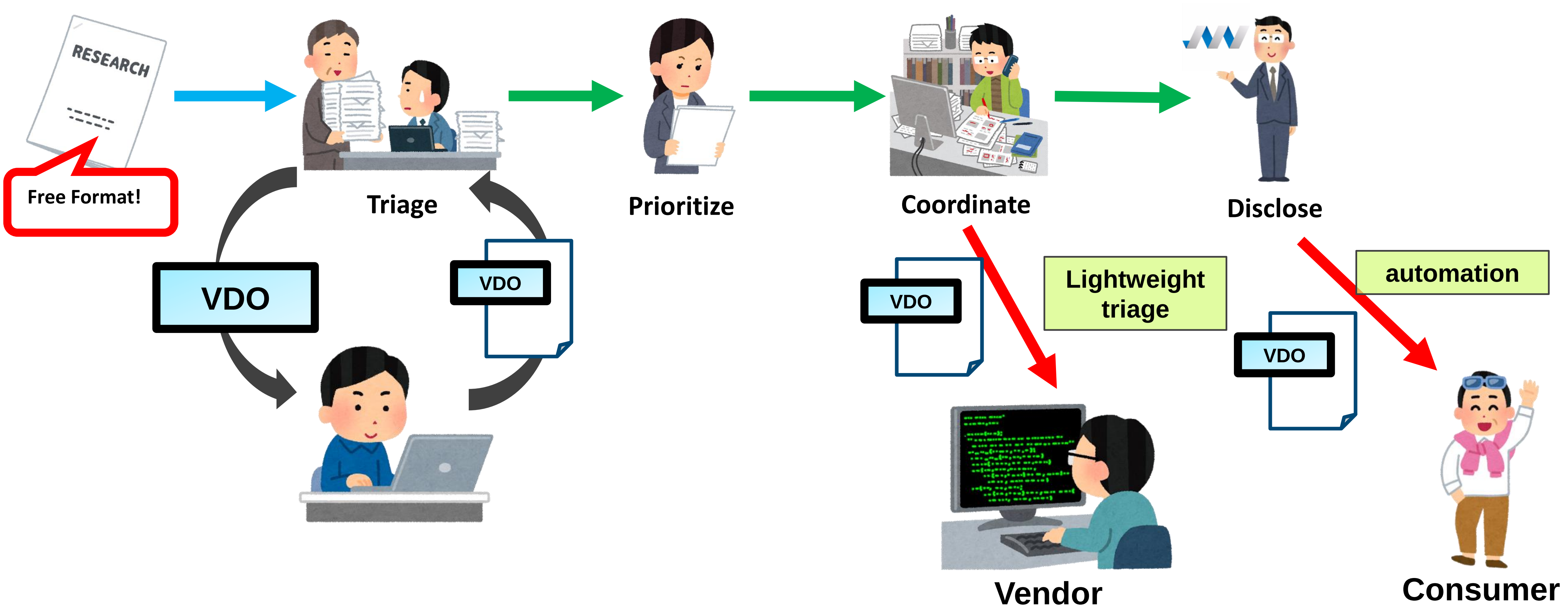
**Vulnerability Description Ontology (VDO)**

*A Framework for Characterizing Vulnerabilities*

Harold Booth
Christopher Turner

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

# Future work: VDO as a common language



# Concluding remarks

- Vulnerability Description Ontology (VDO)
  - Core information model to describe vulnerability information
  - Has huge potential to aid
    - A format to automatically manage vulnerability information
    - A common language (Taxonomy) for understanding and exchanging vulnerability information
- JPCERT/CC
  - Defined VDO in a JSON format and implemented JSON Schema
  - Started a feasibility study of VDO to improve vulnerability management

# Thank you!

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