

# Towards More Effective Responsible Disclosure for Vulnerability Research

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What is *Unpatched* Vulnerability?

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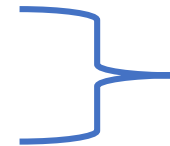
Unpatched vulnerabilities refer to weaknesses that allow attackers to leverage a known security bug that has not been patched by running malicious code.

# “Horrible” Example

- CVE-2021-44228 (**Log4Shell**)
  - Affects Apache’s Log4j Library
  - CVSS Score: **10.0 CRITICAL**
    - **Affect at least 90% JAVA**
  - NVD Published Date: 12/10/2021
  - Patched Date: 12/28/2021

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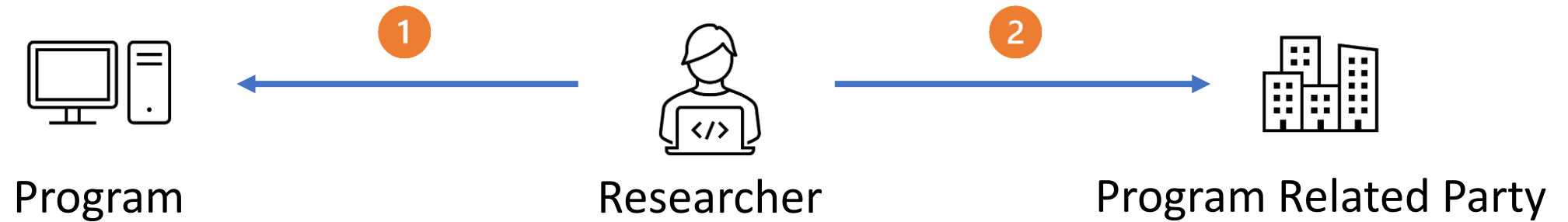
**18 days gap**

- Other examples

- CVE-2021-26855, CVE-2021-26858, etc. (**ProxyLogon**)
- CVE-2021-34523, CVE-2021-34473, etc. (**ProxyShell**)
- ... ..

# Finding-Reporting Bug process

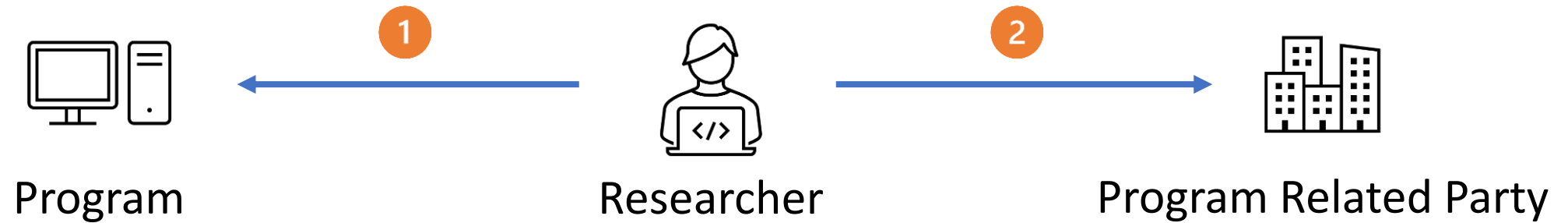
# Finding-Reporting Bug process



- 1 Researcher -> Program: Find Vulnerabilities



# Finding-Reporting Bug process



- 1 Researcher -> Program: Find Vulnerabilities
- 2 Researcher -> Program Related Party: **Responsible Disclosure**

# Two Common Issue of Responsible Disclosure

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2. Many reports are of low quality; as a result, reports are often completely ignored by maintainers, or their acceptance is significantly delayed

# Aim of our Work

1. Is it common that security-critical bug reports are disclosed publicly in the first place?
2. What factors of a bug report contribute to delaying or ignoring?
3. Provide insights into how to improve the quality of bug reports and the effectiveness of the responsible disclosure

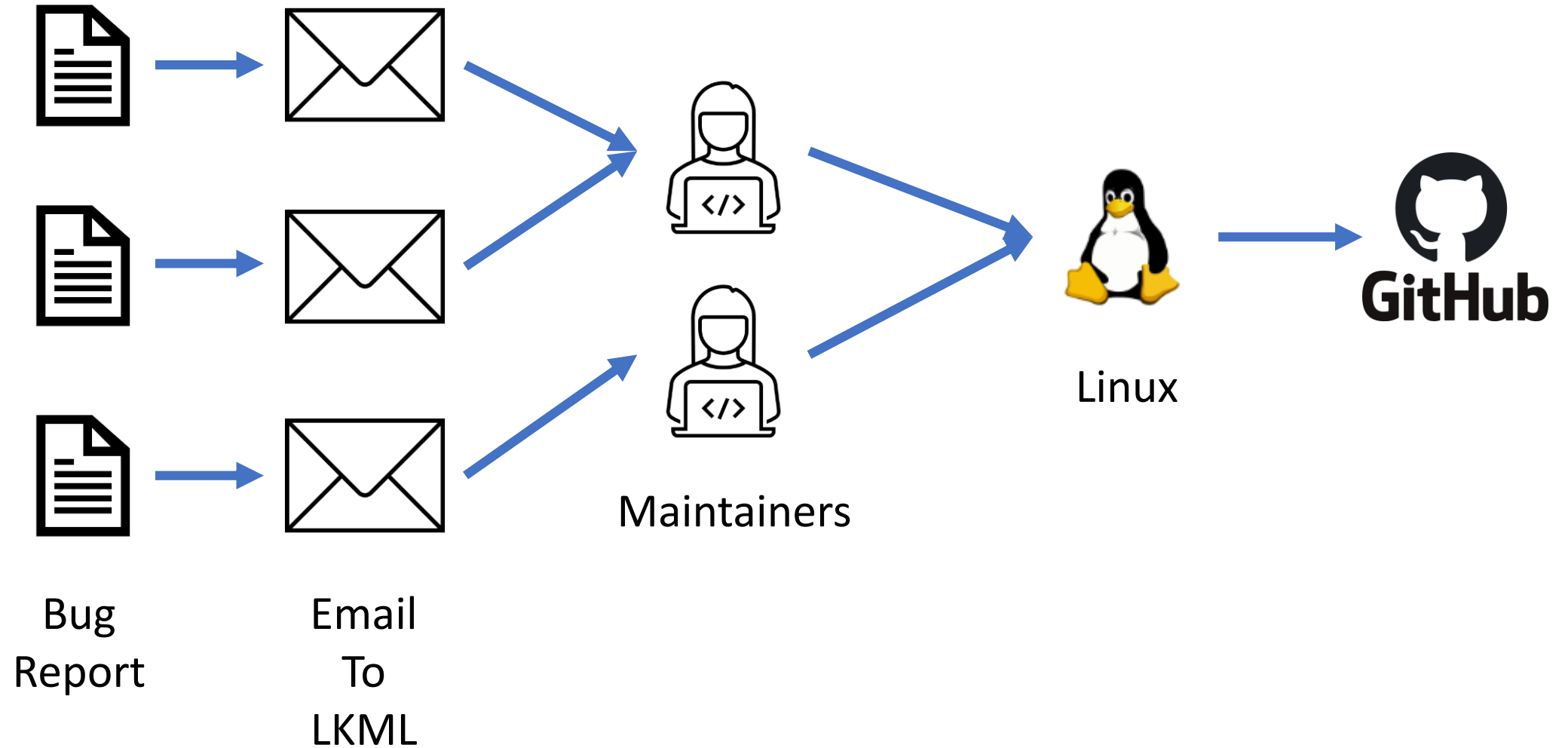
# Target

- Linux Kernel
- Linux Bug Reports
- Linux Patch History

# Why Linux Kernel?

- 47% of professional developers use Linux-based operating systems.
- Linux powers nearly 40% of websites whose operating system is known.
- Linux has over 27.8 million lines of code.
- 85% of smartphones are Linux-powered.
- Etc.

# What is Patch History?





# Linux Bug Report Example

[1.] One line summary of the problem:

[2.] Full description of the problem/report:

[3.] Keywords (i.e., modules, networking, kernel):

[4.] Kernel information

[4.1.] Kernel version (from `/proc/version`):

[4.2.] Kernel `.config` file:

[5.] Most recent kernel version which did not have the bug:

[6.] Output of Oops.. message (if applicable) with symbolic information

resolved (see [Documentation/admin-guide/bug-hunting.rst](#))

[7.] A small shell script or example program which triggers the problem (if possible)

[8.] Environment

[8.1.] Software (add the output of the `ver_linux` script here)

[8.2.] Processor information (from `/proc/cpuinfo`):

[8.3.] Module information (from `/proc/modules`):

[8.4.] Loaded driver and hardware information (`/proc/ioproports`, `/proc/iomem`)

[8.5.] PCI information ('`lspci -vvv`' as root)

[8.6.] SCSI information (from `/proc/scsi/scsi`)

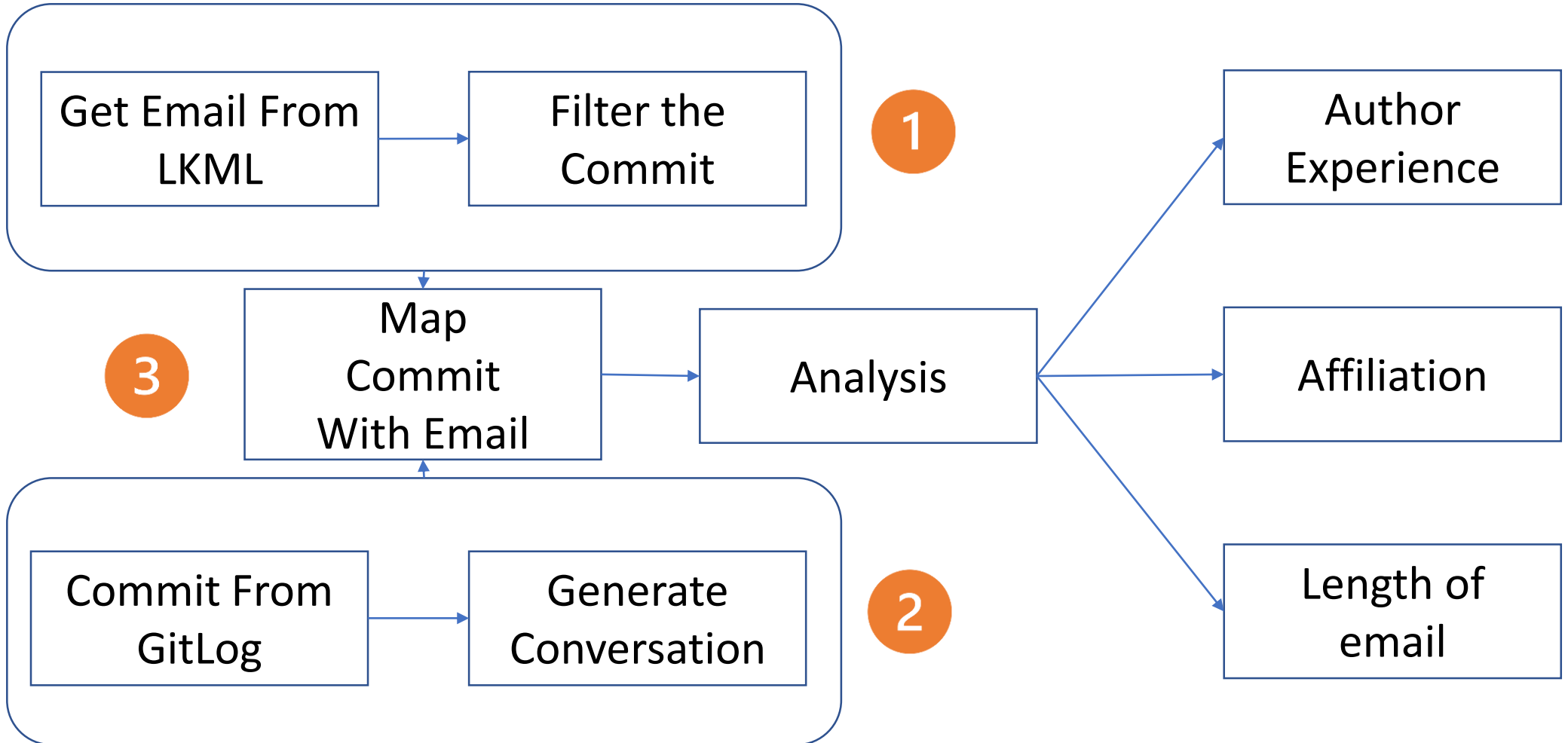
[8.7.] Other information that might be relevant to the problem

(please look in `/proc` and include all information that you

think to be relevant):

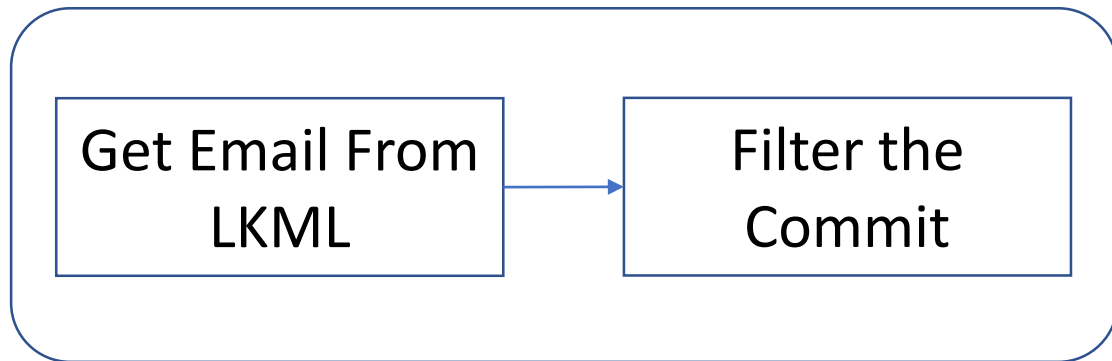
[X.] Other notes, patches, fixes, workarounds:

# Overview of Our Approach



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1



1

## Crawling bug-reporting emails.

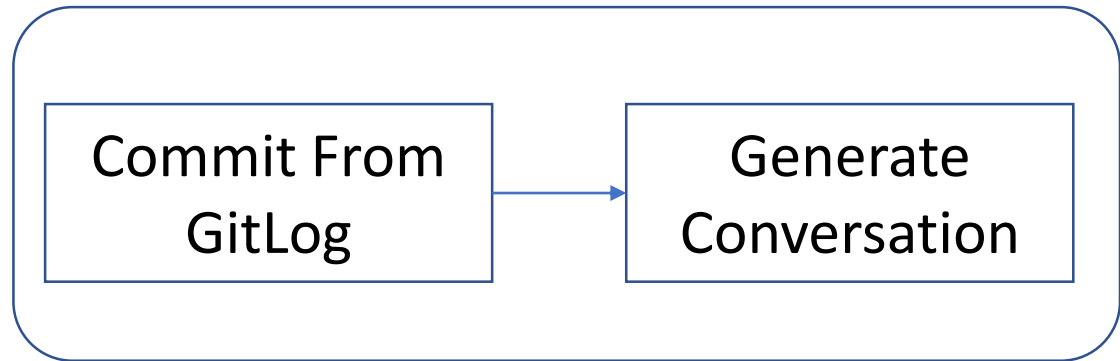
Source: <https://lkml.org/lkml/>.

Date Range: 01/01/2017 to 03/21/2022.

Year	Emails	Fix-related Emails	Conversations
2017	274,798	30,169	16,636
2018	312,810	35,847	22,135
2019	357,936	51,136	32,062
2020	423,133	57,574	35,671
2021	407,657	56,436	34,930
2022	91,023	10,316	6,122
Total	1,867,357	241,478	147,556

# Overview of Our Approach

2



2

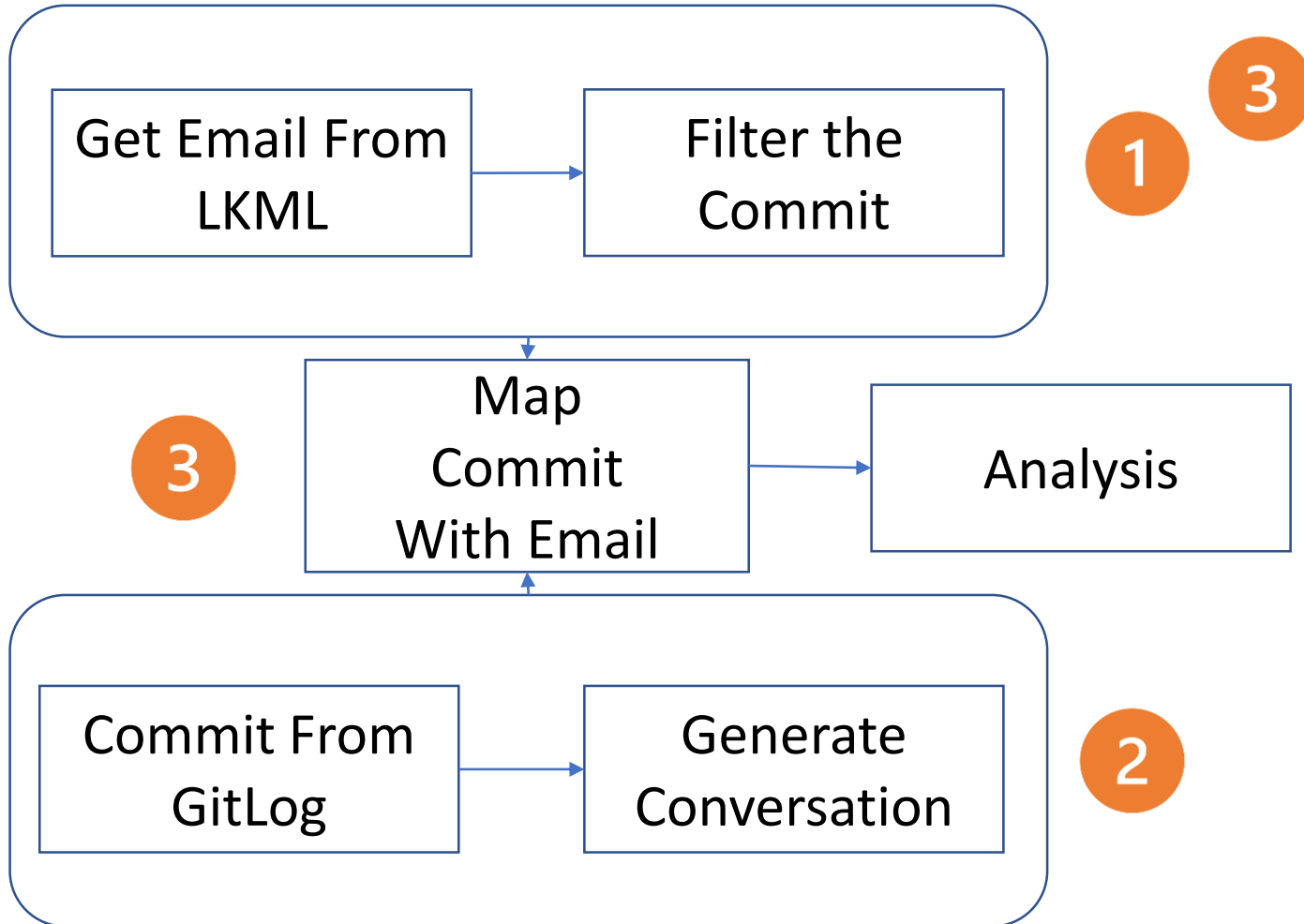
## Collecting Git commits.

Source: Git Log

Date Range: 01/01/2017 to 03/21/2022.

Year	Total Commits	Fix-related Commits
2017	80,850	9,563
2018	80,161	9,406
2019	82,915	10,342
2020	90,329	11,164
2021	85,156	11,133
2022	13,518	1,716
Total	1,085,249	53,326

# Overview of Our Approach



## Mapping commits and emails

- **Purpose of Mapping:**
  - Mapping the email conversation with the existed commits
- Mapping method:
  - Mapping by:
    - Commit ID
    - Authors of the commit
    - Authored time of the commit
    - Patches inside the commit

# Preliminary Results

1. “Irresponsible” Public Vulnerability Reports
2. Factors Contributing to Delays

# “Irresponsible” Public Vulnerability Reports

- Target:
  - 100 latest CVE
- Method:
  - Manually check the content and the corresponding commit ID
- Result:
  - They were all publicly reported before they were fixed.

# How easily take advantage of the content

The Google logo is centered on the page, featuring its characteristic multi-colored letters: 'G' in blue, 'o' in red, 'o' in yellow, 'g' in blue, 'l' in green, and 'e' in red.A search bar with a magnifying glass icon on the left and a close 'x' icon on the right. The text 'https://lkml.org/' is entered and underlined. To the right of the search bar are icons for voice search (a microphone) and image search (a camera).

Google Search

I'm Feeling Lucky



# Public Channel vs. Private Channel

- Public Channel:
  - Everyone has access to it
  - <https://lkml.org/>
- Private Channel:
  - Contact with security team and no one has access to it before it discloses.
  - [security@kernel.org](mailto:security@kernel.org)

# “Irresponsible” Public Vulnerability Reports

- Target:
  - 100 latest CVE
- Method:
  - Manually check the content and the corresponding commit ID
  - Check when the vulnerabilities were disclosed (reported)
- Result:
  - They were all publicly reported before they were fixed.

***\*Private Channel\**** for Bug report:  
***security@kernel.org***

# Insight into the Result

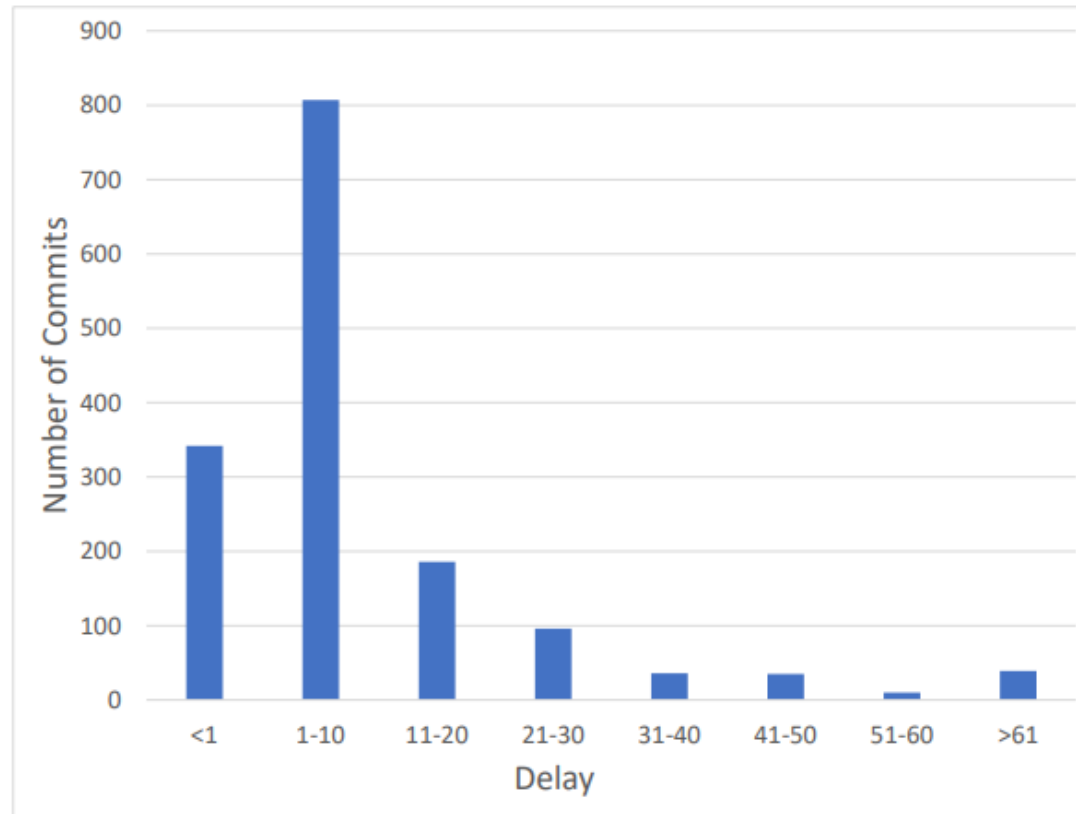
- Results from fuzzers will be reported to public channel directly
- Hard to determine the **impact of the security bugs** before they are exploited
- **Less care** about security than performance and functionality.
  - Eg: *Linus* "security problems are just bugs"  
(<https://lkml.iu.edu/hypermail/linux/kernel/1711.2/01701.html>)

# Factors Contributing to Delays

- Distribution of Delays
- Factors Contributing to Delays
  - Author Experience
  - Author Affiliations
  - Length of Reports
  - etc

# Factors Contributing to Delays

## *-Distribution of Delays*



**Definition:** We define delay as the time gap between the time of the original bug report (the email) and the time of patch merging (commit).

**Target:** memory-corruption bugs

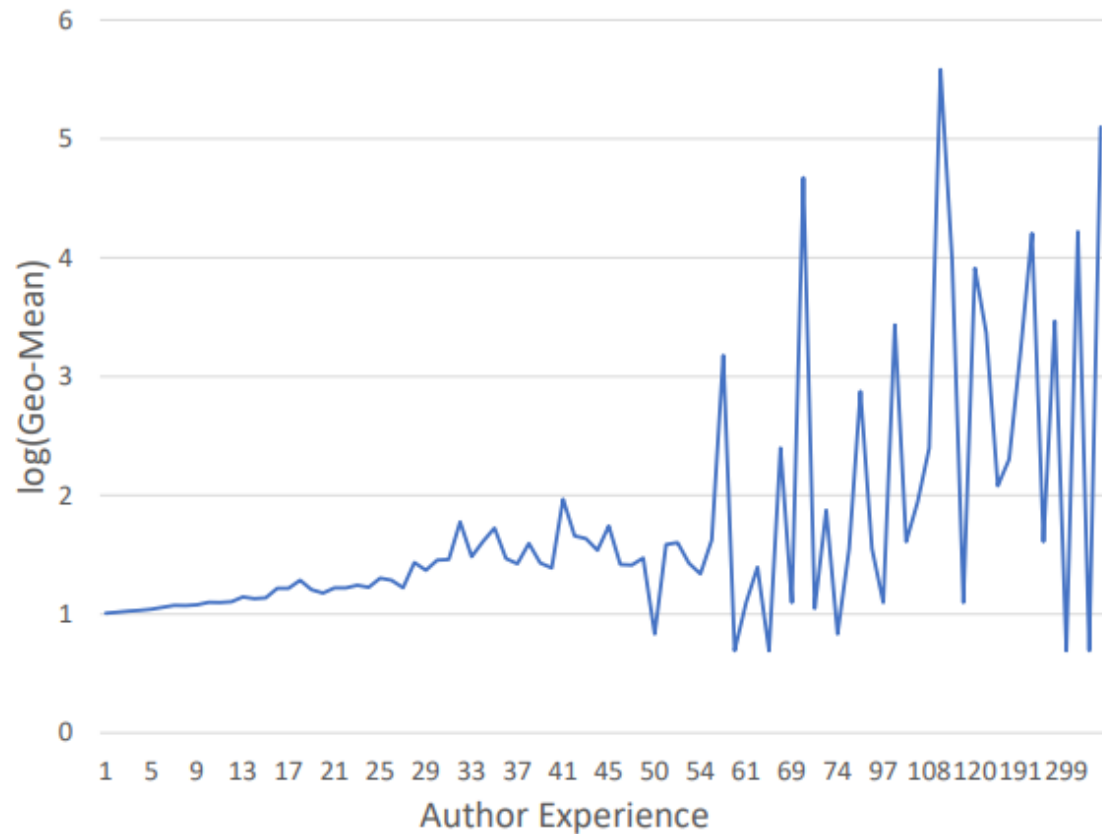
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# Factors Contributing to Delays

## *-Author Experience*

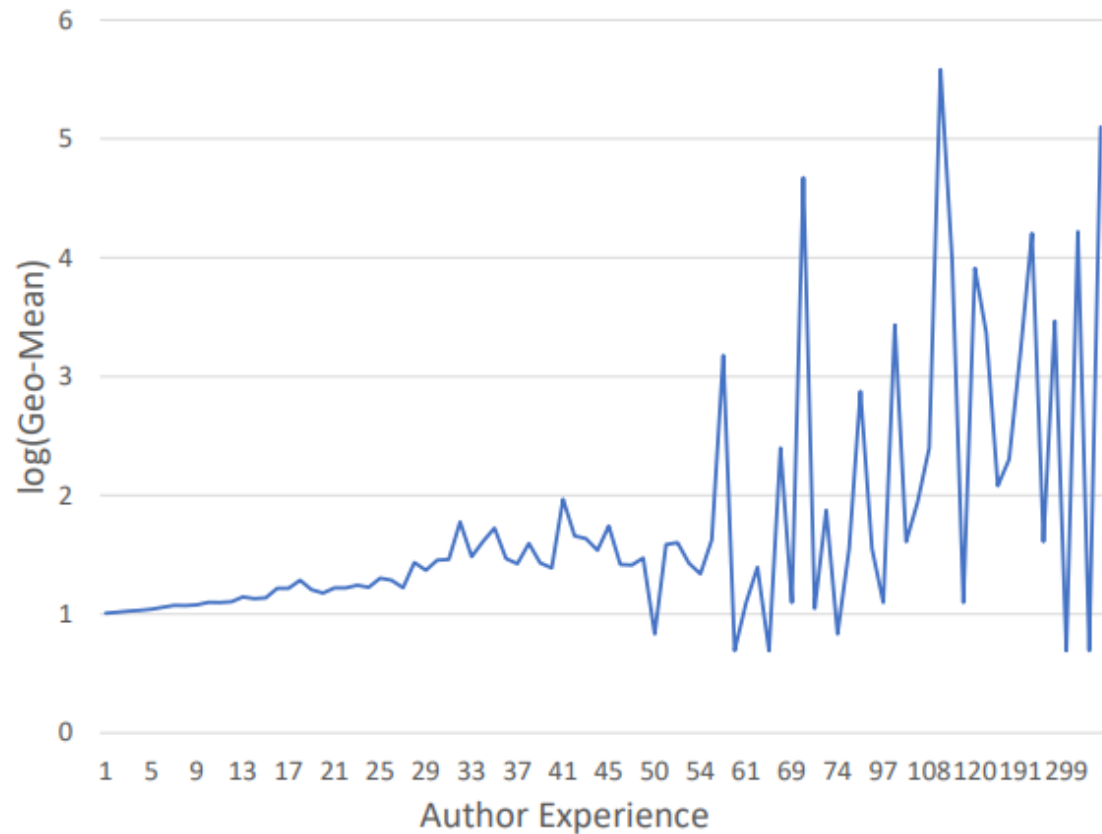


**Definition:** We define author experience based on how many commits (i.e., accepted bug reports or patches) has the author contributed to.

**Result:** Authors with the number of submission under 65 (i.e., less experienced authors based on our definition) have relatively smaller delays in general.

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**Insight:** Bugs from less experienced reporters are much easier



# Factors Contributing to Delays

## *-Author Affiliations*

Days (Geo-Mean)	E	LRO	O	P	LDC	C
	3.65	3.25	2.76	2.73	2.72	2.72

### ***Categories of affiliations:***

- Education
- Linux-Related Organizations
- Other Organizations.
- Personal
- Linux Department of Companies
- Companies

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### ***Reason of Education having more delays:***

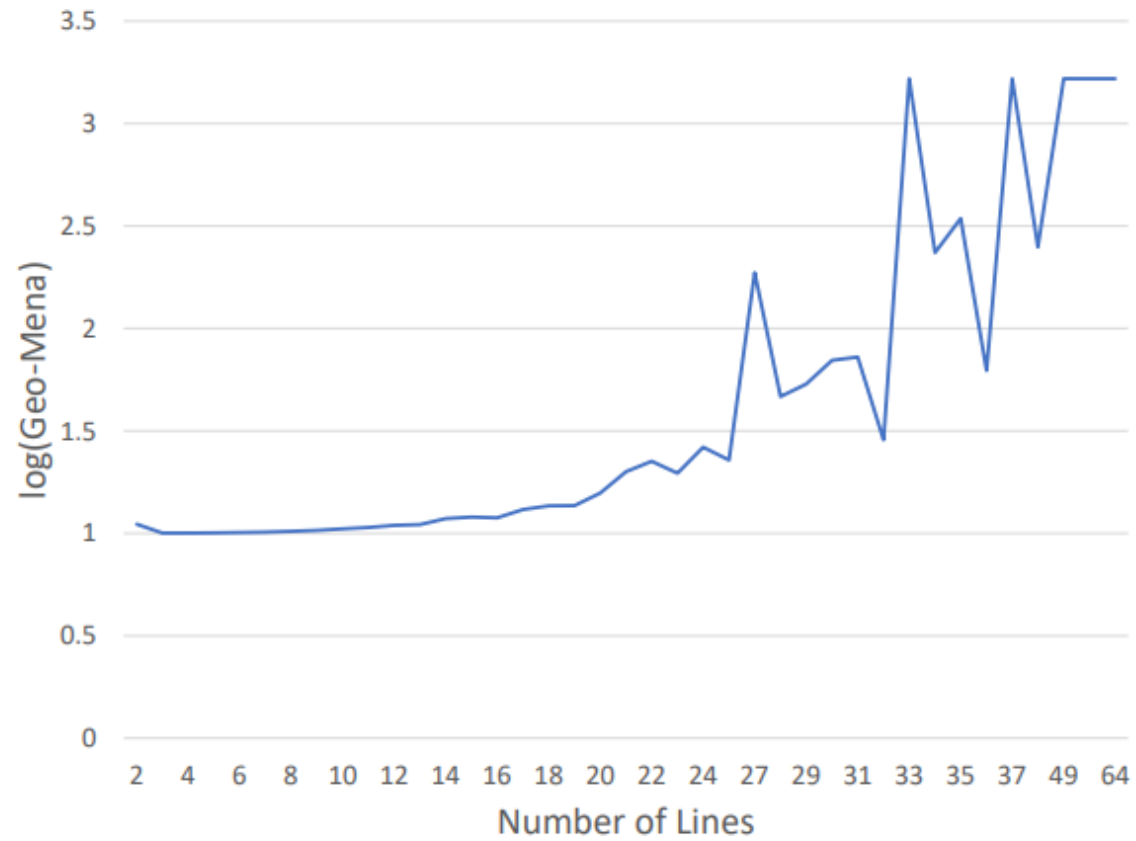
Every reporter should

**cc** [linux-kernel@vger.kernel.org](mailto:linux-kernel@vger.kernel.org)

but they did not.

# Factors Contributing to Delays

## *-Length of Reports*



**Definition:** We define length of a report as the number of lines of textual description.

**Correlation:** Generally, bug reports with a lengthy description tend to have a longer delay.

# Discussion

## Ethical concerns and Insights.

1. Not properly using *the private reporting channel* may violate the ethical requirement of the responsible-disclosure process
2. It is essential to have an *automatic tool* for inferencing the security of bugs based on their patches.
3. *Training* for students on how to improve the report quality would help.
4. A *concise and per-case report* is preferred and can avoid longer delays.

# Future Work

- Identify more factors and study their impacts on delays.
  - **Ignore Rate** (percentage of bug reports being ignored)

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- Smore popular open-source projects
  - **Bug-tracking platforms**: Github, Bugzilla, etc,
  - **Categories of project**: OS, browsers, web servers, script engines, etc.

# GitHub Example

## ELECTRON (106k stars)

- The Electron framework lets you write cross-platform desktop applications using JavaScript, HTML and CSS. It is based on Node.js and Chromium and is used by the Atom editor and many other apps.

<a href="#">Window menu folders not opening after resizing window</a> #37415 opened 8 hours ago by Mike-Wood
<a href="#">[Bug]: Frameless window is not draggable when running MAS build</a> <span>bug</span> #37414 opened 11 hours ago by streamer45 <span>3 tasks done</span>
<a href="#">[Bug]: window.loadFile not updating window.</a> <span>bug</span> #37413 opened 16 hours ago by koen1711 <span>3 tasks done</span>
<a href="#">[Bug]: GPU process crashes intermittently when using webContents.beginFrameSubscription() with a resized browser window</a> <span>bug</span> #37412 opened 19 hours ago by briskycat <span>3 tasks done</span>
<a href="#">Facebook login</a> #37411 opened yesterday by Fb9027
<a href="#">[Bug]: proxyquire can't load modules after window.open method is called</a> <span>bug</span> #37404 opened yesterday by kirylo-hrechynkin <span>3 tasks done</span>
<a href="#">[Bug]: nativeImage.getSize, and nativeImage.toPNG ignore scaleFactor</a> <span>bug</span> #37401 opened yesterday by dtaskoff <span>3 tasks done</span>
<a href="#">[Bug]: BrowserWindow rendering error with setting frame:false,transparent:true and resizable:true</a> <span>bug</span> #37400 opened 2 days ago by Aze-ziv <span>3 tasks done</span>
<a href="#">[Bug]: offscreen rendering doesn't paint after gpu process crashed</a> <span>bug</span> #37399 opened 2 days ago by tuanzijiang <span>3 tasks done</span>
<a href="#">[Bug]: Obsidian (on Electron) throwing AMD GPU timeout error crashing Ubuntu</a> <span>bug</span> #37393 opened 2 days ago by BryanWilhite <span>3 tasks done</span>
<a href="#">[Feature Request]: Auto focus to devtools webcontents when a devtools breakpoint is triggered</a> <span>enhancement</span> #37388 opened 3 days ago by 1339240789 <span>3 tasks done</span>
<a href="#">[Bug]: no scrollbar is showing in browserview and popup is out of frame.</a> <span>blocked/need-repro</span> <span>bug</span> #37387 opened 3 days ago by amabTeknikforce <span>3 tasks done</span>
<a href="#">[Bug]: can't grab the window from the very top of the screen (windows)</a> <span>blocked/need-repro</span> <span>bug</span> #37384 opened 3 days ago by Meteor0id <span>3 tasks done</span>
<a href="#">[Bug]: Windows transparency fails after the taskbar is hidden</a> <span>blocked/need-info</span> <span>bug</span> #37379 opened 4 days ago by HAPENLY <span>3 tasks done</span>
<a href="#">[Bug]: No way to close a browserView</a> <span>bug</span> <span>bug/regression</span> <span>component/BrowserView</span> <span>has-repro-comment</span> <span>status/confirmed</span> #37378 opened 4 days ago by t57ser <span>3 tasks done</span>

# Future Work

- Identify more factors and study their impacts on delays.
  - **Ignore Rate** (percentage of bug reports being ignored)
- Study more popular open-source projects.
  - **Bug-tracking platforms**: Github, Bugzilla, etc,
  - **Categories of project**: OS, browsers, web servers, script engines, etc.
- Develop **automated tools** to help reporters and maintainers.



# Thanks for Listening

Q & A

**Code Release: <https://github.com/Wayne-Bai/BugReportProject.git>**