Sharing cyber threat intelligence: Does it really help?

Beomjin Jin*, Eunsoo Kim*, Hyunwoo Lee†, Elisa Bertino‡, Doowon Kim§ and Hyoungshick Kim*

***Sungkyunkwan University, †KENTECH, ‡Purdue University, §University of Tennessee**

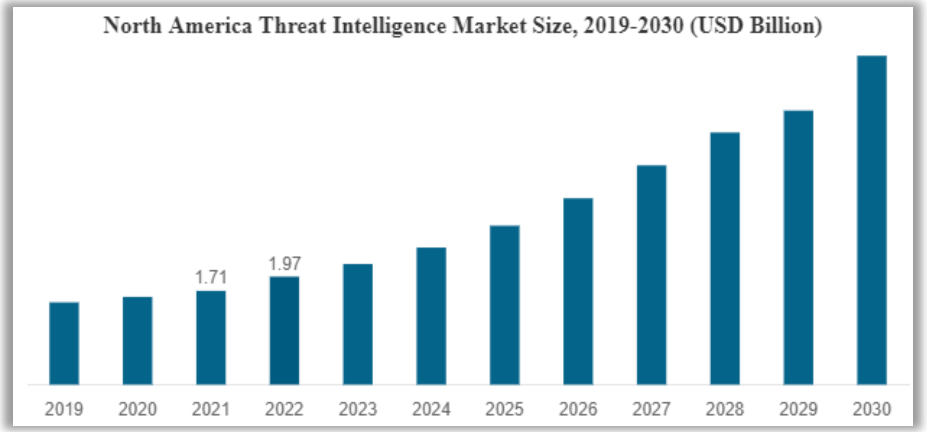
Cyber Threat Information sharing

The New York Times

Americans Have Lost $145 Million to Coronavirus Fraud

More than 200,000 complaints of scams and fraud have been filed so far this year, data from the Federal Trade Commission shows.

- *COVID* frauds caused a lot of financial damage[1]
- Threat information sharing resulted in proactive prevention of *COVID* frauds[2]

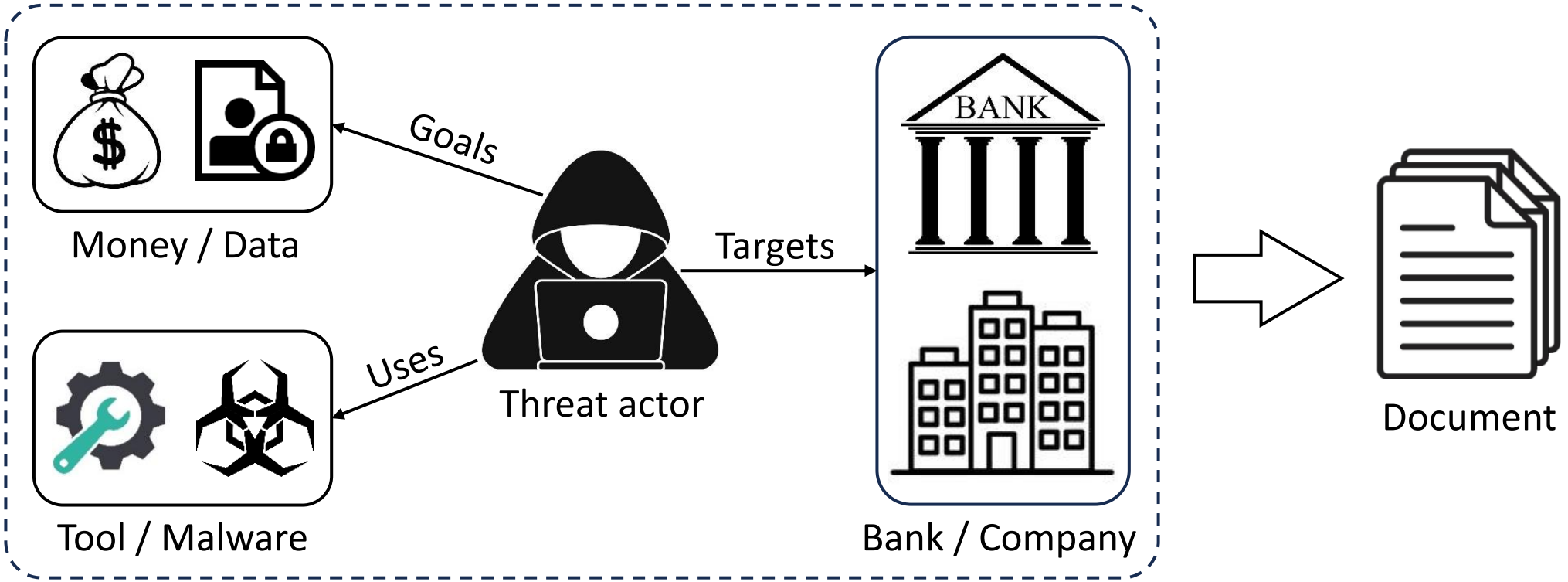


- Surge of *COVID* frauds led to the threat sharing market growth in North America[3]

[1] https://www.nytimes.com/2020/09/23/us/coronavirus-scams-ftc-reports.html
[2] Bouwman *et al.*, "Helping hands: Measuring the impact of a large threat intelligence sharing community," *USENIX Security* 2022
[3] https://www.fortunebusinessinsights.com/threat-intelligence-market-102984

Cyber Threat Intelligence

- Cyber threat intelligence (CTI) is the **knowledge** to understand and mitigate cyberattacks



CTI formats

- CTI data is shared in various formats

- *Campaign*
- *Threat actor*
- *Malware*
- *Vulnerability*

Threat report

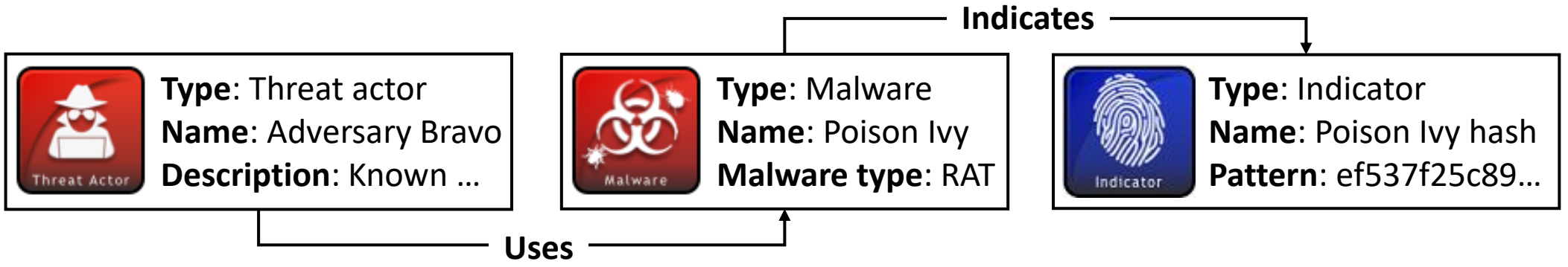
- *Malware file hash*
- *Malicious IP address*
- *Malicious domain/URL*

Blacklist

CTI standards

STIX (Structured Threat Information eXpression)

- STIX is a *de facto* standard and is widely used in cybersecurity



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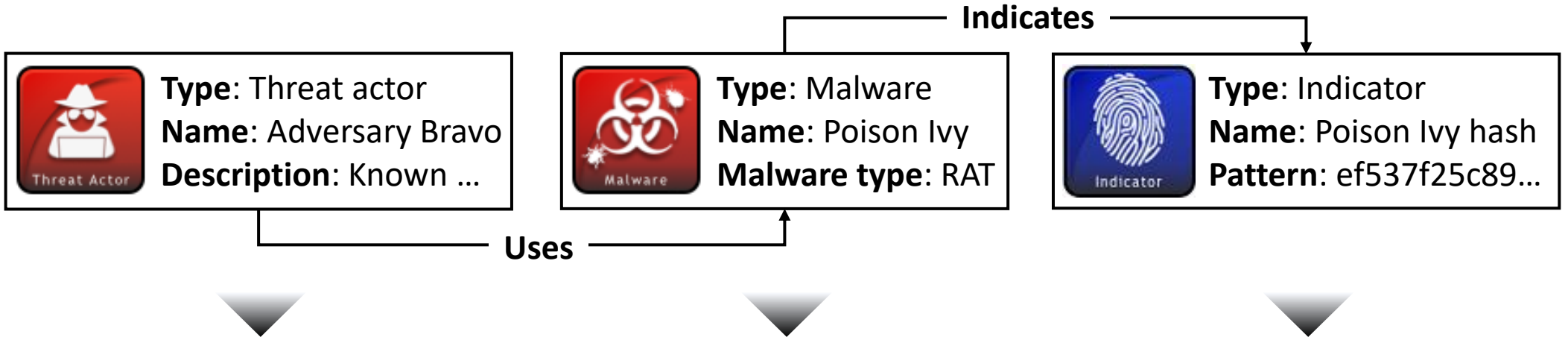



```
{
  "type": "threat-actor",
  "id": "threat-actor--d9…",
  "name": "Adversary Bravo",
  "description": "Known …",
  …
}
```

```
{
  "type": "malware",
  "id": "malware--541c…",
  "name": "Poison Ivy",
  "malware_types": ["RAT"],
  …
}
```

```
{
  "type": "indicator",
  "id": "indicator--9422f…",
  "name": "Poison Ivy hash",
  "pattern": "ef537f25c89…",
  …
}
```

Is sharing STIX really helpful?

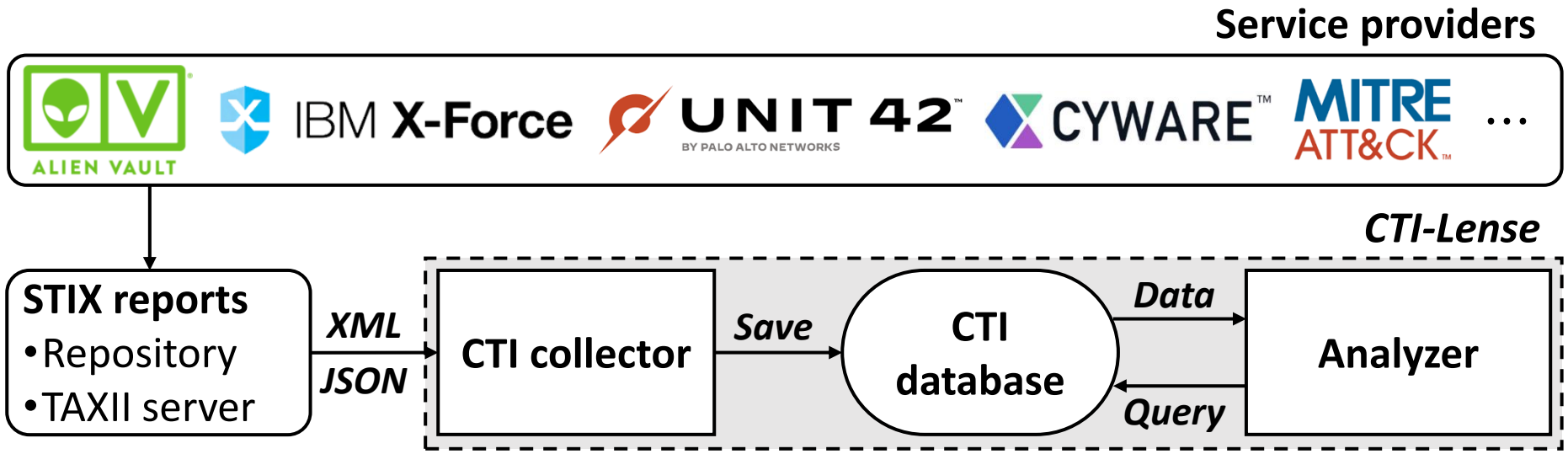
- Volume
- Coverage
- Timeliness
- Quality

RQ1 (Volume): How much STIX data is being generated and shared publicly?

Data duplication ***Daily/monthly number of STIX data***

CTI-Lense

- A framework that aggregates and assesses the STIX data
  - We collected **10M** STIX objects from publicly available service providers:
    - TAXII servers: *Hail a TAXII*, *AlienVault OTX*, *IBM X-Force Exchange*, *etc.*
    - Web repositories: *JamesBrine*, *DigitalSide*, *MITRE ATT&CK*
    - Period: From October 31, 2014 to April 10, 2023
  - We analyzed **data duplication** and **daily/monthly shared STIX data**



Volume

Version	Sources	Unique	Duplication	
			Intra	Inter
STIX 1	Hail a TAXII	1,900,237	50.71%	0.76%
	AlienVault OTX	1,647,509	38.93%	1.16%
	IBM X-Force Exchange	273,274	46.36%	20.32%
	PickupSTIX	73,575	18.13%	6.86%
STIX 2	AlienVault OTX	1,657,442	3.02%	2.00%
	JamesBrine	205,776	68.74%	0.00%
	DigitalSide	198,439	33.52%	7.78%
	Cyware	228,782	11.94%	2.51%
	IBM X-Force Exchange	119,611	1.25%	2.54%
	Unit42	33,379	7.03%	13.29%
	MITRE ATT&CK	17,042	0.05%	1.73%
	Limo from Anomali	6,492	0.06%	12.68%
	PickupSTIX	507	1.74%	0.00%

Data duplication

- **38%** of STIX data are duplicated **within** a single source

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Requires additional efforts to remove duplicated data before deployment

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Number of STIX data

- Open STIX dataset predominantly depends on **a few sources**
- A daily average of **2,063** unique STIX objects are publicly shared

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- A daily average of **2,063** unique STIX objects are publicly shared

This number seems significantly insufficient to handle the daily emerging malware samples

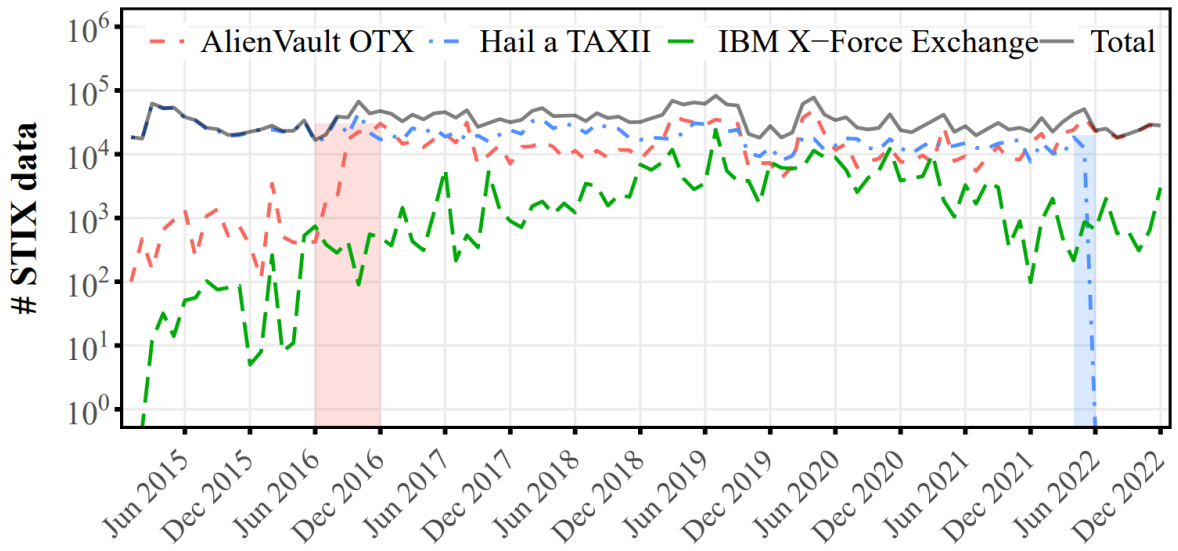
AV-TEST *450,000 malware per day*[5]

[5] https://www.av-test.org/en/statistics/malware/

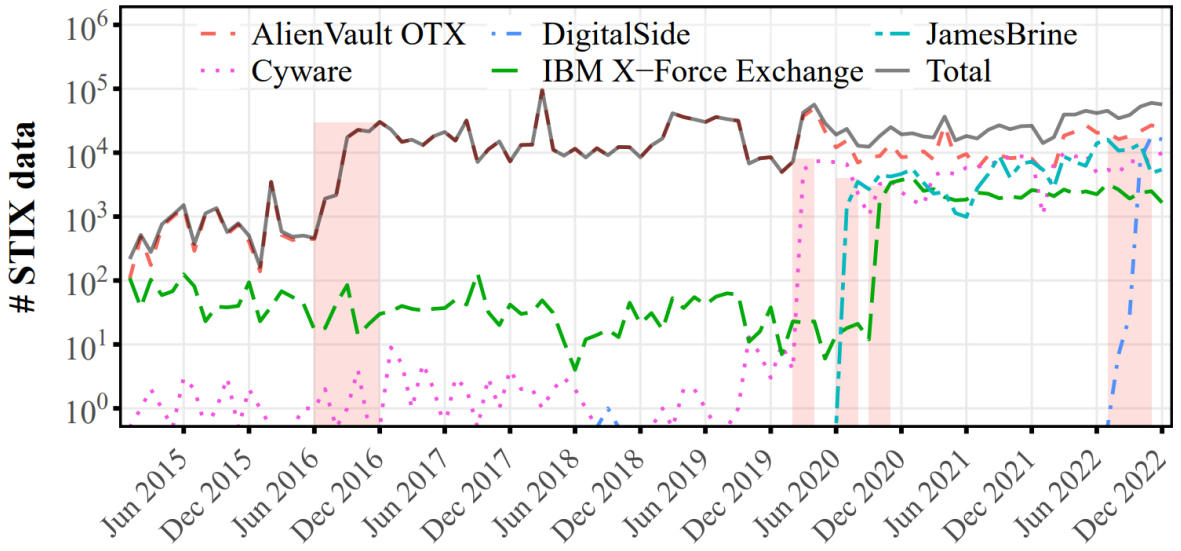
Volume

STIX data sharing over time

- STIX data sharing has increased in recent years
  - The trend of sharing STIX data has been rising since 2016
  - Various STIX 2 data sources have been emerged since 2020



STIX 1



STIX 2

RQ2 (Timeliness): How promptly is STIX data shared following a cyber threat discovery?

vs. security incidents ***vs. online scanning services***

Timeliness

vs. security incidents

- We analyzed relationship between the STIX data and corresponding **security incidents**
  - We found weak evidence of causal relationship from **security news websites** to the sharing of STIX data, with **p < 0.05** for the **2–12** days *time-lag*

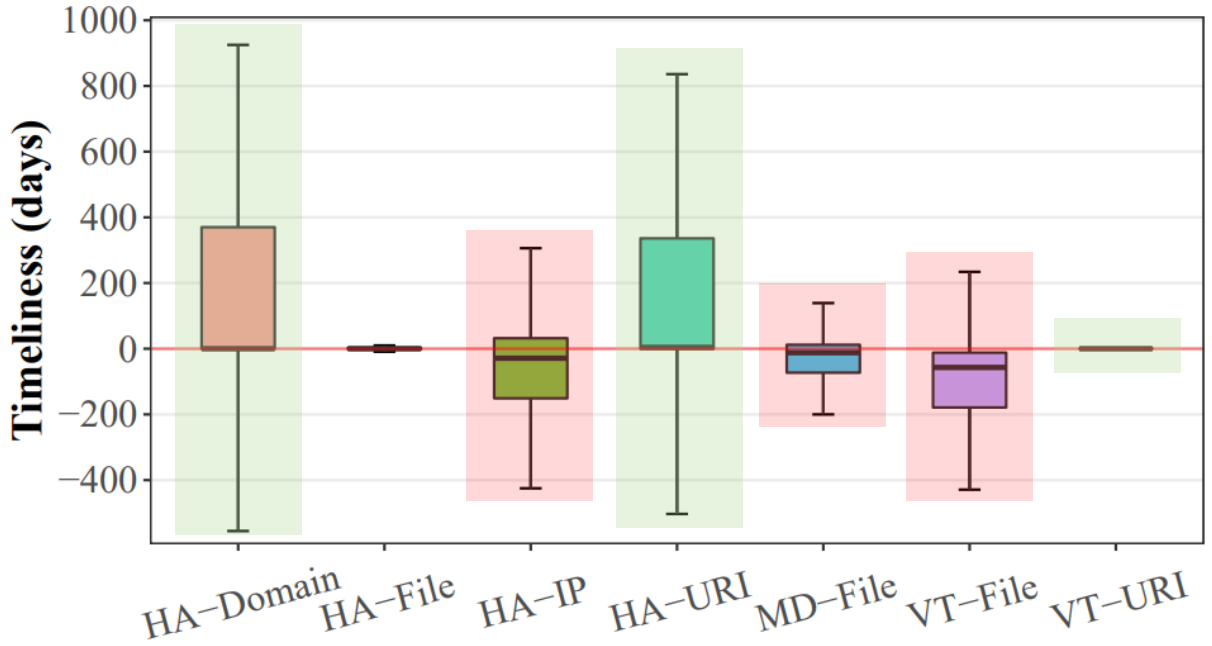
Security incident

STIX data are shared after 2–12 days following the reporting of security incidents in security news websites

Timeliness

vs. online scanning services

- We measured the latency between the initial appearance of STIX data and its subsequent detection by popular **scanning services**, such as
  - ViursTotal, HybridAnalysis, and MetaDefender



Differences in the data generation time

- **Domain** and **URI** data shared **faster** than scanning services
- **File** and **IP** data shared **slower** than scanning services

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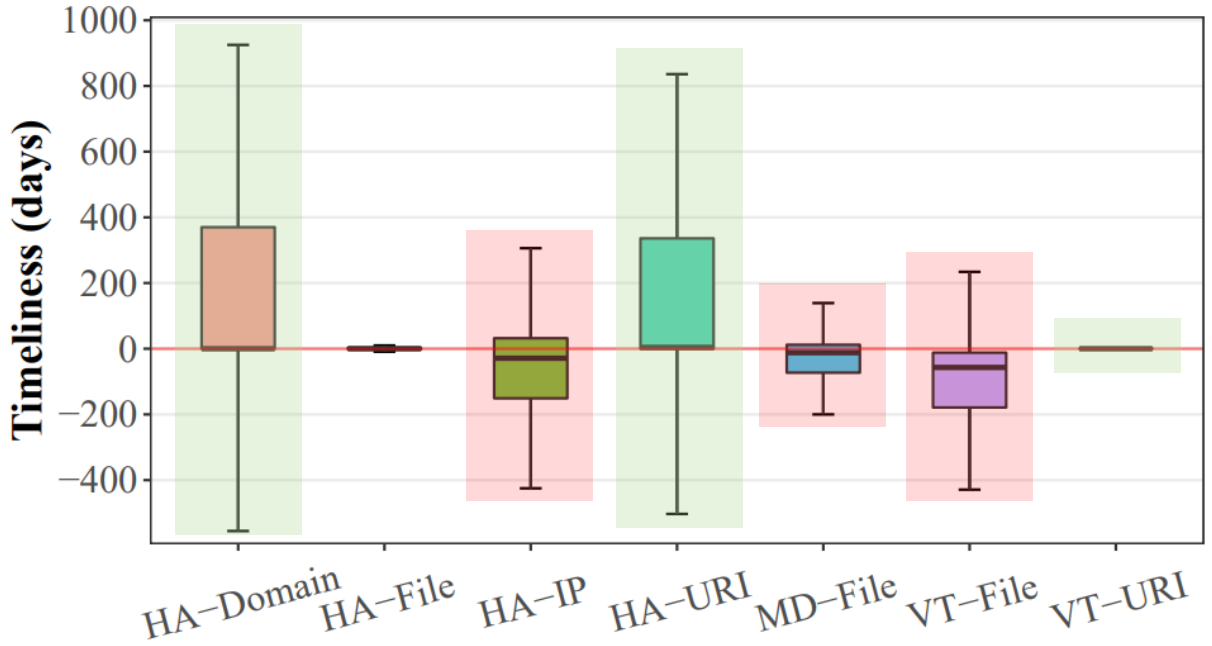

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STIX is ineffective in detecting the near zero-day malware

RQ3 (Coverage): How many objects and attributes defined in STIX are used?

STIX object usage ***STIX attribute usage***

Coverage

Versions	Objects	Prop.
STIX 1	Indicator	98.77%
	Other	1.23%
STIX 2	Indicator	94.93%
	Other	5.07%

Versions	Indicator attributes	Prop.
STIX 1	Observable	99.92%
	Type	53.73%
	Producer	51.28%
	Indicated_ttps	34.76%
	Test_mechanisms	0.09%
STIX 2	Pattern	100.00%
	Labels	32.62%
	Indicator_types	17.13%
	Kill_chain_phases	17.13%
	Created_by_ref	10.20%

Object usage

- ***Indicator*** object type accounts for more than **90%** for both STIX versions

Attribute usage in Indicator

- Nearly 100% of *Indicator* objects contain simple **IoC data**, such as malware hash
- Few *Indicator* objects contain **types, producers, and detection rules**

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A limited number of STIX data types are used in practice

RQ4 (Quality): What is the quality of STIX data in terms of its correctness and completeness in representing cyber threats?

Improper value ***Improper usage***

Quality

Improper values – Incorrect values in STIX objects

- Focused on values in *Indicator*, *TTP*, *Malware*, and *Threat actor* objects

```
1  <stix:Indicator id="indicator-...">
2    <indicator:Observable idref="...">
3      <cyboxCommon:simple_hash_value>
4        12cc14bbbc421275c3c6145bfa186dff
5      </cyboxCommon:simple_hash_value>
6    </indicator:Observable>
7    <indicator:Indicated_TTP>
8      <stix:TTP id="ttp-...">
9        <ttp:Behavior>
10         <ttp:Malware_Instance>
11           <ttp:Name> Lazarus </ttp:Name>
12         </ttp:Malware_Instance>
13       <ttp:Behavior>
14       ...
15     </stix:TTP>
16   </indicator:Indicated_TTP>
17 </stix:Indicator>
```

Indicator → **Must include malicious file hash!**

TTP – Malware instance → **Must include malware instance name!**

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Indicator → **Must include malicious file hash!**

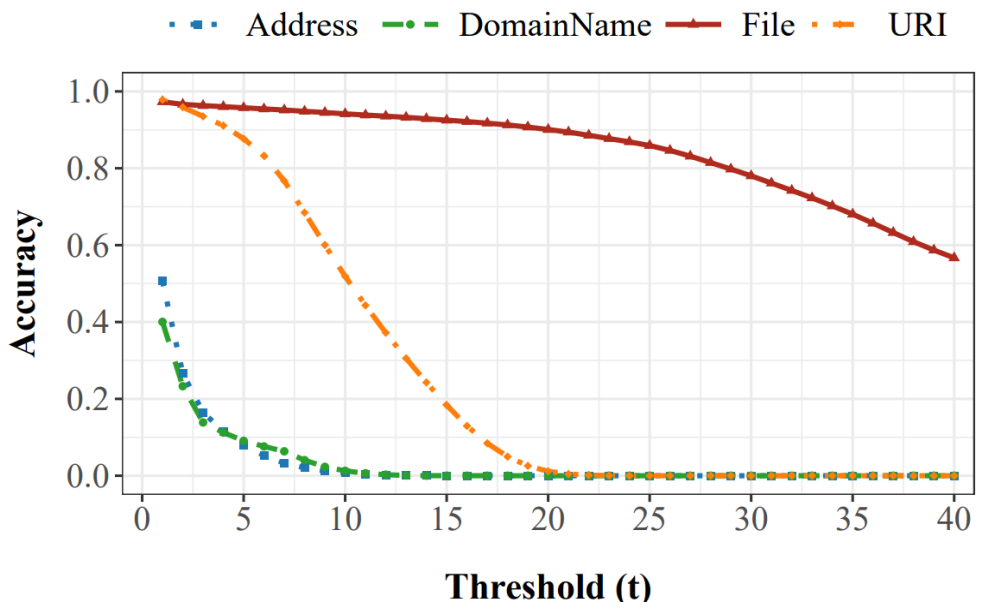
Measure detection rate using online scanning services

TTP – Malware instance → **Must include malware instance name!**

Match the keywords from trustworthy data sources

Quality

Types	Count	Detected	Not det.	N/A
Address	43,537	50.62%	49.38%	0.00%
DomainName	163,121	39.99%	59.90%	0.12%
File	88,470	78.37%	1.87%	19.75%
URI	377,857	97.06%	2.18%	0.76%
Total	672,985	77.77%	19.18%	3.05%



Improper values in Indicator

- **78%** IoC data are confirmed by at least one of the engines in VirusTotal
- Among the data confirmed by the VirusTotal:
  - ***File*** and ***URI*** types achieved over **90% detection rate** ($1 \leq t < 5$)
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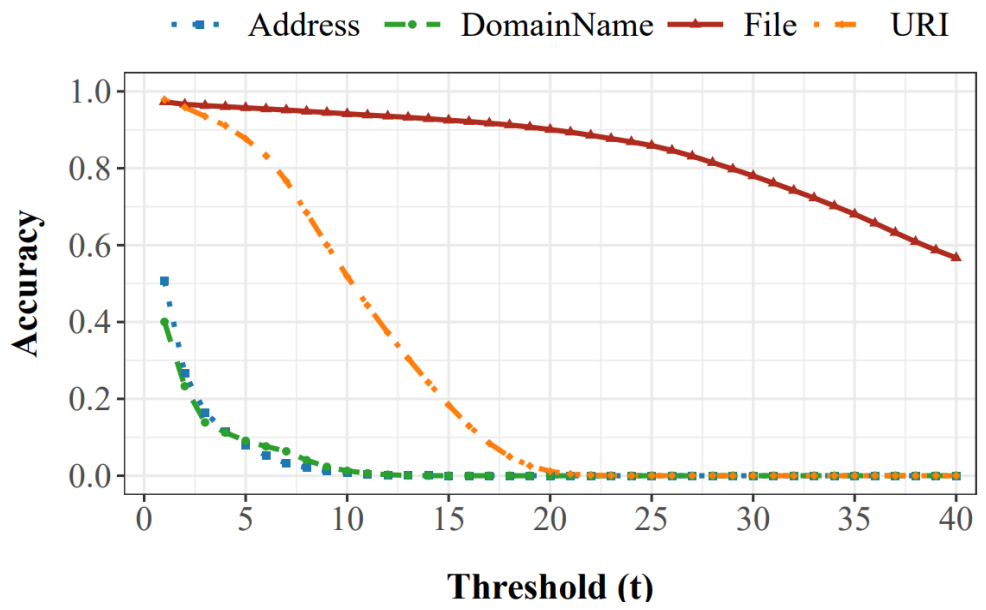

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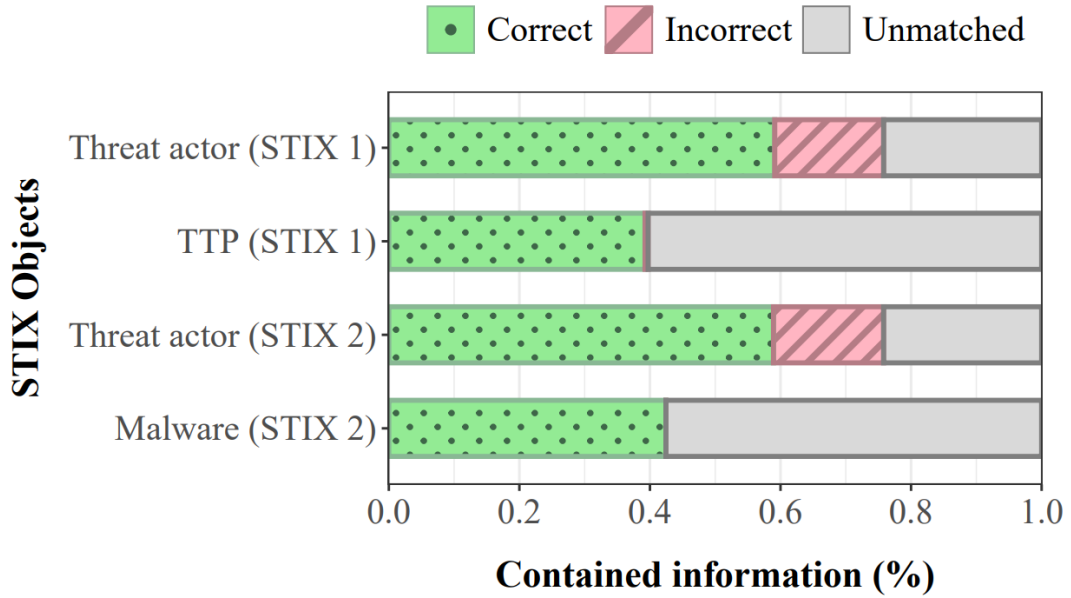
Most file and URI data included in STIX are correct

Quality

Improper values in TTP, Threat actor, and Malware

- **19%** of *Threat actor* objects contain malware family names
- **60%** of malware family information does not match any of the entries
  - The majority of the values are named based on producers' own conventions



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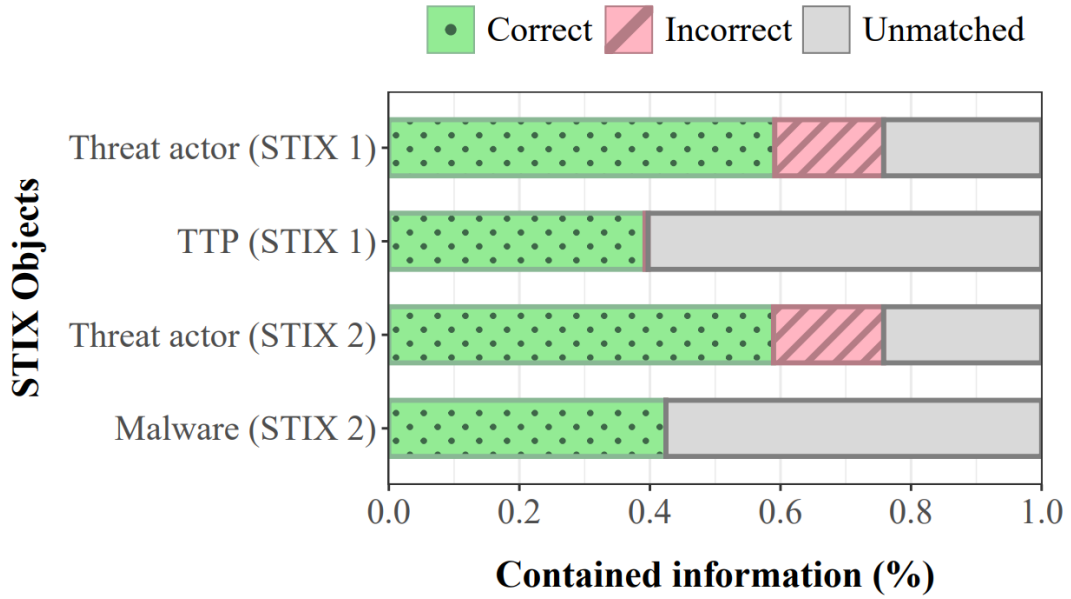

STIX does not always contain accurate values and most values are named based on producers' own conventions

Requires additional data validation process

Quality

Improper usage – Imprecise STIX object usage

- Focused on narrative description rather than using specific STIX objects

```
1  <stix:STIX_Package ...>
2    <stix:STIX_Header>
3      <stix:Title> Dtrack and ATMDtrack ATM
       Malware Linked to Lazarus </stix:Title>
4      <stix:Description> Summary After discovering
        ATM malware they named ATMDtrack, Kaspersky
        found a significant number of other related
        samples of malware which they have named
       Dtrack ... A remote access Trojan (RAT) is
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8      <stix:Indicator id="...">...</stix:Indicator
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Can be described using STIX objects!

- TTP – Malware instance
  - Dtrack, ATMDtrack, RAT
- Threat actor
  - Lazarus

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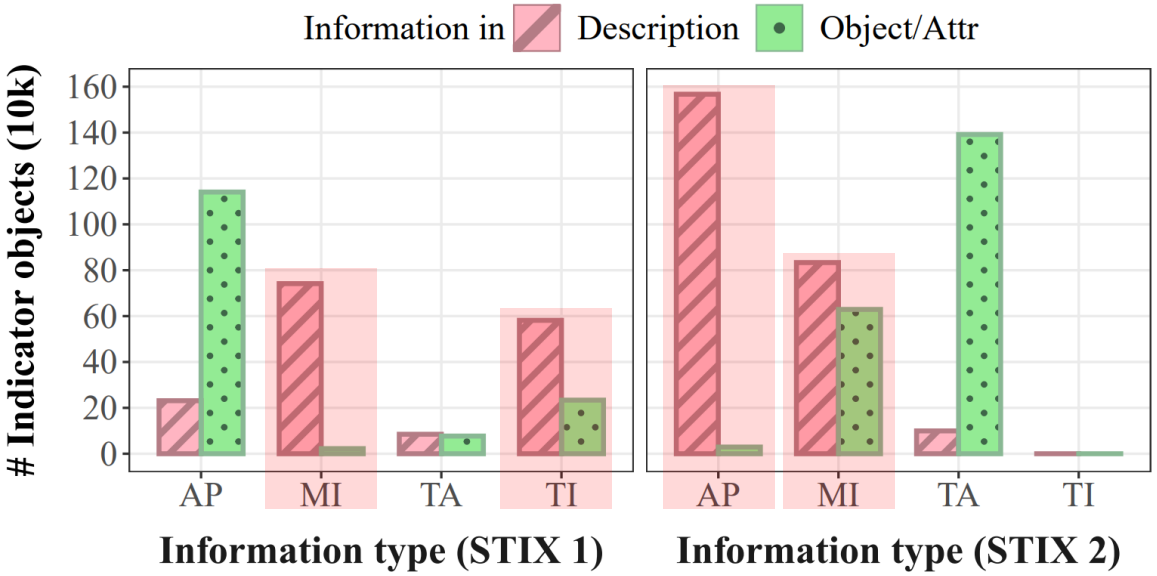
Count the number of *Indicator* objects where information is written narrative form

Quality

Improper usage

- Significant number of *indicator* objects describe related information in narrative form
  - **98%** of the *Indicator* objects in STIX 2 includes attack patterns only in a narrative form



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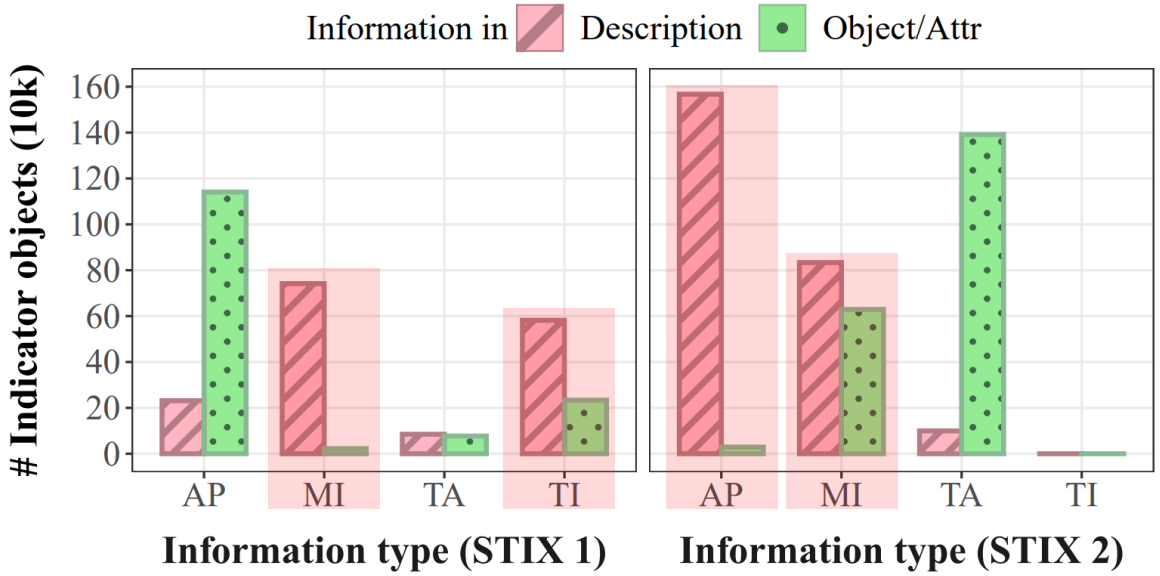

The producers often describe threat information in a narrative form, rather than using specific STIX objects

This can make automatic processing difficult

Our recommendations

- We need to know how to create better STIX data!
  - Provide **educational programs** and **practical guidelines** for effectively using STIX data types
- We need to generate and manage STIX data automatically!
  - Develop ML-based **tools for verification** and **deduplication** to minimize human error
- We need to maintain consistency in STIX terms and usage!
  - **Standardize naming conventions** to avoid confusion and inconsistency

Thank you, any questions?

https://github.com/SKKU-SecLab/CTI_Lense

jinbumjin@skku.edu