Real-time Log Analysis Tool with STIX 2.0

Interfaculty Initiative in Information Studies Graduate School of Interdisciplinary Information Studies,

The University of Tokyo

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Profile

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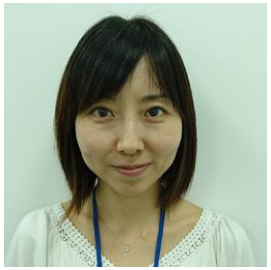
- Project researcher, Secure Information Society Research Group, the University of Tokyo (SiSOC)
- Job description:
  - Analysis and publication on cyber security
  - Education for human resources for cyber security
  - Presentations and lectures in seminars/universities etc.
- Publication/Works :
  - CSIRT – from building to running – (coauthor)
  - Tracking mimikatz by Sysmon and Elasticsearch

https://hitcon.org/2017/CMT/slide-files/d2_s1_r1.pdf


About Secure Information Society Research Group, the University of Tokyo

- SISOC-TOKYO researches on Internet security through collaboration with industry, academia and government.
  - SISOC-TOKYO gathers human resources through collaboration among industries, academia and government to research on social and international issues and widely reports on the analysis results.
  - SISOC-TOKYO promotes interdisciplinary research, human resource education and policy recommendation against issues on cyber space and security from a macro and long-term perspective.

Agenda

- Background
- Challenges
- Solution
- Demonstration
- Conclusion

BACKGROUND

Background

- Cyber attacks become more sophisticated
- To detect cyber attacks, shared indicators such as C&C server **domain** and **IP address** can be useful
- Information sharing scheme has been developed globally, and indicator formats such as STIX are standardized during the past years
- As indicator exchange increases, however, there are new challenges to handle indicators, comparing **increasing number of shared indicators** against **a large amount of logs**
- In this presentation, we will present how our tool works for effective detection to take advantage of STIX

Indicator

- Indicators are information indicating the features of attacks
  - Host name, IP address and URL of C2 servers, etc.

Example 1

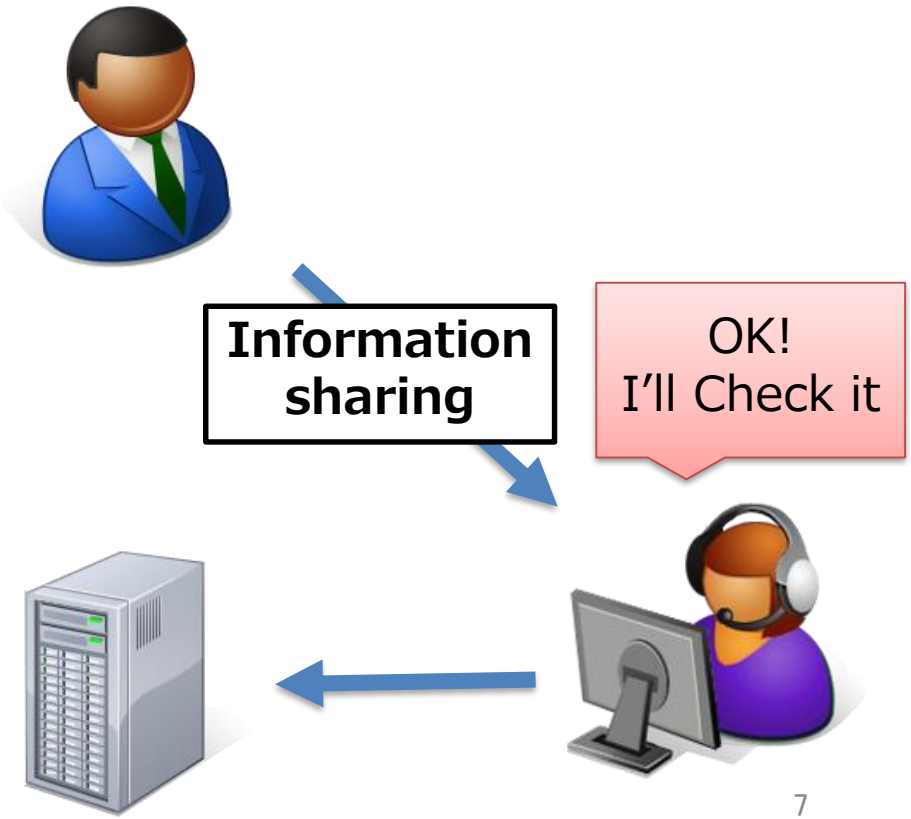
Malware's C&C server

- Duration
- IP address (Outbound)
- Characteristics in communication
- Action (Detect, Block in Proxy log)

Example 2

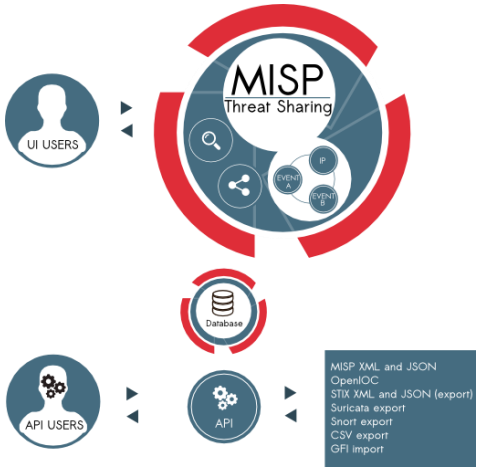
Source of DDoS attack

- Duration
- IP address (Inbound)
- Characteristics in communication
- Action(Detect, Block in Apache log)

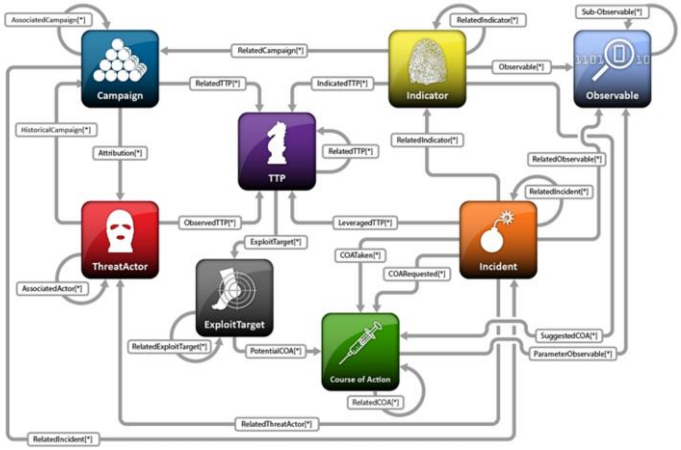


Trends of information sharing

- Information sharing schemes have been developed globally in recent years
  - DHS has been operating AIS (Automated Indicator Sharing) since 2016
  - CIRCL (The Computer Incident Response Center Luxembourg) shares malware information through MISP
- STIX(The Structured Threat Information eXpression) was introduced by MITRE



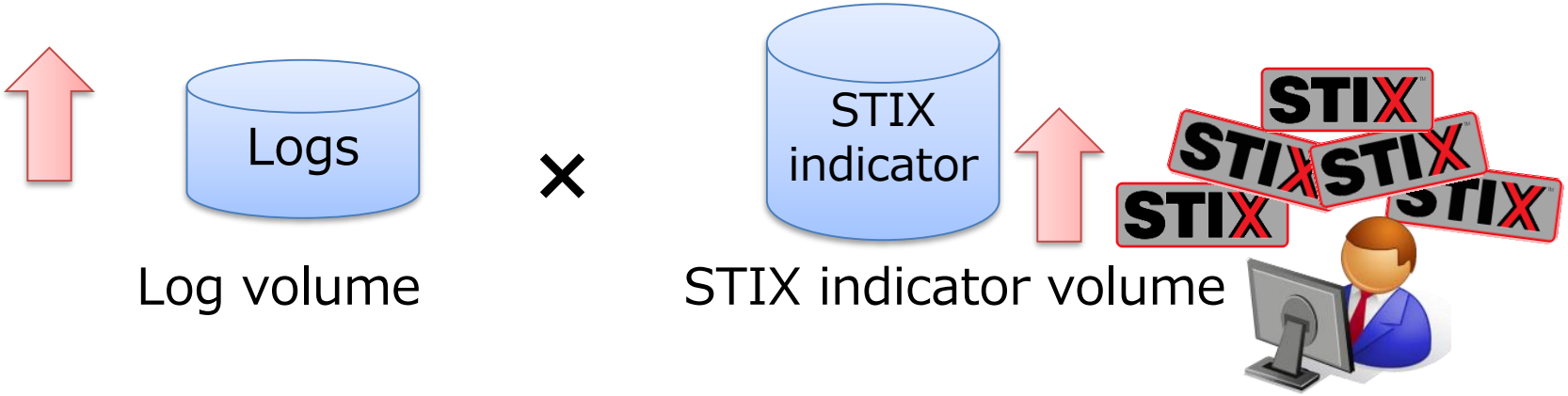
(from https://www.circl.lu)



(from http://stixproject.github.io/getting-started/whitepaper)

Challenges

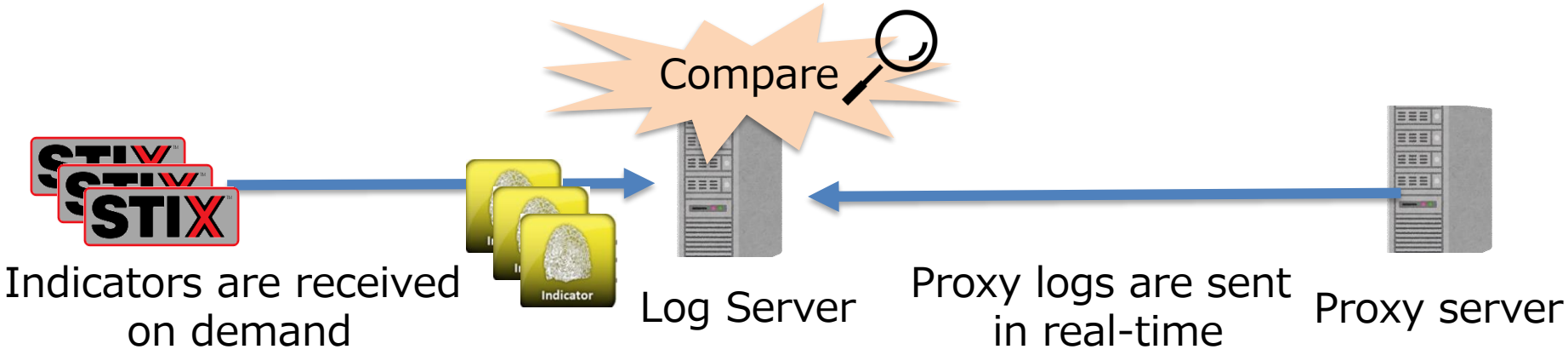
- STIX is becoming more popular, and shared information is increasing through the STIX format
- We need to compare a large amount of logs with a number of STIX indicators
- We need appropriate tools which can extract indicators from STIX and compare with the logs



CHALLENGES

Challenges of the detection trigger

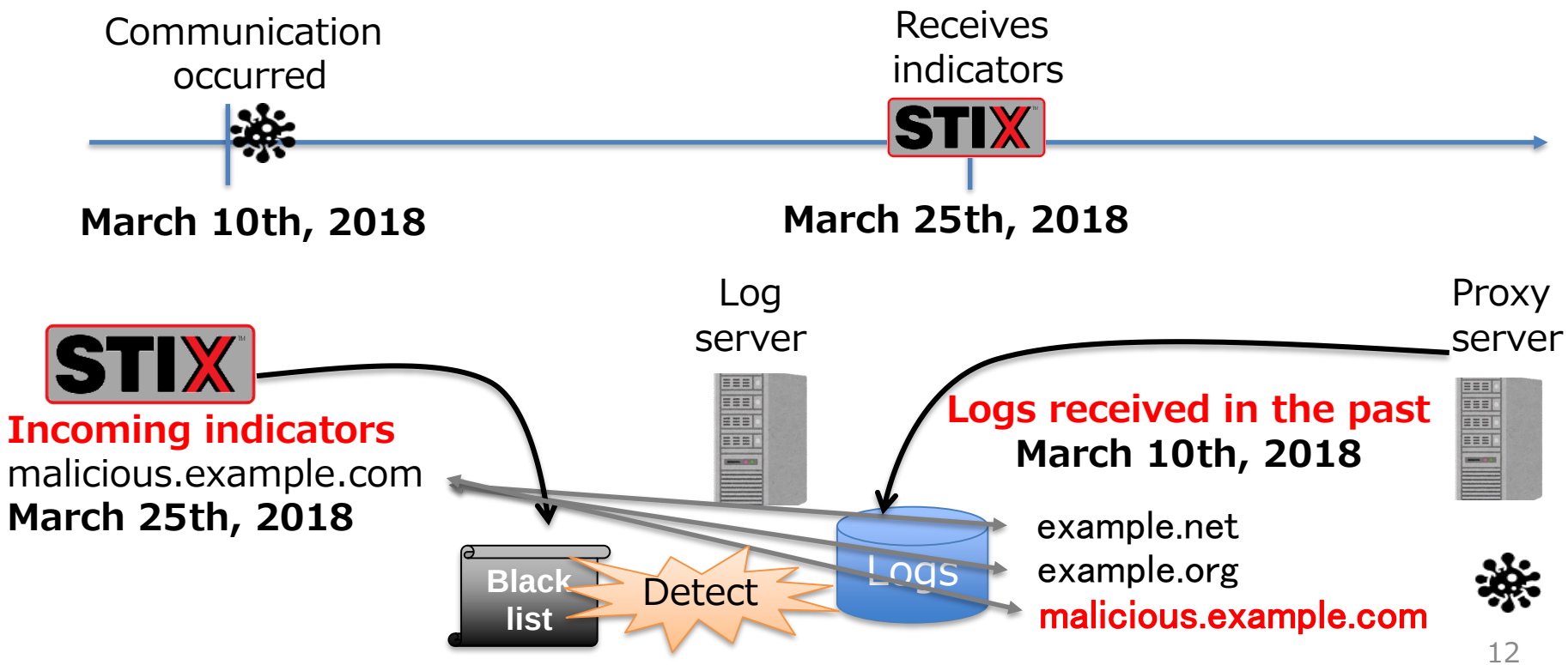
- There are challenges in automated detection
  - It is important to detect attacks immediately, also we have to detect potential infected computers
  - There is a time lag between the observation of an attack and the release of the indicator
- We need to compare indicators with logs **in a timely manner**



Challenges of the detection trigger

Detection trigger 1: when we receive indicators

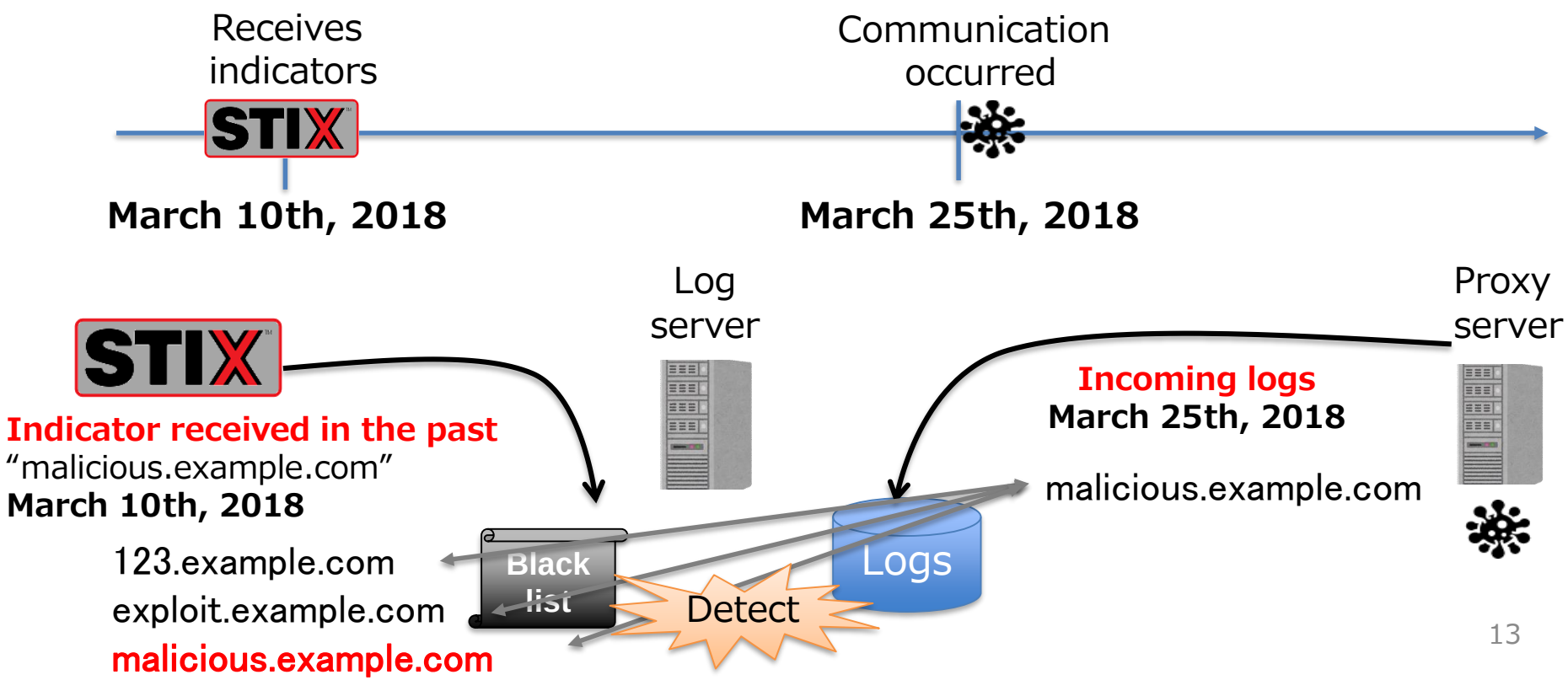
- When we receive STIX indicators, we have to compare them with past logs to find potential infected computers
- Many organizations may adopt this detection approach



Challenges of the detection trigger

Detection trigger 2: when communications to the Internet are performed

- When communications to the Internet are performed, we have to compare them with all indicators to detect attacks immediately



Considerations for blocking domains

The reason why we focus on **Detecting** malicious domains rather than **Blocking** them by Firewall or URL filtering:

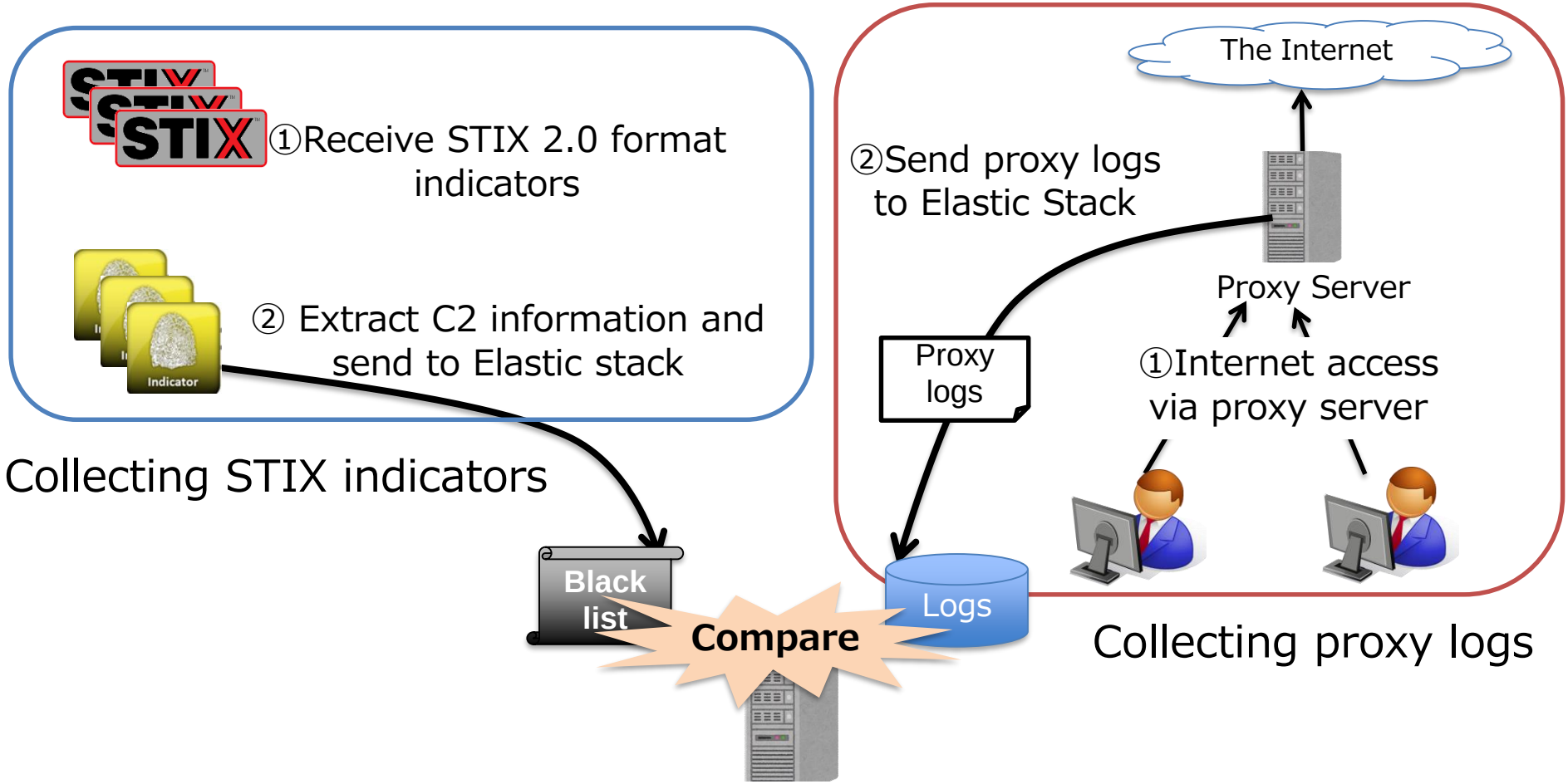
- We should consider the valid period of the C2 server
  - Some indicators have the information of the valid period
  - Sometimes legitimate websites are used as C2 servers (Keep blocking the domains are difficult when they are used in business operations)
- We should consider the reliability of indicators
- There are maximum number of URLs in filtering functions

Blocking specific domains for a long period is difficult.

SOLUTION

Summary of the proposed method

- We propose a method which compares logs with STIX 2.0 indicators automatically using Elastic Stack



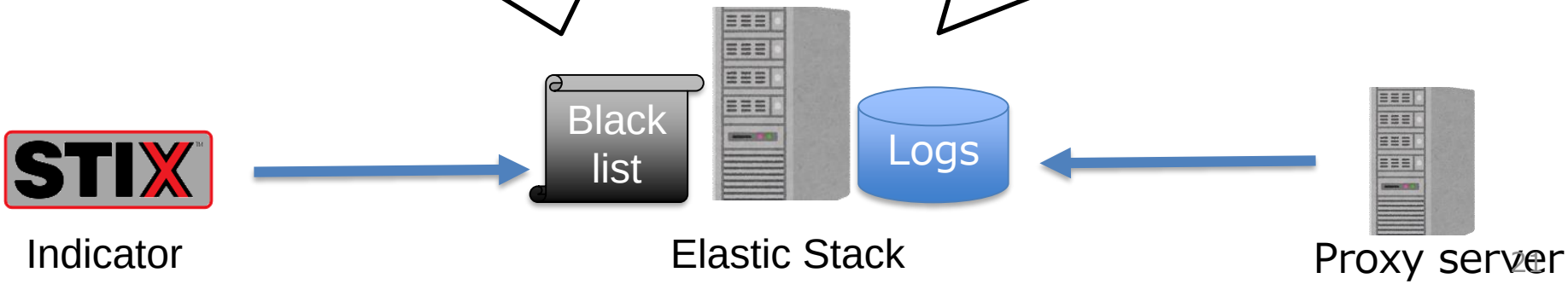
Elastic Stack(Elasticsearch, Logstash, Kibana, Filebeat)

Summary of the proposed method

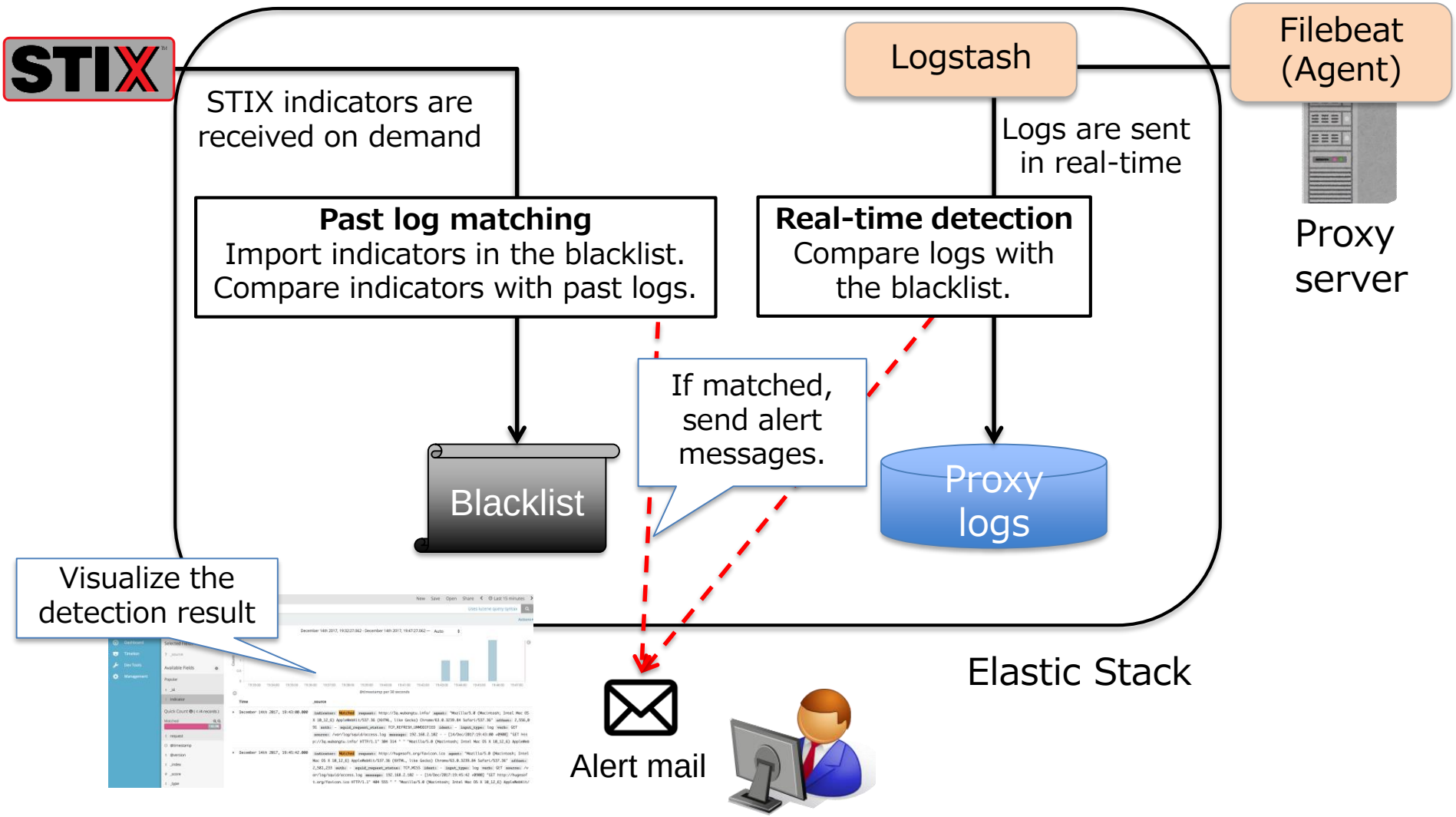
- Our method solves issues mentioned in previous slides
  (1)Effective log analysis and automated detection using Elastic Stack
  (2)Compare indicators with logs in a timely manner

Past log detection
When STIX indicators are imported into Elastic Stack, the tool compares indicators with past logs.

Real-time detection
When proxy logs are transferred into Elastic Stack, the tool compares proxy logs with indicators in the blacklist.



Structure of the proposed method



← Flow of detection

← - - Flow when a log matches the blacklist

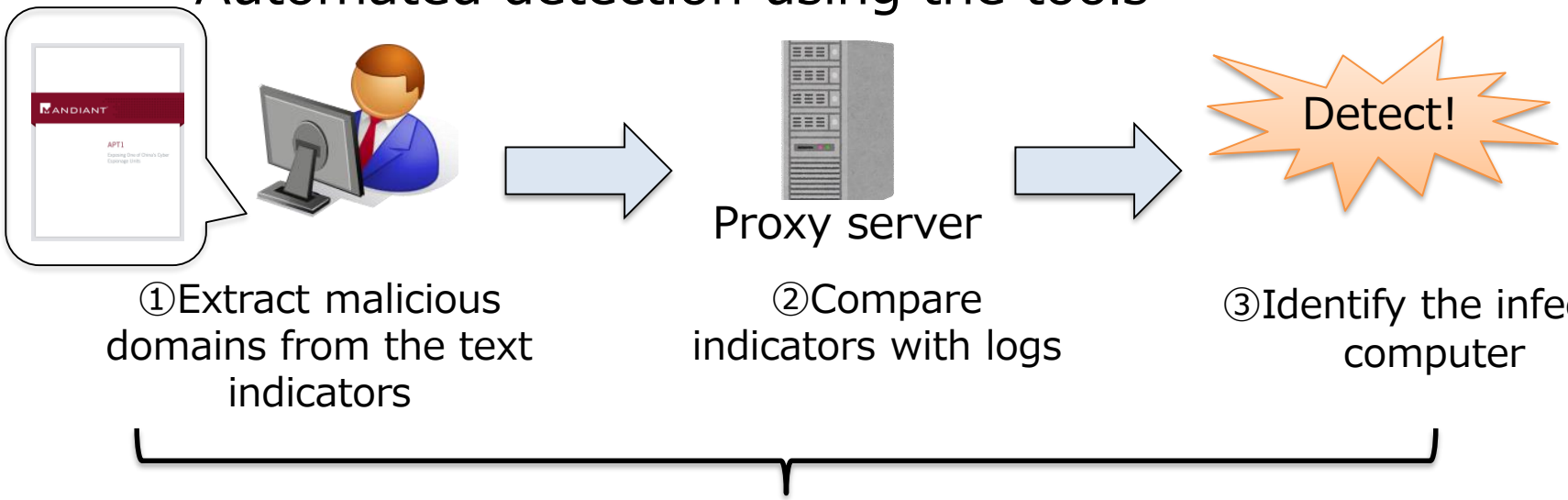
Time saving by using the system

Incident response flow

The system uses automated detection to reduce the incident response time.

Time saving by using the system

- Compare total amount of time needed to identify the compromised computer
  - Manual operation
    - Extract malicious domains from the text format indicators
    - Search malicious domains from proxy logs using “grep” command
  - Automated detection using the tools



The tool utilizes automated detection process.

Time saving by using the system

The incident response time has been successfully reduced by 84% using the system.

Manual operation

Operations	The time required
Extract indicators from APT1 report	About 3.5 minutes
Search indicators from proxy logs	About 6 minutes
Total	About 9.5 minutes

Automated detection using the tools

Operations	The time required
Launch the detection tool	About 1.5 minutes

DEMONSTRATION

Demonstration

東京大学 情報学環

SiSOC TOKYO

stix2.0_ELK 〉 apt1.json 〉

input_report

Project

stix2.0_ELK ~/PycharmProjects/stix2.0_ELK

- old
- apt1.json
- filebeat.yml.squid
- imddos.json
- input_report.py
- logstash.conf
- poisonivy.json
- poll_create_file.py
- search_blacklist.py
- send_alert.py
- taxiidata.json

External Libraries

search_blacklist.py | send_alert.py | logstash.conf | input_report.py | apt1.json

```
303        "valid_from": "2015-05-15T09:00:00.000Z",
304        "kill_chain_phases": [
305          {
306            "kill_chain_name": "mandiant-attack-lifecycle-model",
307            "phase_name": "establish-foothold"
308          }
309        ]
310      },
311      {
312        "type": "indicator",
313        "id": "indicator--3f3ff9f1-bb4e-4392-89e5-1991179042ba",
314        "created": "2015-05-15T09:00:00.000Z",
315        "modified": "2015-05-15T09:00:00.000Z",
316        "object_marking_refs": [
317          "marking-definition--3444e29e-2aa6-46f7-a01c-1c174820fa67"
318        ],
319        "name": "FQDN hugesoft.org",
320        "pattern": "[domain-name:value = 'hugesoft.org']",
321        "labels": [
322          "malicious-activity"
323        ],
324        "valid_from": "2015-05-15T09:00:00.000Z"
325      },
326      {
327        "type": "indicator",
328        "id": "indicator--8390fd29-24ed-45d4-84d7-c5e5feaf195d",
329        "created": "2015-05-15T09:00:00.000Z",
330        "modified": "2015-05-15T09:00:00.000Z",
331        "object_marking_refs": [
332          "marking-definition--3444e29e-2aa6-46f7-a01c-1c174820fa67"
333        ],
```

objects 〉 pattern

Run input_report

CONCLUSION

Conclusion

- Indicators can be useful to detect targeted attacks effectively
- Tools for automation and recognizing STIX are necessary for effective detection
- We introduce a Real-time Log Analysis tool for practical use of STIX
- We can reduce the incident response time by using the system
- As a result, damage from attacks can be minimized by immediate detection

Future works

- Comparison using valid period of the indicators
- Supporting more STIX indicator patterns
- Real-time importing of STIX indicators using TAXII (Trusted Automated eXchange of Indicator Information)

※TAXII is a technical specification to securely share and exchange threat information

REFERENCE

Evaluation of the system

- Summary of evaluation
  - Import the following STIX 2.0 indicators to Elastic Stack
    - Indicators of APT1:

      https://oasis-open.github.io/cti-documentation/examples/example_json/apt1.json
    - Indicators of poisonivy:

      https://oasis-open.github.io/cti-documentation/examples/example_json/poisonivy.json
  - Conduct normal business operations including Internet browsing via the proxy server
    - Access malicious URL on the blacklist several times
  - Transfer proxy logs to Elastic Stack
  - Evaluate whether the system can detect malicious communications correctly

Evaluation result

- Total amount of URL access: 15,790
- Total amount of C2 server access: 34

- False positive rate: 0%
- False negative rate: 0%

We published the source code of our tool.
https://github.com/sisoc-tokyo/STIX2_ES_detection

Thank you for your attention!
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