Machine Learning Based Intrusion Detection System for IoT Network

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1. INTRODUCTION: CYBERSECURITY

Confidentiality

Risk = Impact x Occurrence

Asset
- Information
- System
- Human

Integrity

Availability

Threats
- unauthorized usage
- malicious usage
- alteration
- hijacking
- abuse
...

Vulnerabilities
- insufficient physical protection
- insufficient logical protection
- lack of validation of input data
- lack of traceability of input data
- reckless behavior
...
2. INTRODUCTION: INTRUSION DETECTION

- Huge volume of traffic impacts processing time
  - Filtering
  - Correlation

- Malicious activities require a model
  - Known activities: misuse detection
  - Unknown activities: anomaly detection
Mostly used approach: signature-based

Features: packet headers, flow statistics, TCP connections, etc.

Relies on data mining and machine learning

Challenges
- Lack of datasets (existence, diversity, freshness, sources)
- Requirement to update the model frequently
Assumption: botnet machines abuse HTTP to contact their C&C

Dataset: generated by malware (malicious HTTP requests)

Goal: generate signatures to detect requests to C&C

<table>
<thead>
<tr>
<th>Signatures</th>
<th>Malware Dataset</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>87% 64% 21%</td>
</tr>
<tr>
<td>2012</td>
<td>NA 86% 57%</td>
</tr>
<tr>
<td>2013</td>
<td>NA NA 81%</td>
</tr>
</tbody>
</table>
4. INTERNET OF THINGS

- Smart home
- Smart grid
- Smart transportation
- Smart industry
- eHealth

Security issues:
- Short time to market
- Vulnerable default configuration
- Example of Mirai botnet
Anomaly detection: detection of any deviation from legitimate behavior. Define a profile of the legitimate traffic and perform outlier detection. Can detect new types of attacks. High false positive rate.

IoT devices have very specific purpose, hence, the variation of the observed network traffic behavior is limited.
- Limitation of existing datasets (DARPA99, KDD99, NSL-KDD)
- Experimental smart home network for legitimate network traffic generation
- Malicious traffic generation
Features selection:

- Avoid features that can introduce bias: IP identifier, addresses, ports number, …
- Features that can be easily extracted from a practical point of view

Examples of feature: Individual packet size, total number of packets, TCP flags, inter packet duration, …
8. FUTURE WORKS

- Intrusion detection system for smart home network
- Mimicking legitimate behaviour to evade intrusion detection system in IoT network
- Public IoT network traffic datasets generation for benchmarking purposes

Partners:
- Nara Institute of Science and Technology (NAIST)
- Yokohama National University