ASPAI 2026
Asia-Pacific Symposium on Process and Artificial Intelligence

QUT

Internet of Things Threat Detection Using Process Conformance and Machine Learning Classification

ASPAI26, Pohang, South Korea

Adam Burke[1,2], Mashal Ashraf[1], Marimbay Kadirov[1] and Andrzej Janusz[1,2]

(1) School of Information Systems, QUT

(2) Centre for Data Science, QUT

Sydney Today 10 °/ 20 °

news.com.au

Sign Up | Log In

National World Lifestyle Travel Entertainment Technology Finance Sport Shopping

Technology > Gadgets

Mum's nightmare as baby monitor gets hacked while son sleeps

A parent's nightmare became reality after a creep hacked into a baby monitor while a little boy was sleeping.

Brooke Rolfe

@rolfeb 2 min read November 2, 2023 - 3:31PM news.com.au

6 Comments

Advertisement

TEQSA Provider ID PRV12079 Australian University | CRICOS No.00213J

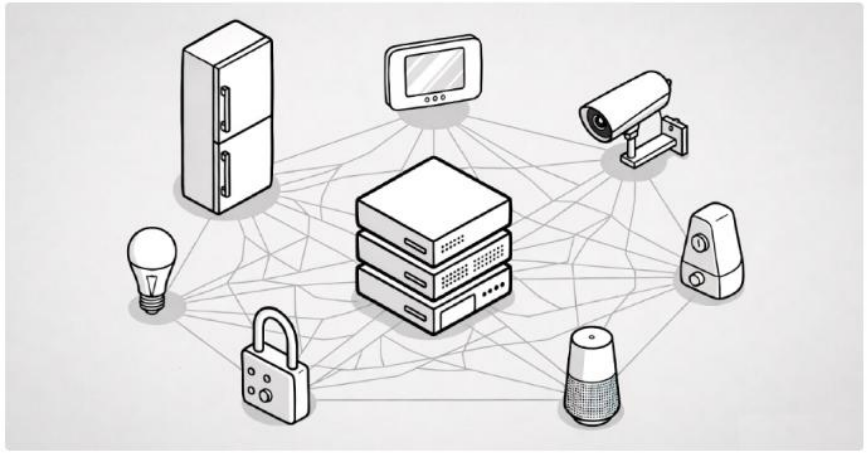
The Hacker News

Get the Latest News

Home Vulnerabilities Cyber Attacks Expert Insights Awards

Mirai-Based xlabs_v1 Botnet Exploits ADB to Hijack IoT Devices for DDoS Attacks

Ravie Lakshmanan May 06, 2026 IoT Security / Malware



Cybersecurity researchers have exposed a new Mirai-derived botnet that self-identifies as **xlabs_v1** and targets internet-exposed devices running Android Debug Bridge (ADB) to enlist them in a network capable of carrying out distributed denial-of-service (DDoS) attacks.

Hunt.io, which detailed the malware, said it made the discovery after identifying an exposed

Attack Detection

- Many vulnerable IoT devices
- High volume
- Attacks follow attack *patterns*
- Attacks inherently *sequential* in time

  Eg, Mirai malware

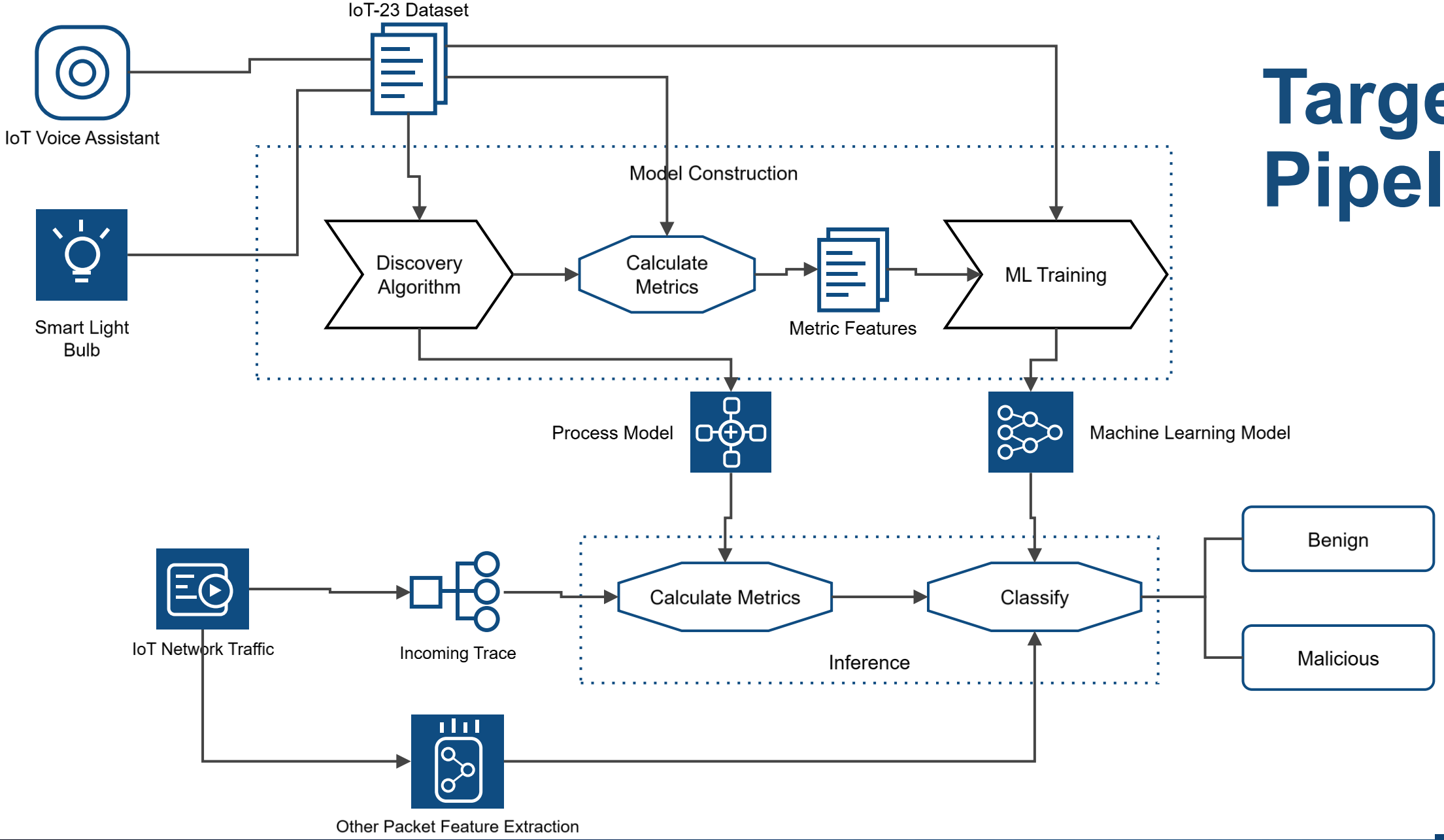
  1. Scans for vulnerable devices
  2. Infects vulnerable devices
  3. Stays dormant
  4. When launching attack, instructs device to perform Denial-of-Service on target

Problem and Solution Space

- High Volume
- Time Sensitive
- Sequential Modal Data
- Pattern Recognition

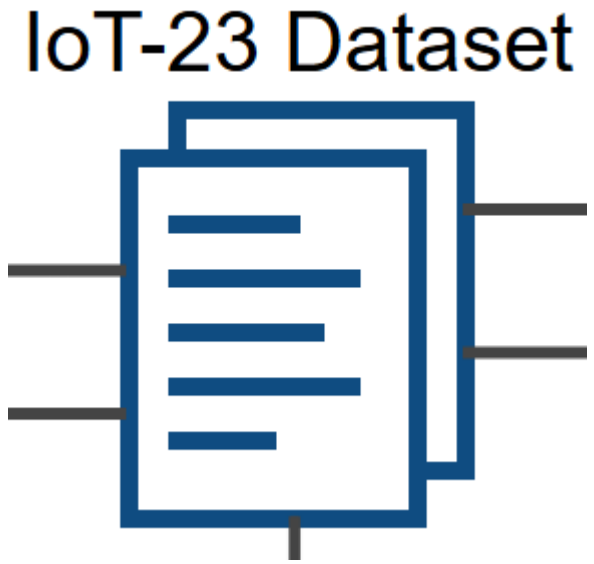
- Automation
- Meaningful Alerting
- Process Mining
- Machine Learning

Target Pipeline



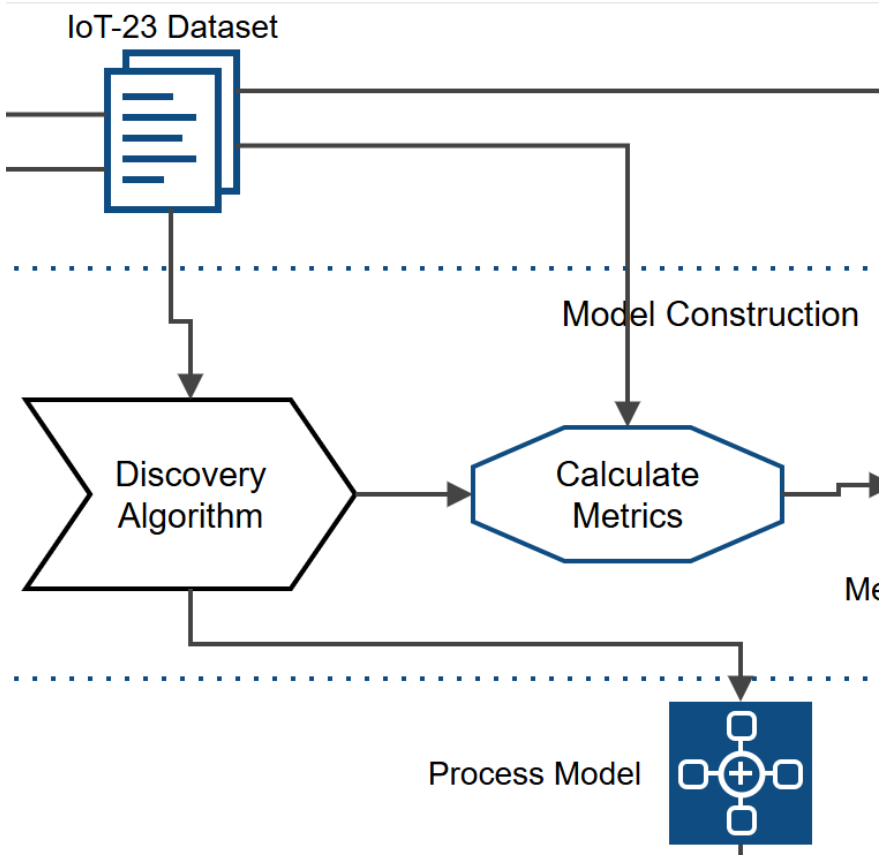
Training and Evaluation Data

- IoT-23 dataset
- Recorded network traffic from 23 IoT devices in laboratory setting
- Several infected with malware
- TCP, UDP and control protocols
- Traffic labelled at connection level as benign or malicious

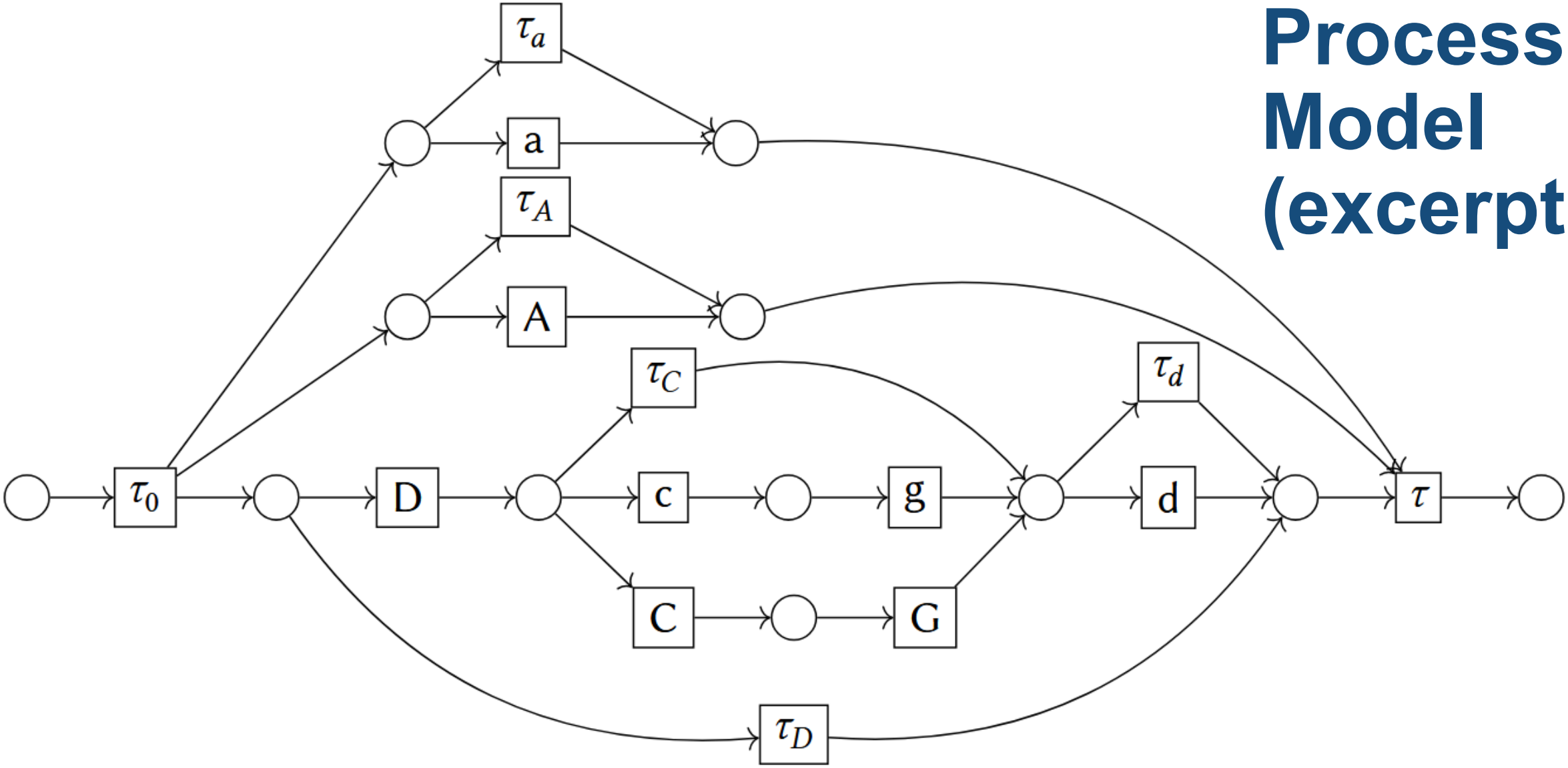


Process Mining Component

- Case notion: network connection
- Activity notion: packet type + direction
  - Client-to-server or server-to-client
- Model discovery (Inductive Miner + Alignment Estimator)
- Conformance Metrics relative to single trace
  - Chi-Squared
  - Earth Movers Stochastic Conformance
  - Entropic Relevance
  - Trace Probability

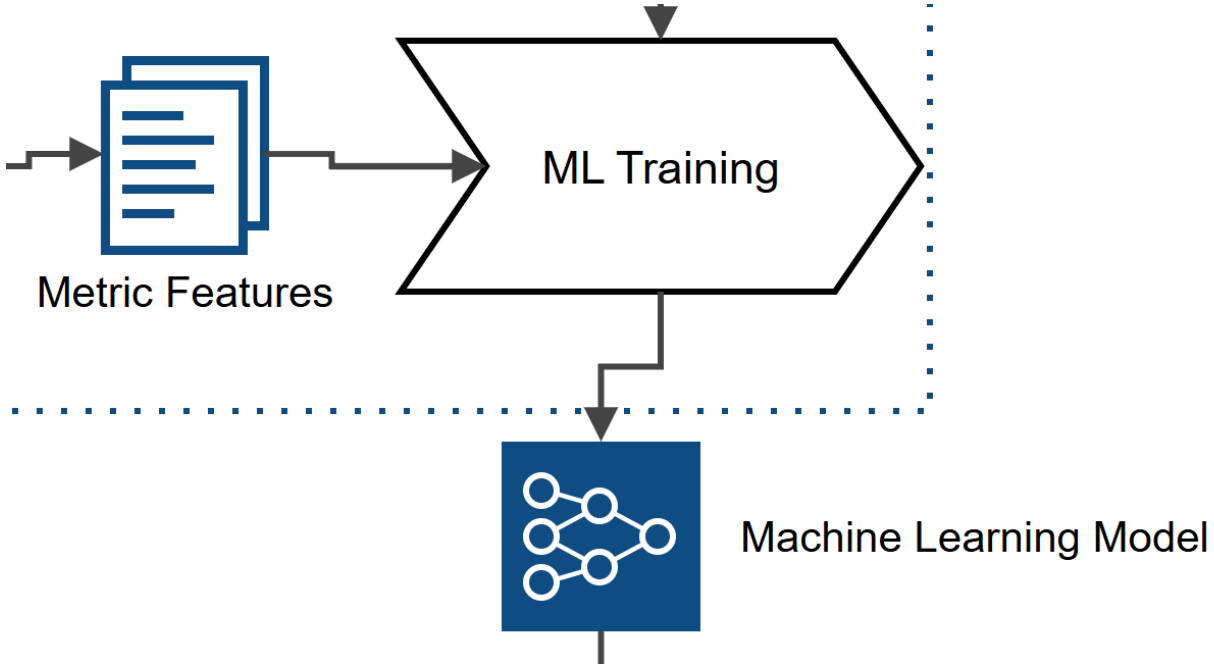


Process Model (excerpt)

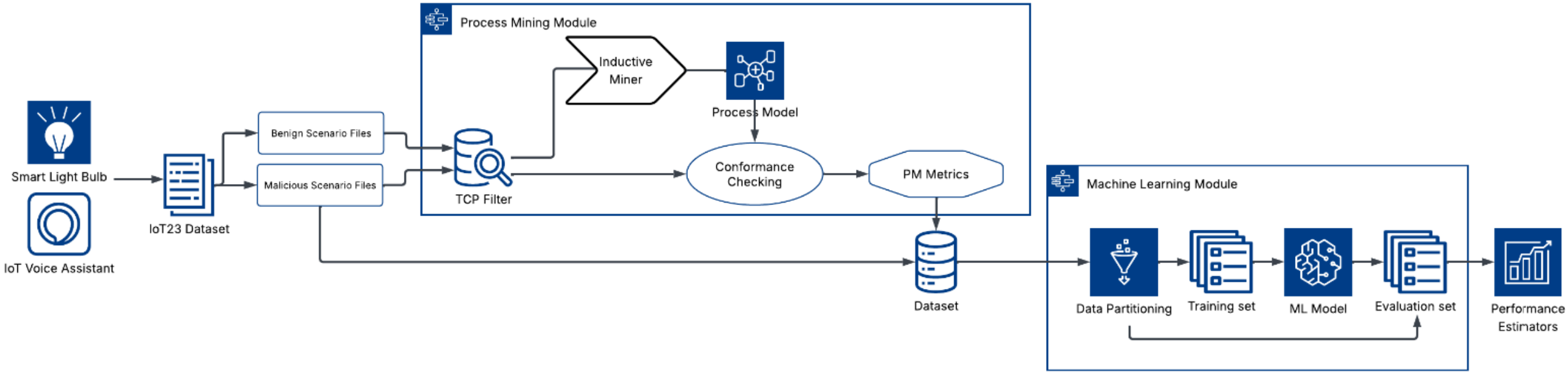


Machine Learning Training

- Machine Learning inputs
  - Data features
    - Source port, destination port, source bytes, duration, …
  - Conformance metric features
    - Chi-Squared
    - Earth Movers Stochastic Conformance
    - Entropic Relevance
    - Trace Probability



Experiment Design



- Training (i.e., process discovery) on benign files only
- ML model: Random Forest

- Leave One File Out (LOFO) evaluation
- Use subset of 15/23 files (scaling and benign partition) – **IoT-15-Light**

Results

Feature	Feature Importance
Earth Movers	0.3651 ± 0.0522
Chi Square	0.3567 ± 0.0472
Entropic Relevance	0.2050 ± 0.0136
Trace Probability	0.0003 ± 0.0004

	Accuracy	Precision	Recall	F1
LOFO Benchmark IoT-15-Light	0.7748 ± 0.3004	0.6459 ± 0.4222	0.8481 ± 0.2896	0.6401 ± 0.3876
LOFO w PM Features IoT-15-Light	**0.9559 ± 0.1232**	**0.8973 ± 0.2712**	**0.9993 ± 0.0021**	**0.9067 ± 0.2720**

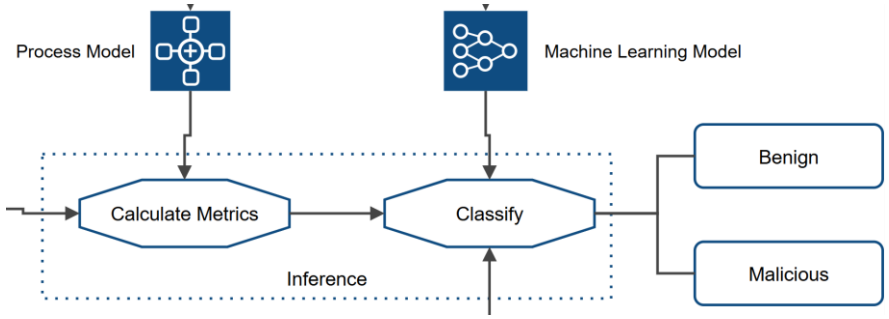
Summary

Conclusion

- Cyberattacks on IoT devices inherently sequential
- Process mining can be used to communicate this sequential information to ML models
- Improved benchmark performance
  - For subset of attack types

Extension

- Full IoT-23 dataset, other datasets
- Expanded benchmarks
- Model discovery variation
- ML model variation
- Hardware footprint



ASPAI 2026
Asia-Pacific Symposium on Process and Artificial Intelligence

QUT

Questions welcome

Acknowledgement:
We would like to thank the **QUT Centre for Data Science** for supporting this research through a travel grant.

Related literature (selected)

1. Garcia, A. Parmisano, M. J. Erquiaga, Iot-23: A labeled dataset with malicious and benign IoT net-work traffic, 2020. doi:10.5281/zenodo.4743746
2. A. Burke, S. J. J. Leemans, M. T. Wynn, Stochastic Process Discovery by Weight Estimation, in: Process Mining Workshops, ICPM 2020
3. S. J. J. Leemans, W. M. P. van der Aalst, T. Brockhoff, A. Polyvyanyy, Stochastic process mining: Earth movers' stochastic conformance, Information Systems 102 (2021) 101724.
4. Li, S. J. J. Leemans, A. Polyvyanyy, Applying statistical distances for stochastic conformance checking (2026). Under review.
5. Alkhammash, A. Polyvyanyy, A. Moffat, L. García-Bañuelos, Entropic relevance: A mechanism for measuring stochastic process models discovered from event data, Information Systems 107(2022)