SoK: Security of Programmable Logic Controllers

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University of California, Santa Cruz[§]

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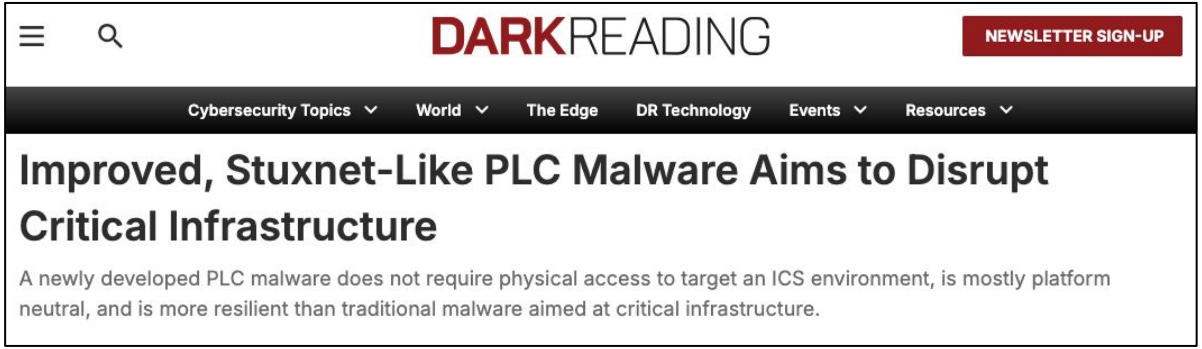
145B
SWEET DEAL
METRO
NO TRESPASSING



Improved, Stuxnet-Like PLC Malware Aims to Disrupt Critical Infrastructure

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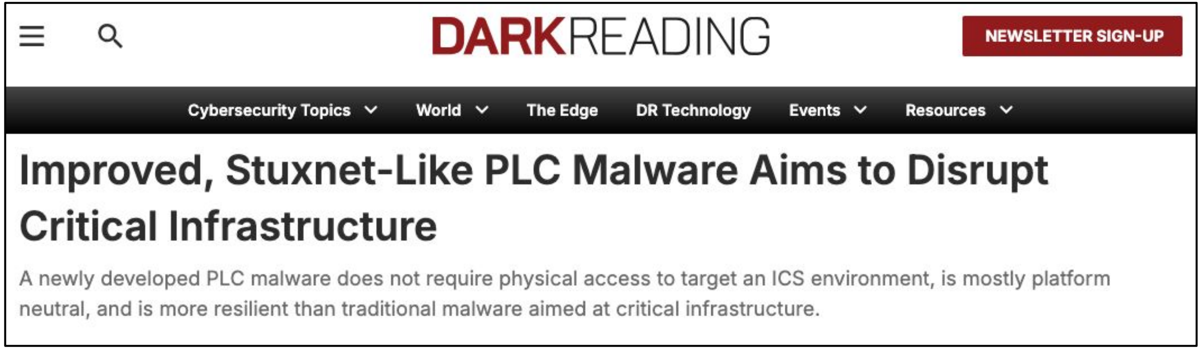

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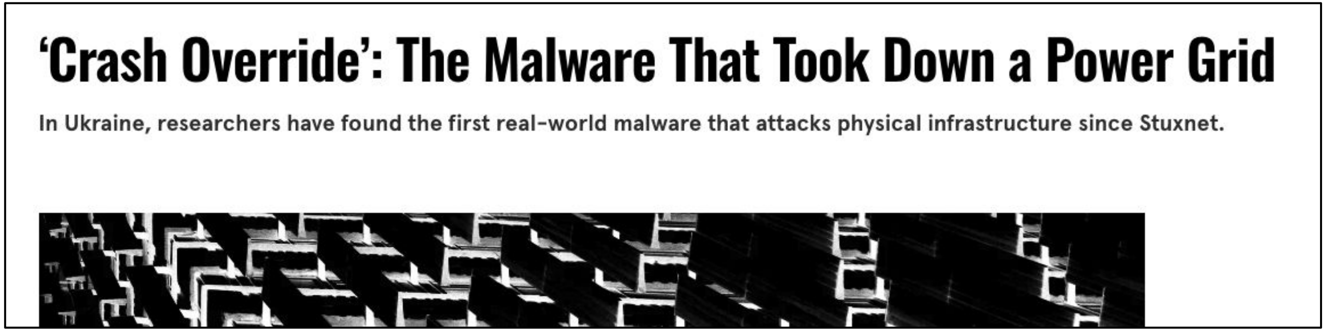

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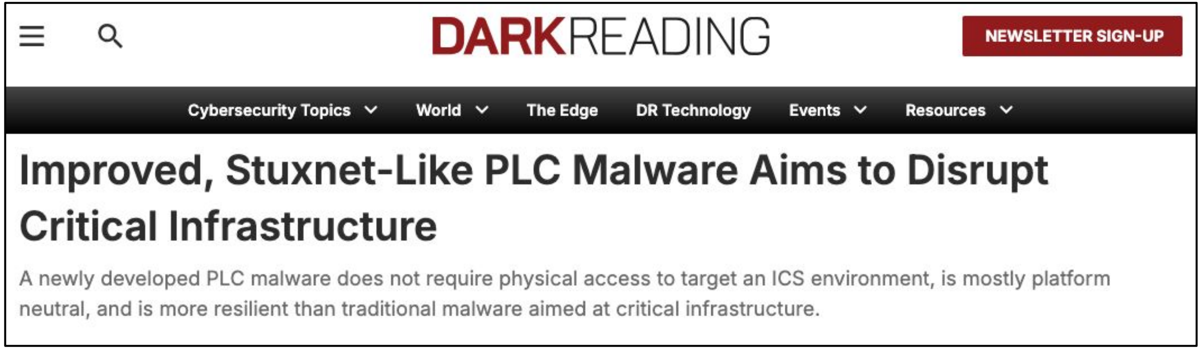
In Ukraine, researchers have found the first real-world malware that attacks physical infrastructure since Stuxnet.



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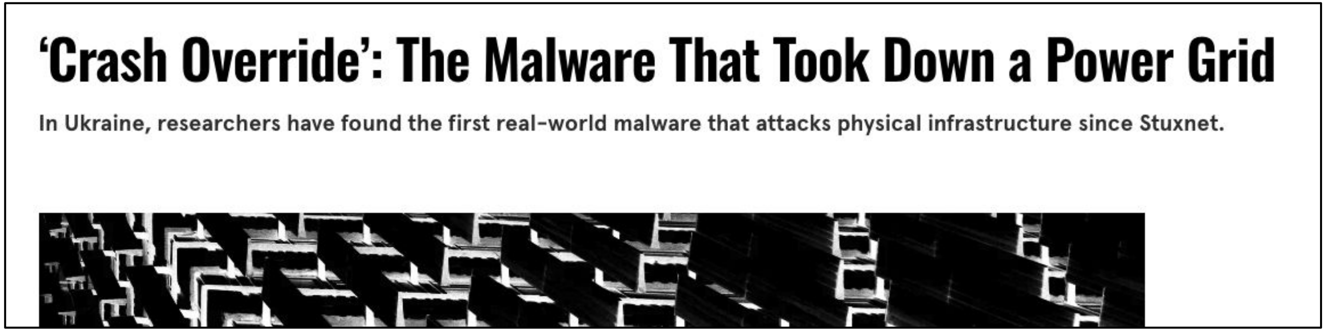

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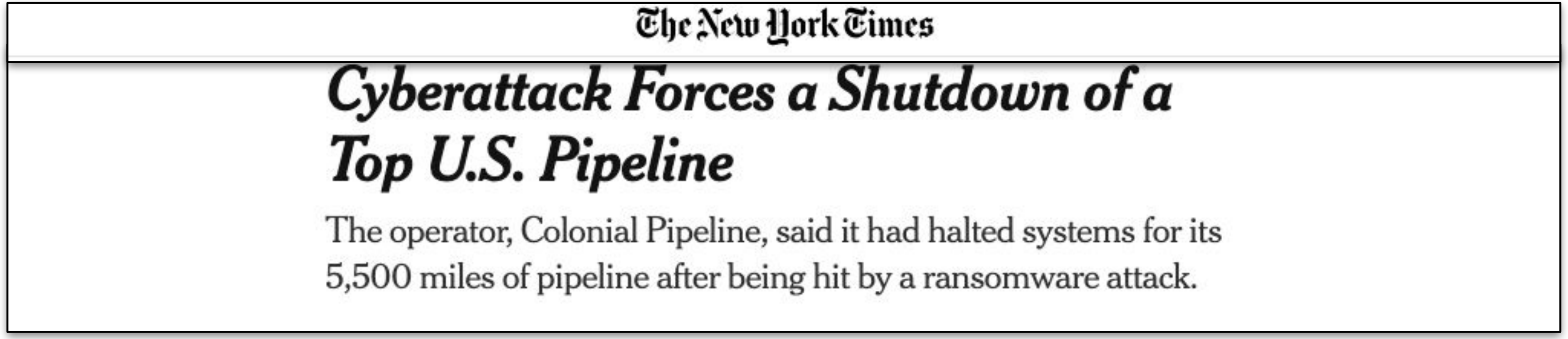

Cyberattack Forces a Shutdown of a Top U.S. Pipeline

The operator, Colonial Pipeline, said it had halted systems for its 5,500 miles of pipeline after being hit by a ransomware attack.

Background

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- Control physical industrial equipment, e.g., pumps.
- Proprietary software and hardware architectures.
- Increasingly interconnected, e.g., cloud.
- Yet, little to no built-in security features.

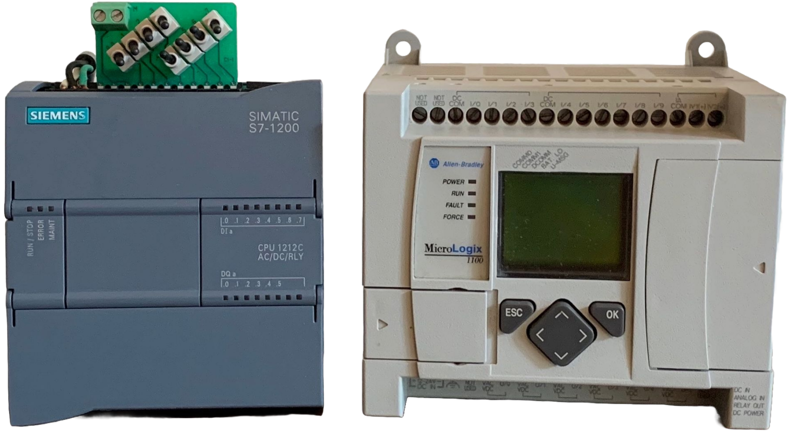
HardPLCs VS SoftPLCs

HardPLCs

SoftPLCs

HardPLCs VS SoftPLCs

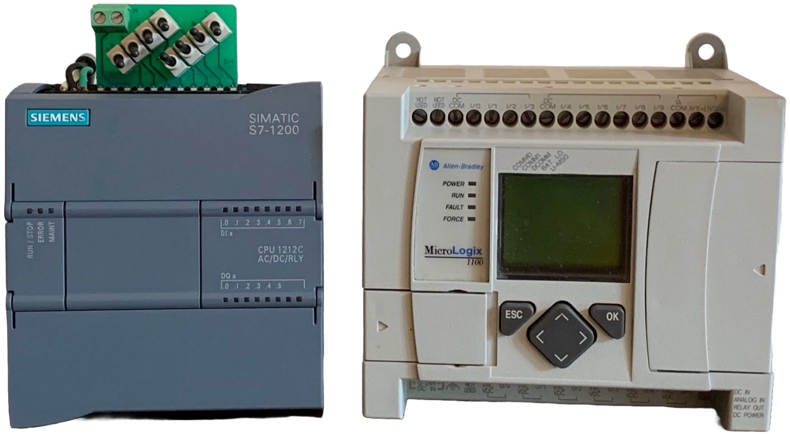
HardPLCs



SoftPLCs

HardPLCs VS SoftPLCs

HardPLCs



SoftPLCs

OPENPLC

TO A MORE
OPEN FUTURE

CODESYS

Problem Statement

Plenty of PLC security research has been produced.

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<u>However, we do not know where the security of PLCs stands and what research directions should (or should not) be taken in the future</u>.

Research Questions

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1. What are the available **attack** methods against PLCs?

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3. Are the current defenses **enough** to address the existing attack methods?

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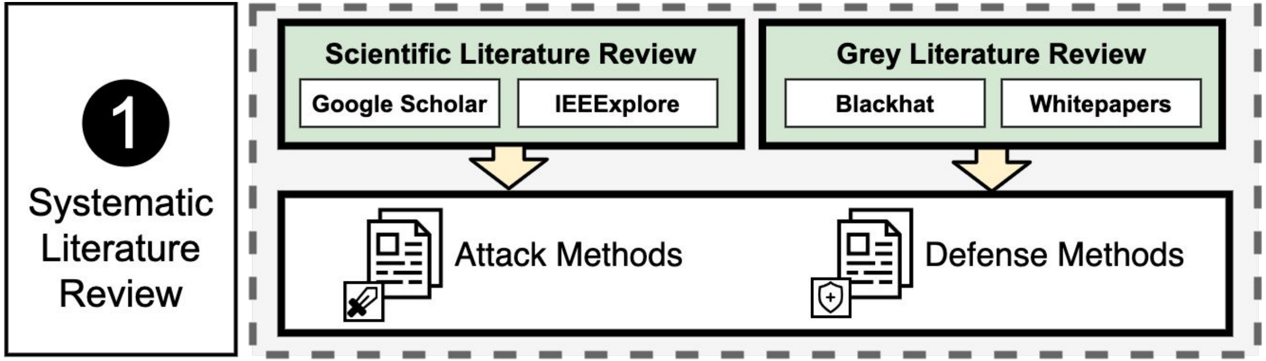
Methodology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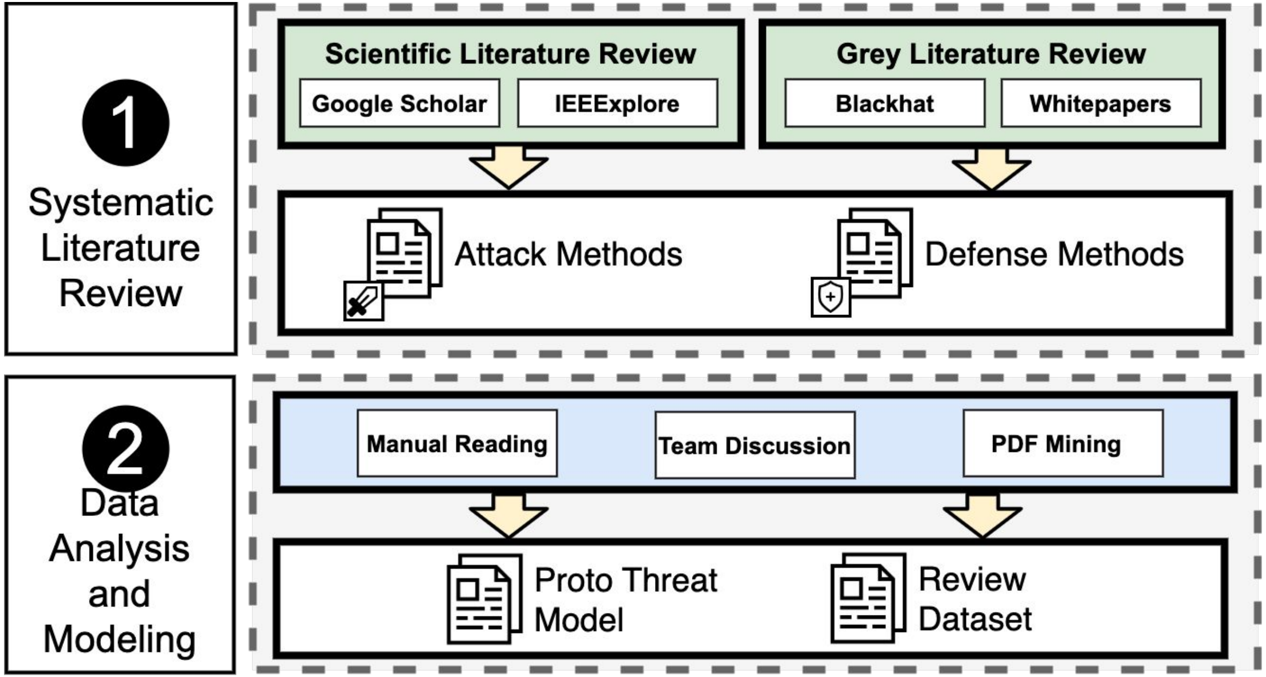
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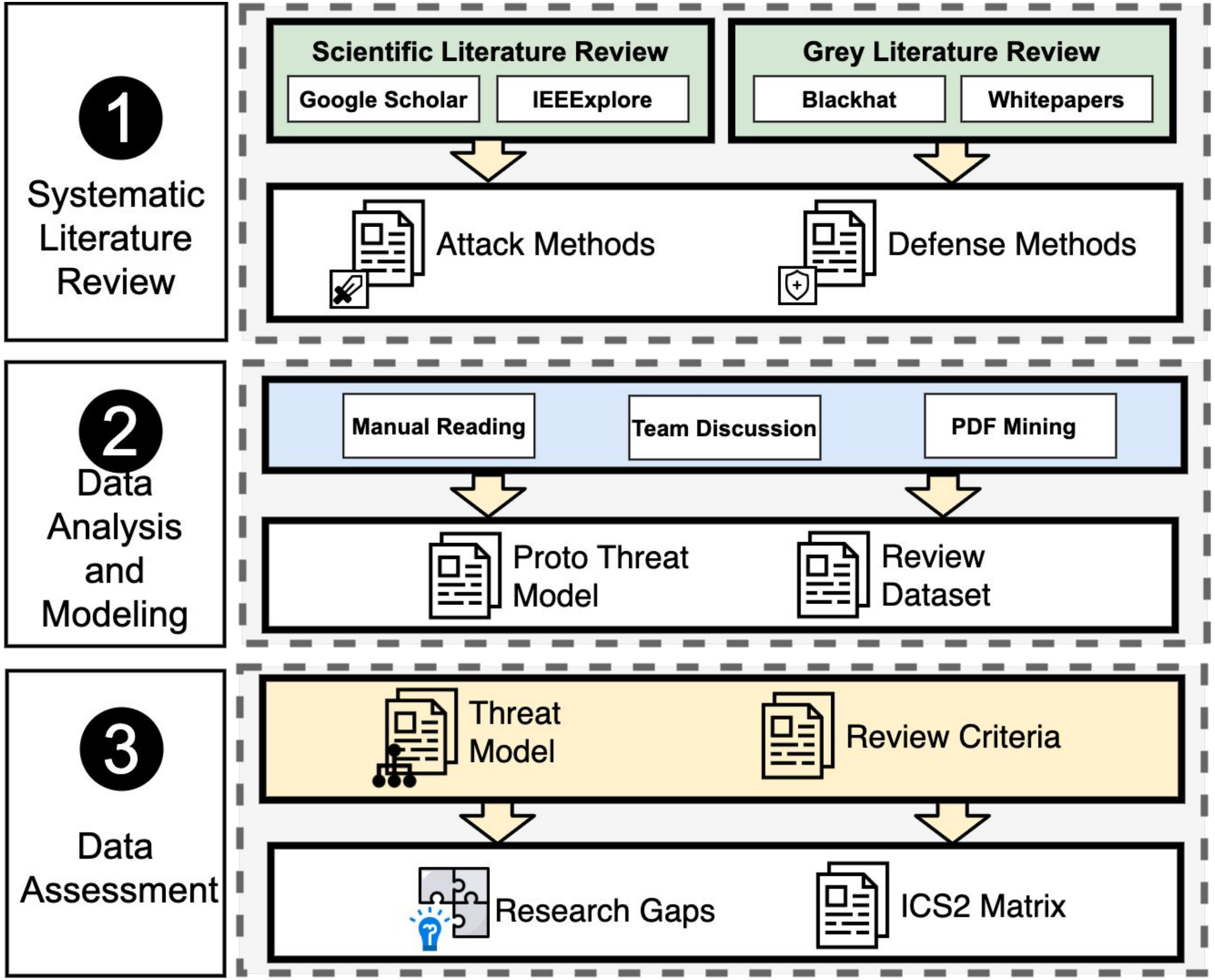

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Defense Methods

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PDF Mining

Proto Threat Model

Review Dataset

3 Data Assessment

Threat Model

Review Criteria

Research Gaps

ICS2 Matrix

Final SoK Scope

- 133 papers

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- From 2007 to 2023

Results

Summary of Results

1. Most of the Attacks Require Zero Environment Knowledge.
2. The Security of Important PLC Brands Has Not Been Explored.
3. Lack of Defenses at the Recovery Stage.
4. Attacks and Defenses are Evaluated on a Small Subset of PLCs
5. Important Tactics have Little to No Research.
6. Most Mitigation Strategies have Little to No Research.
7. Weaknesses of State-of-the-Art Defenses.
8. Reproducible Research Crisis.
9. Transition from HardPLCs to SoftPLCs.
10. We introduce a new threat taxonomy for ICS and PLCs.

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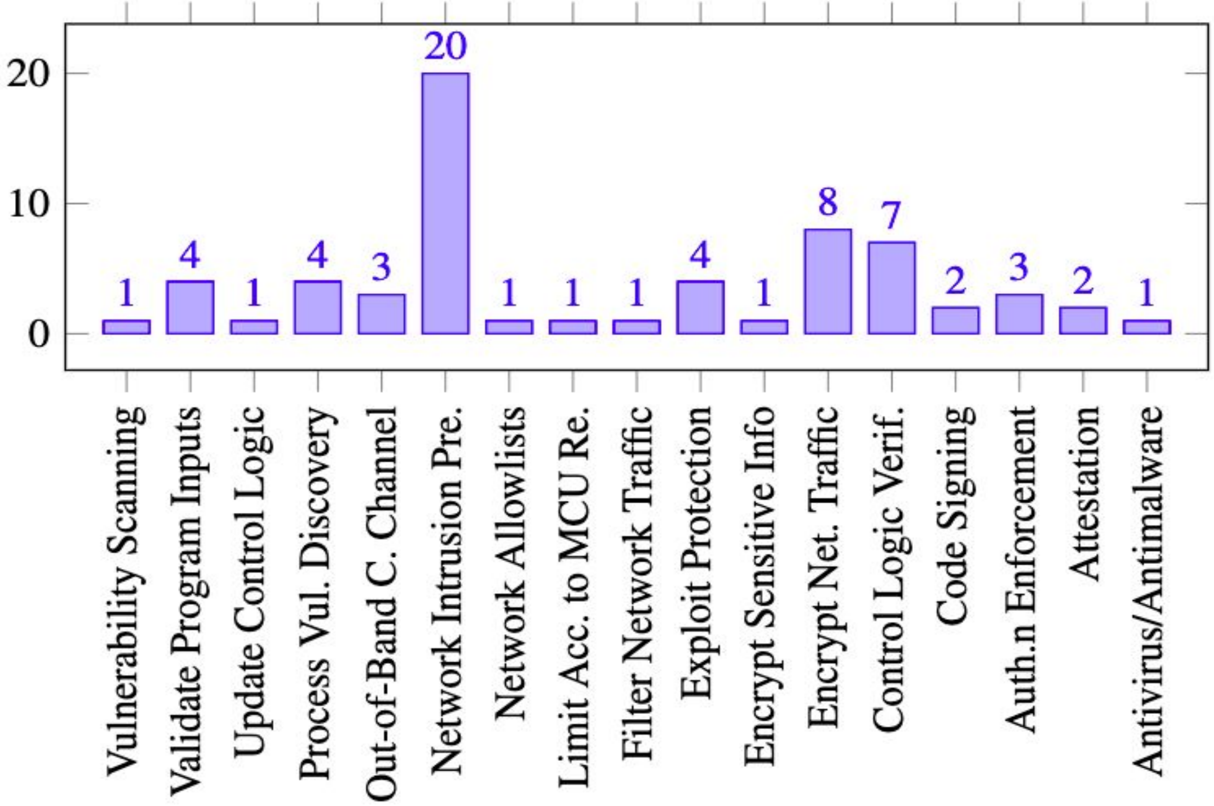
Multiple PLC Defenses Have Almost No Research



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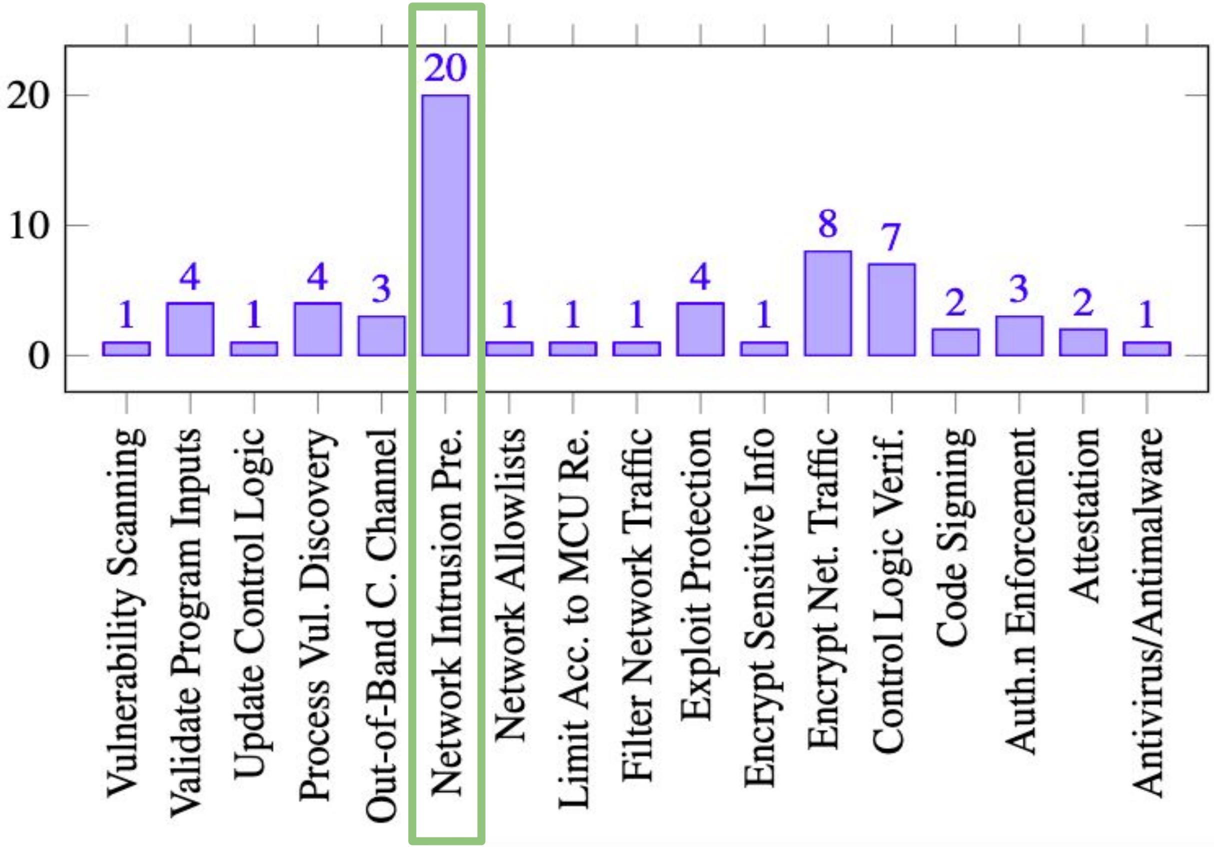

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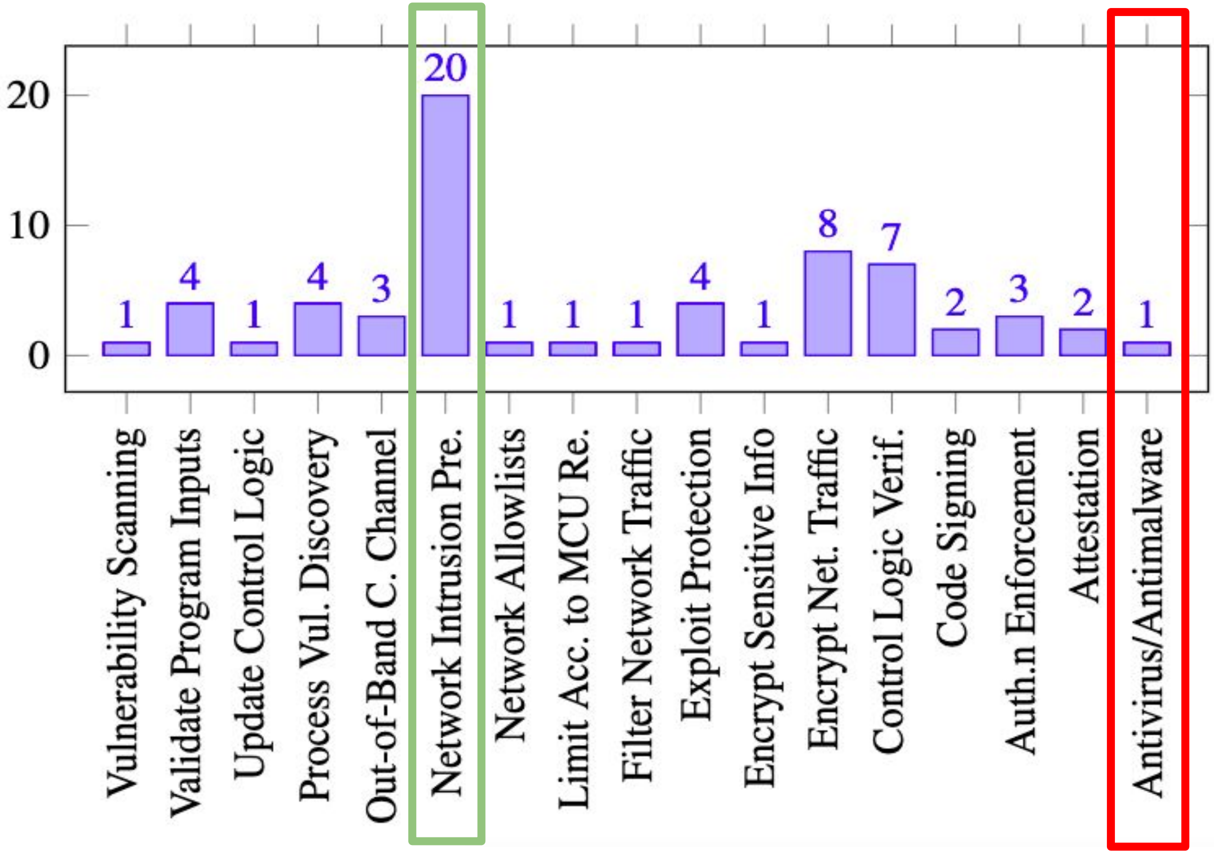

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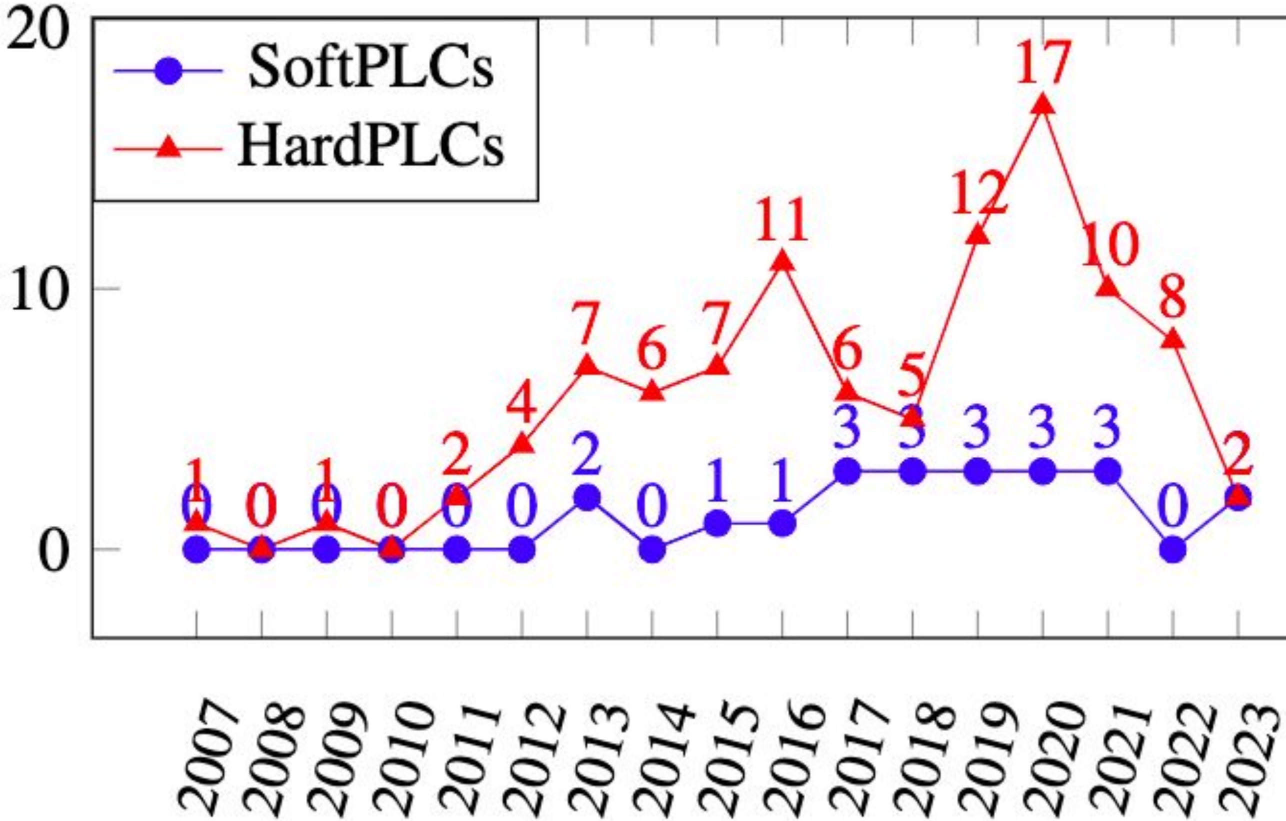

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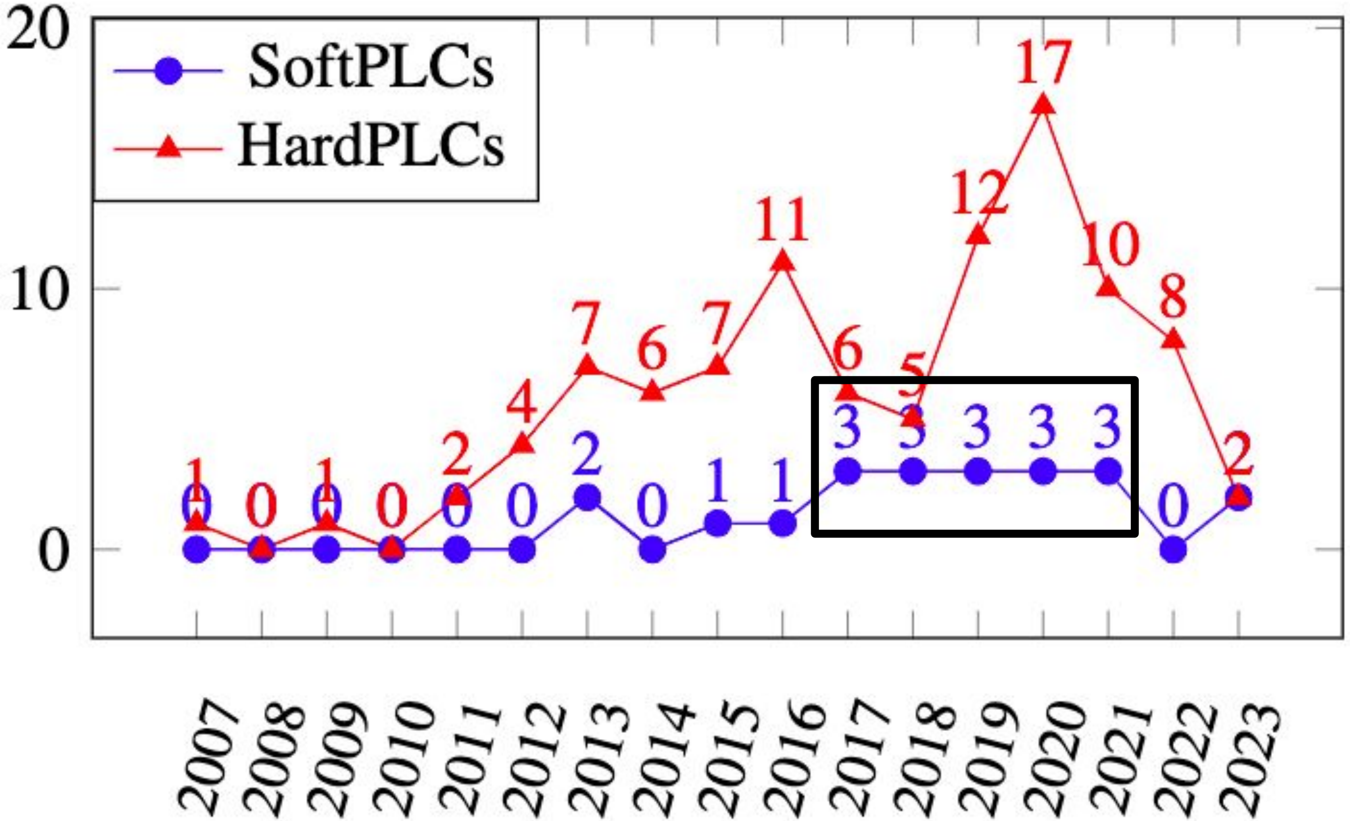

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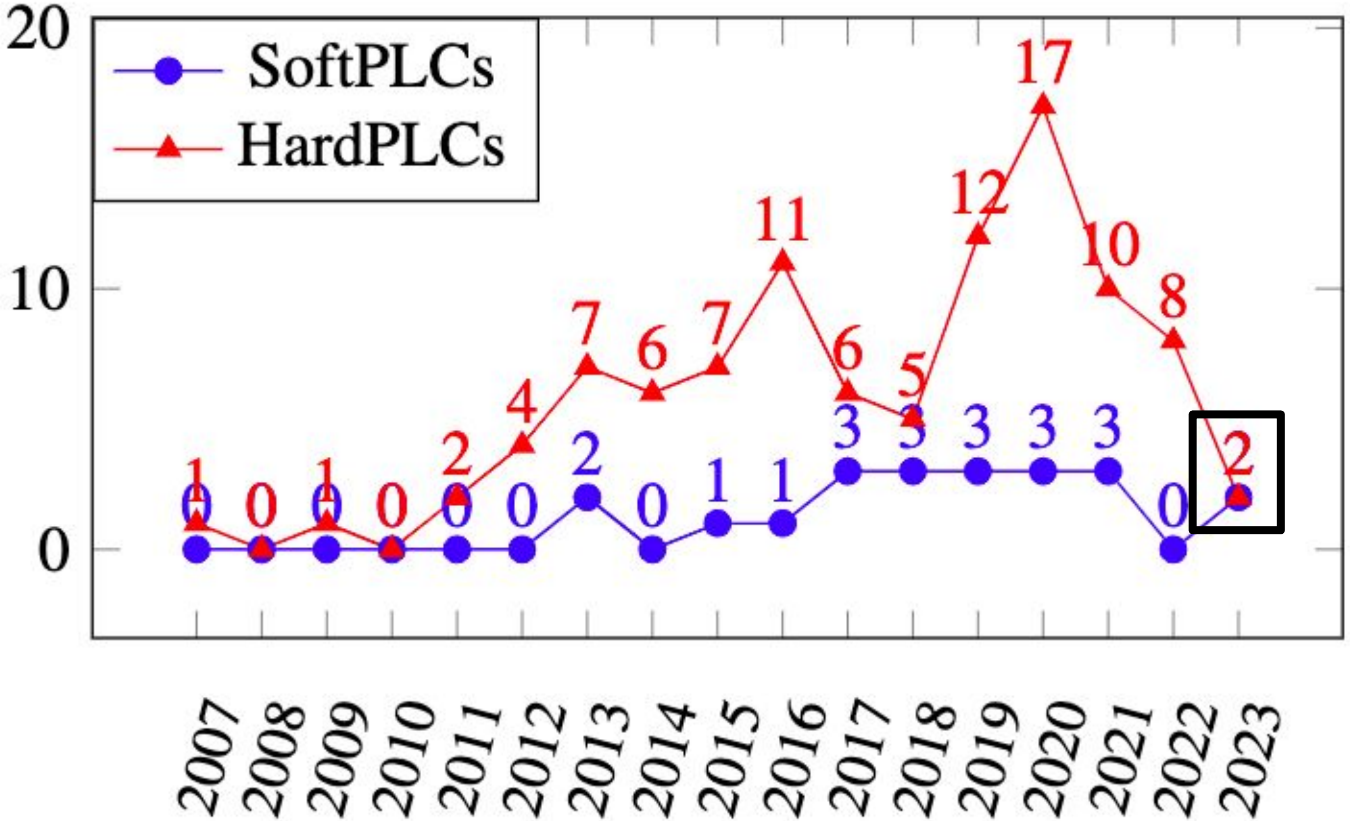

Recommendations For Hard to SoftPLC Transition

- Developing transitional defense methods that **secure both** HardPLCs and SoftPLCs.

Recommendations For Hard to SoftPLC Transition

- Investigating defense mechanisms available for SoftPLCs **previously unavailable** for HardPLCs (*no proprietary restrictions*).

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- Investigating both attack and defense methods that are **possible only** with SoftPLCs (*use new features such as cloud integration*).

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- Only **3 authors (3%)** shared their artifacts.

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Thank you for your attention!

ARTIFACT EVALUATED

usenix ASSOCIATION

AVAILABLE

Contact me!

efrenlopez.org

I am on the job market