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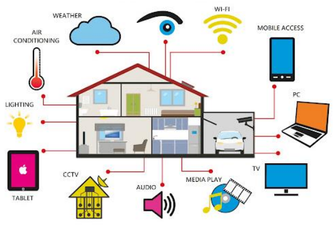
Engineering Sustainably Secure Cyber-Physical Systems

Liliana Pasquale, Kushal Ramkumar, Wanling Cai, Gavin Doherty, John McCarthy, Bashar Nuseibeh

1 ENGINEERING SECURITY BY DESIGN IS DIFFICULT IN MODERN CYBER-PHYSICAL SYSTEMS (CPS)

Smart Home



Smart Factory

Cyber-Physical Systems (CPS) allow security threats to extend over a wider attack surface and cause physical damage [1].

CPS operate in an open world.

Adding/removing system components and device behaviour changes

Evolving Security Goals & Requirements

Unknown Attacks

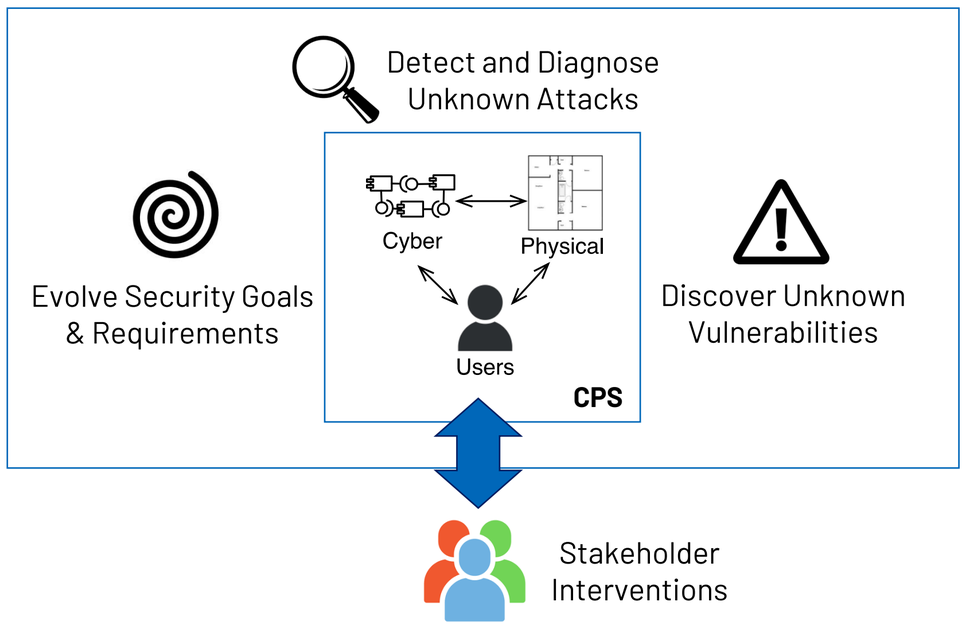
Zero-day or previously known attacks that can manifest differently depending on the CPS configuration.

Unknown Vulnerabilities

Unpatched or zero-day vulnerabilities.

2 SUSTAINABLE SECURITY:

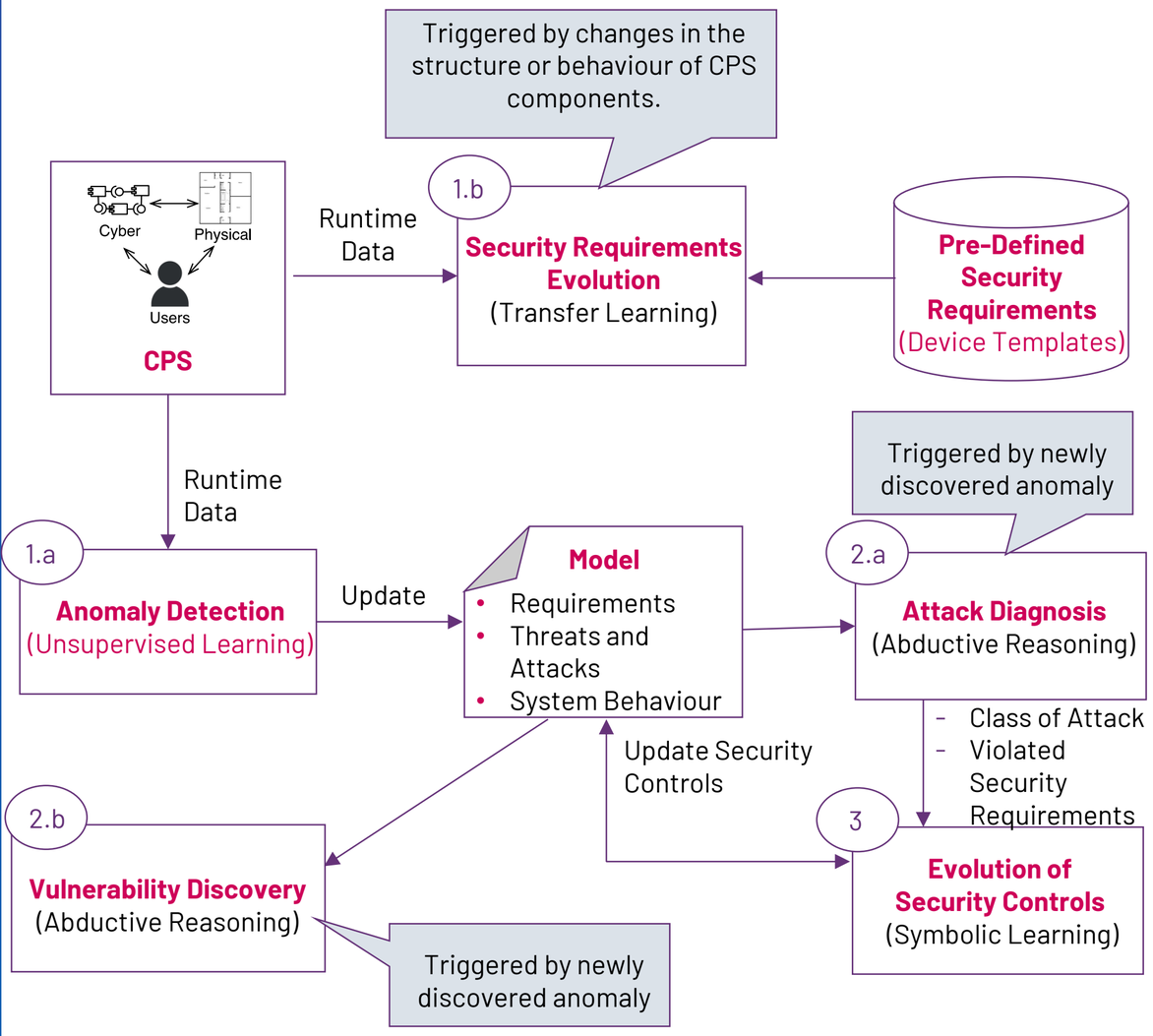
This project aims to engineer sustainably secure CPS [2] that can preserve security goals and requirements.



Objectives:

1) **Engineering Security Evolution:** CPS should evolve their security controls to address attacks, vulnerabilities and security goals & requirements changes.
2) **Engineering Stakeholders Interventions:** stakeholders should be involved in securing the CPS when this cannot be done automatically.

3 ENGINEERING SECURITY EVOLUTION:



4 ENGINEERING STAKEHOLDERS INTERVENTIONS:

Designing interactions with stakeholders to foster their engagement and improve the CPS security posture.

Stakeholders and Tasks

- **Users**: Monitor data, confirm anomalies, execute security controls
- **Engineers:** Diagnose attacks, select or execute security controls
- **Pentesters:** Diagnose attacks and discover unknown vulnerabilities

When?

Reasoning techniques based on projected satisfaction of security goals.

Who?

Reasoning techniques based on models of humans in a cyber-human system (e.g., [3]).

Situational Awareness

Personalised synthetic explanations of the state of the CPS (using LLMs).

Interaction Design

- User-centred design
- Human-machine collaboration
- Automation and human agency

References

[1] Tsigkanos, C., Pasquale, L., Ghezzi, C. and Nuseibeh, B., 2016. "On the interplay between cyber and physical spaces for adaptive security". *IEEE Transactions on Dependable and Secure Computing*, *15*(3), pp.466-480.

[2] Pasquale, Liliana, Kushal Ramkumar, Wanling Cai, John McCarthy, Gavin Doherty, and Bashar Nuseibeh. "Sustainable Adaptive Security." *arXiv preprint arXiv:2306.04481*(2023).

[3] Eskins, D. and Sanders, W.H.. "The multiple-asymmetric-utility system model: A framework for modeling cyber-human systems. In *2011 8th International Conference on Quantitative Evaluation of SysTems*, pp. 233-242, 2011.

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