Globally Accessible Test Environment (GATE) Attacks and Defense Agents

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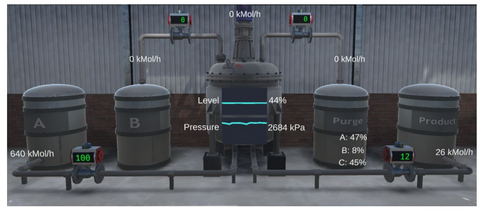
Introduction

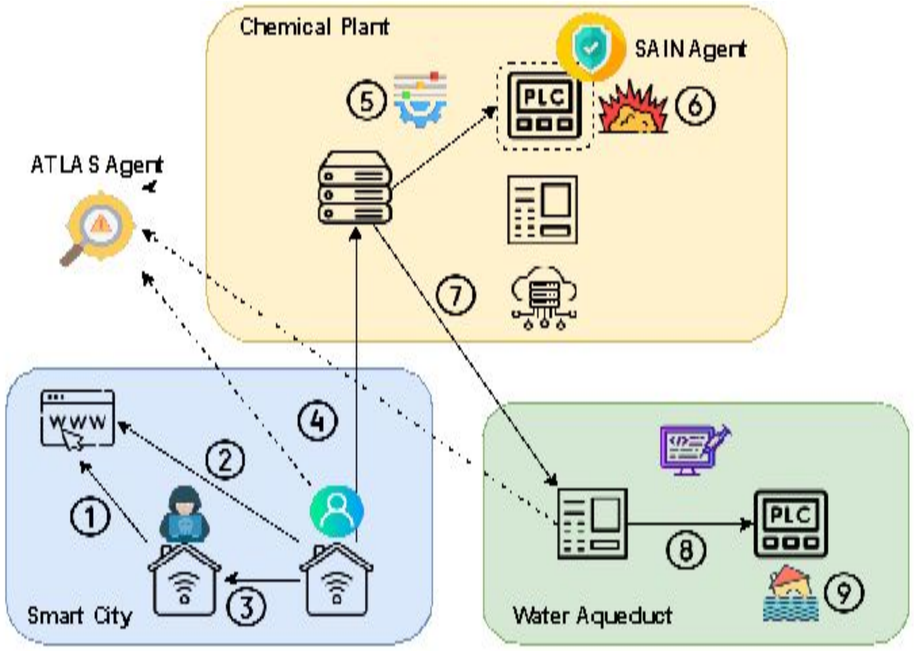
GATE is an AWS-based testing platform to run large-scale and comprehensive experiments to evaluate all facets of the Institute's research in realistic settings.

GATE currently includes three main components:

1. **Smart City** includes Linux-based machines that the users in smart homes interact with
2. **Las Palomas Power Plant** involves two feed supplies given to the reactor for an exothermic reaction
3. **Great Aqueduct** runs a water treatment plant simulator that purifies raw water through several PLC-controlled processes



Attack Overview



1) Attacker serves a phishing website
2) Victim downloads and runs payload
3) Attacker exfiltrates important ICS schematics
4) Laterally moves to power plant HMI
5) Modifies the PLC configuration parameters
6) The power plant explodes
7) Laterally moves to great aqueduct
8) Injects malicious actuator command
9) The water tank overflows

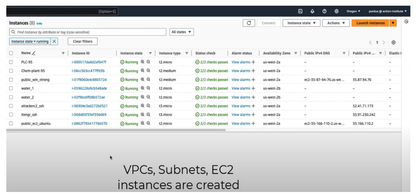
Defense Agents Overview

SAIN [1] is an **attack detection and mitigation agent** that generates and enforces state-aware knowledge with tight PLC variable value bounds to protect industrial control systems

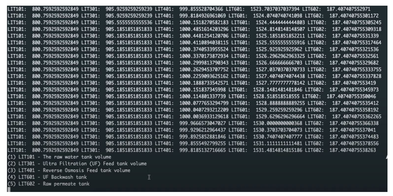
ATLAS [2] is an **attack investigation agent** that integrates natural language processing and deep learning techniques into data provenance analysis to model sequence-based attack and non-attack behavior

Evaluation Results

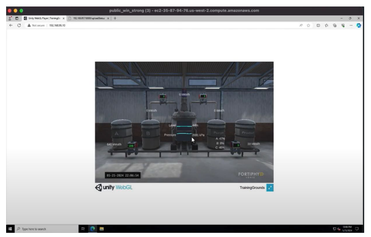
Initial Setup



List of Instances



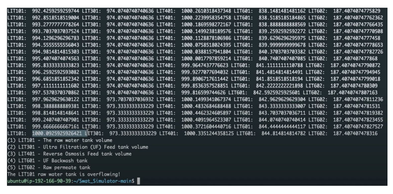
Aqueduct Operation



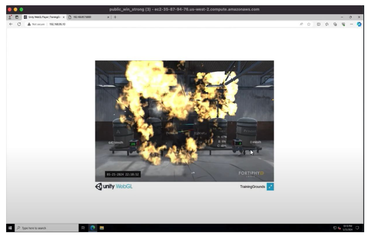
Power Plant Operation

Attack Demonstration

The Attack Initialization



Water Tank Overflows



Power Plant Explosion

We also employ our defense agents to show that SAIN successfully detects and mitigates the attack against the chemical plant and notifies the ATLAS agent, which then generates the attack story (i.e., the steps the attacker has taken)

References

[1] Syed Ghazanfar Abbas, Muslum Ozgur Ozmen, Abdulellah Alsaheel, Arslan Khan, Z. Berkay Celik, and Dongyan Xu. SAIN: Improving ICS Attack Detection Sensitivity via State-Aware Invariants. Usenix Security 2024.

[2] Alsaheel, Abdulellah, Yuhong Nan, Shiqing Ma, Le Yu, Gregory Walkup, Z. Berkay Celik, Xiangyu Zhang, and Dongyan Xu. ATLAS: A sequence-based learning approach for attack investigation. USENIX Security 2021.

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