Offensive AI

A fun and not (so) explored field mixing **offensive cybersecurity** and **machine learning**.

Dorian BACHELOT

About Me!

Dorian Bachelot

Research Engineer

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#Malware Developer/Detection

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Introduction

AI, ML, DL, OAI...

Field Overview

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Offensive artificial intelligence (OAI) can be defined as the field in which artificial intelligence algorithms or models are used to **automate one or multiple parts of an offensive security task**.

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This cover:

- Vulnerability scanning
- Exploit automation
- Attack path identification
- ...

Reminder on AI

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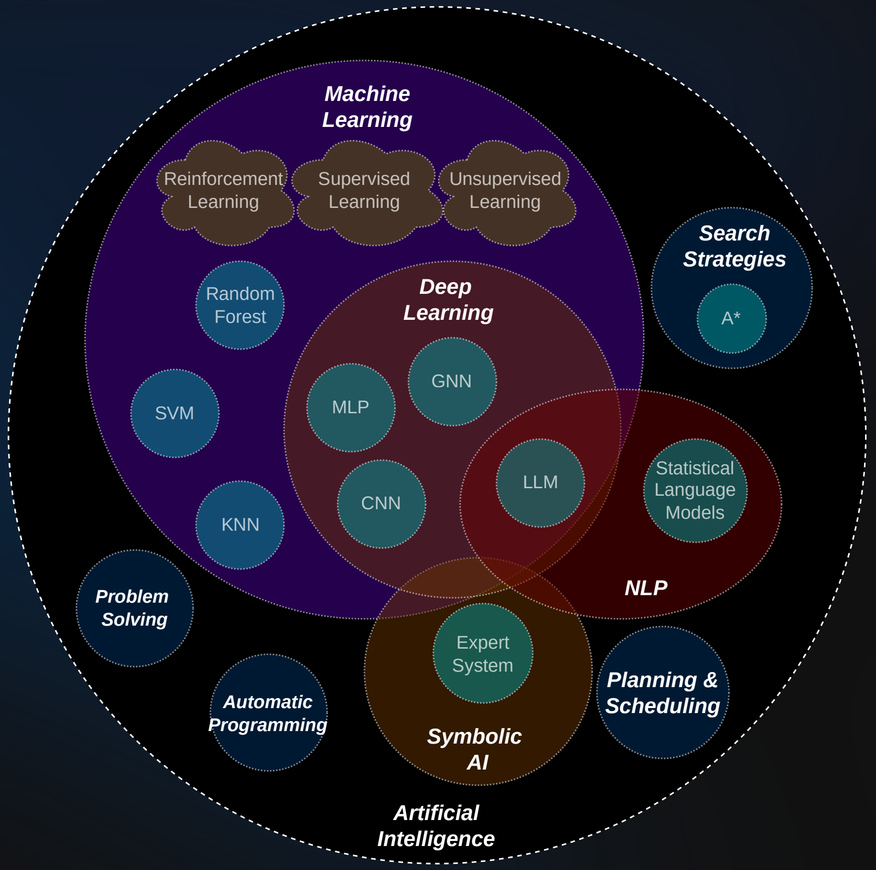

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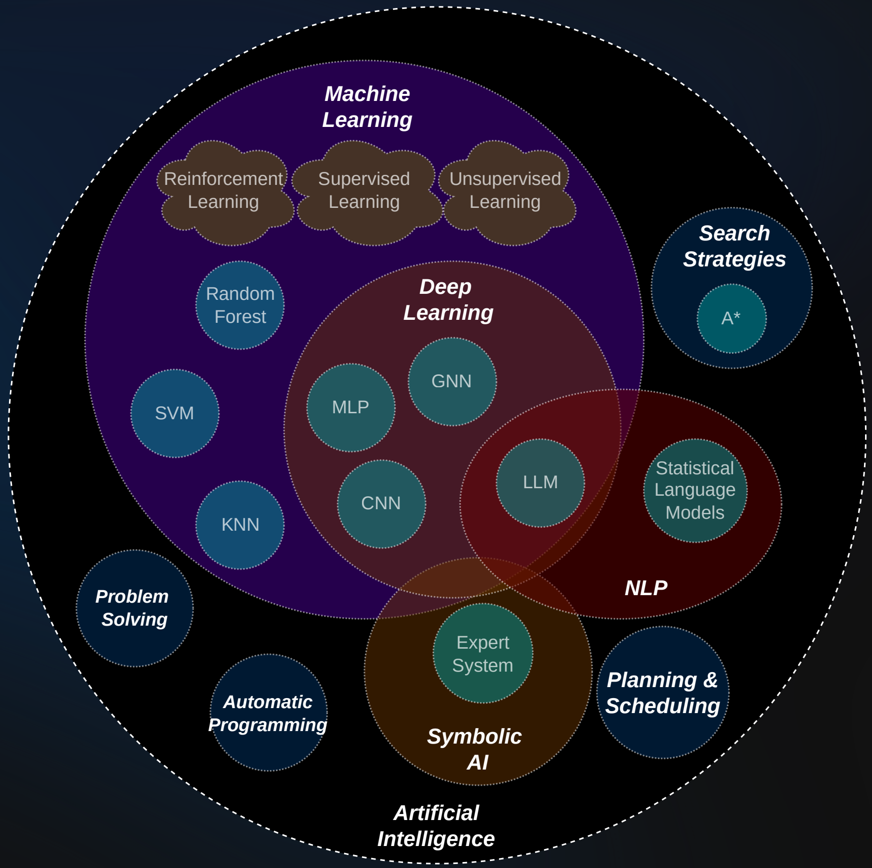

Machine Learning ≠ AI ≠ Deep Learning ≠ LLMs

OAI

Global overview

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Automation ≠ Better than Humans

The different subfields

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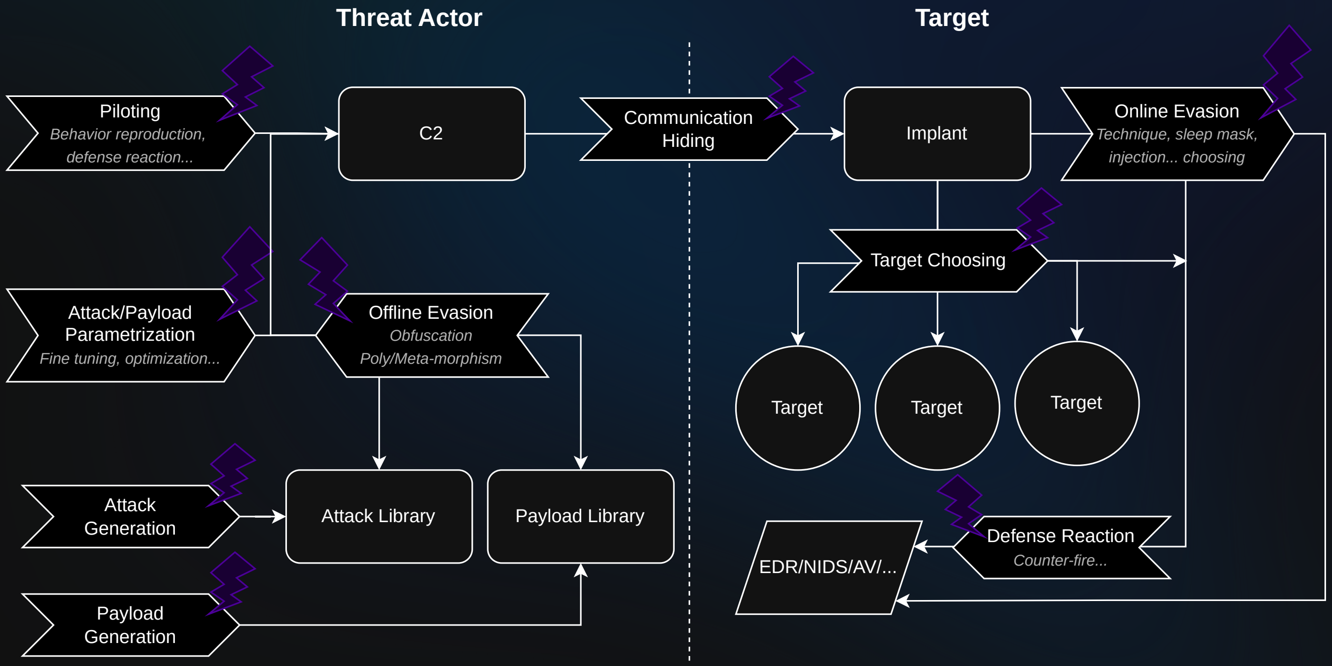

OAI for C2 Piloting

Target choosing, attack choosing...

C2 Piloting

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What is a C2?

- **Pilot implants**, that have infected some hosts.
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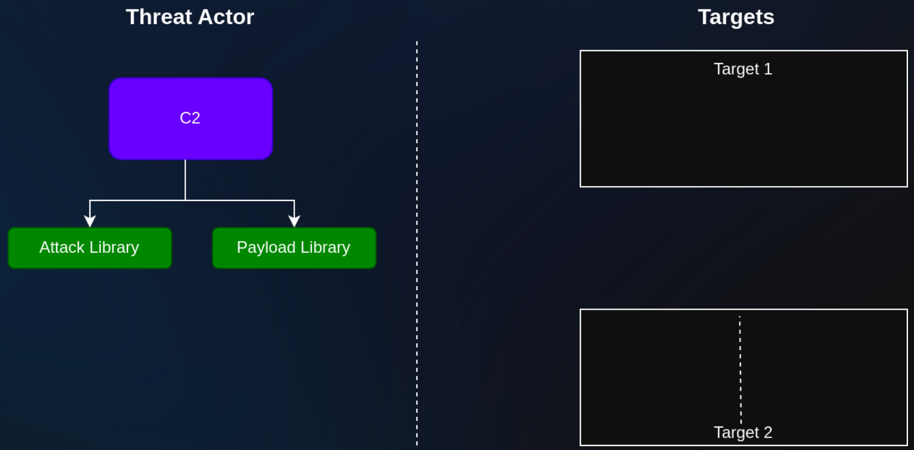

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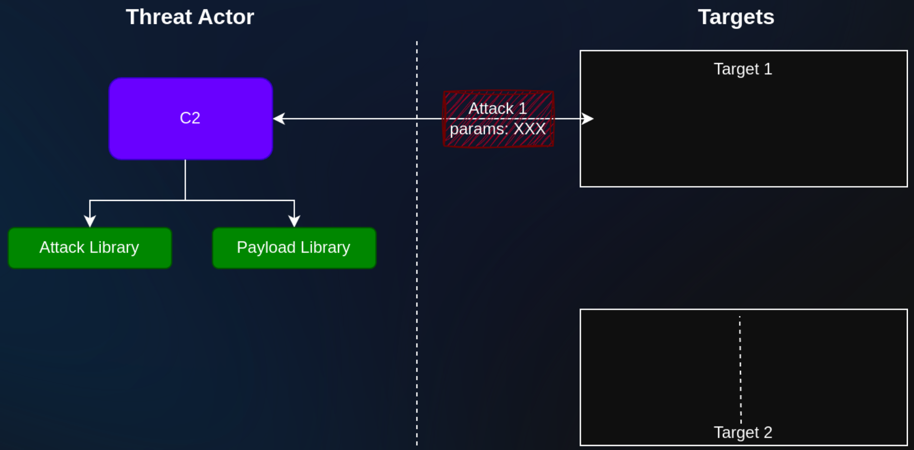

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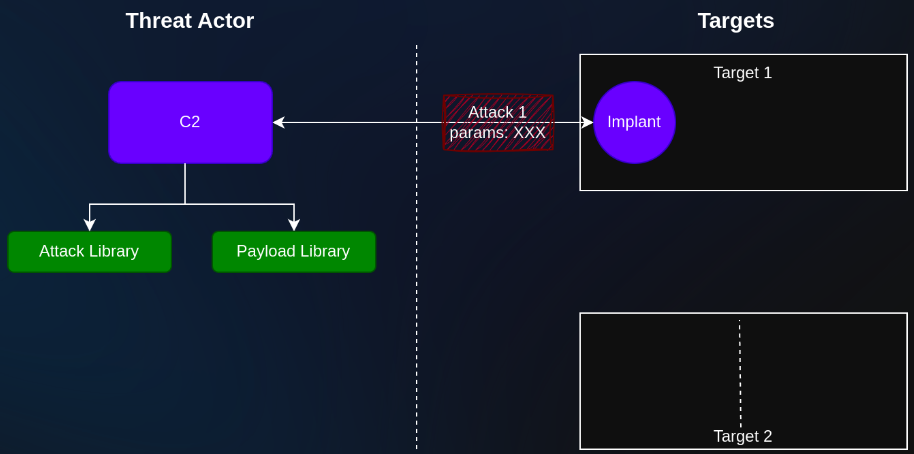

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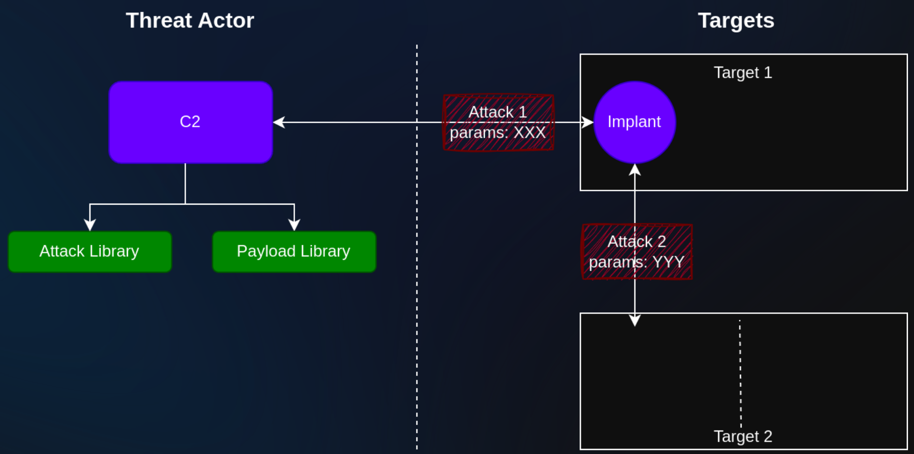

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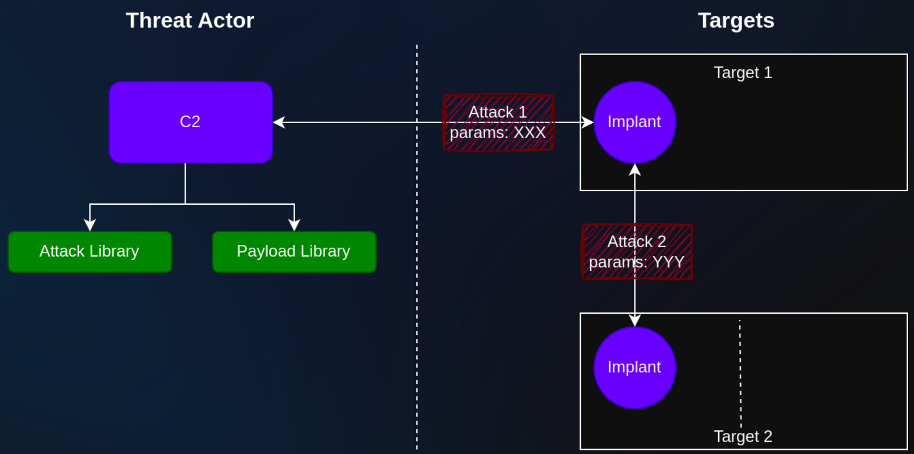

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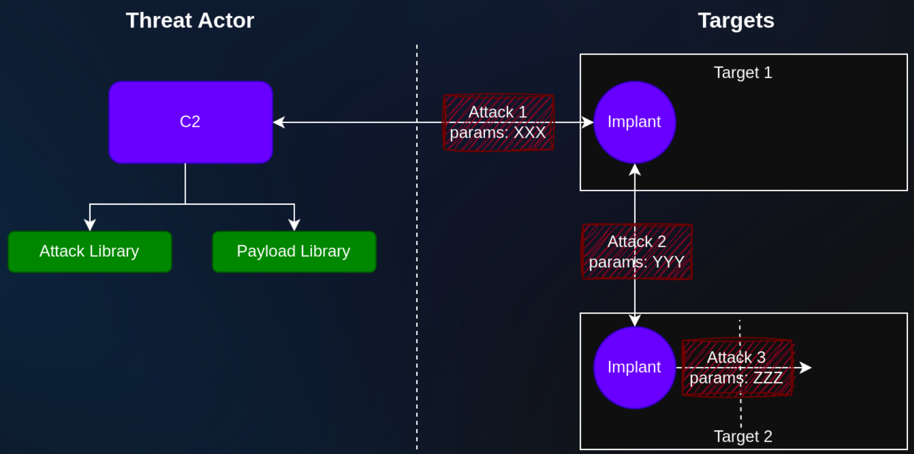

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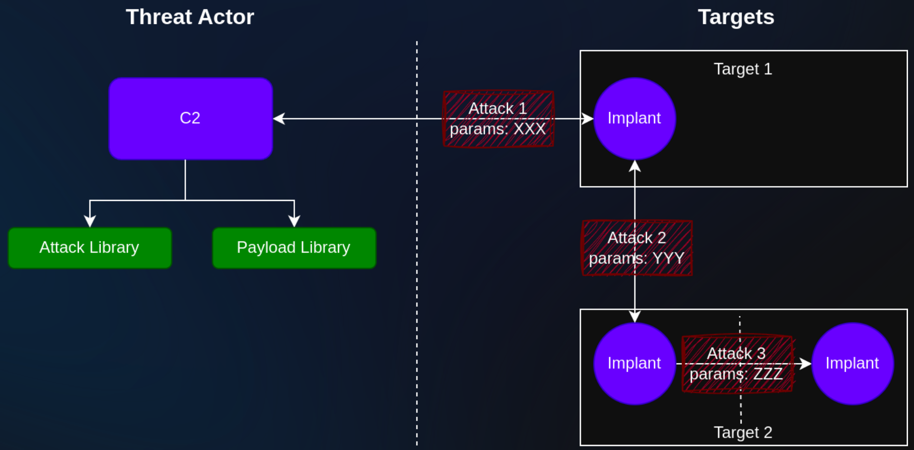

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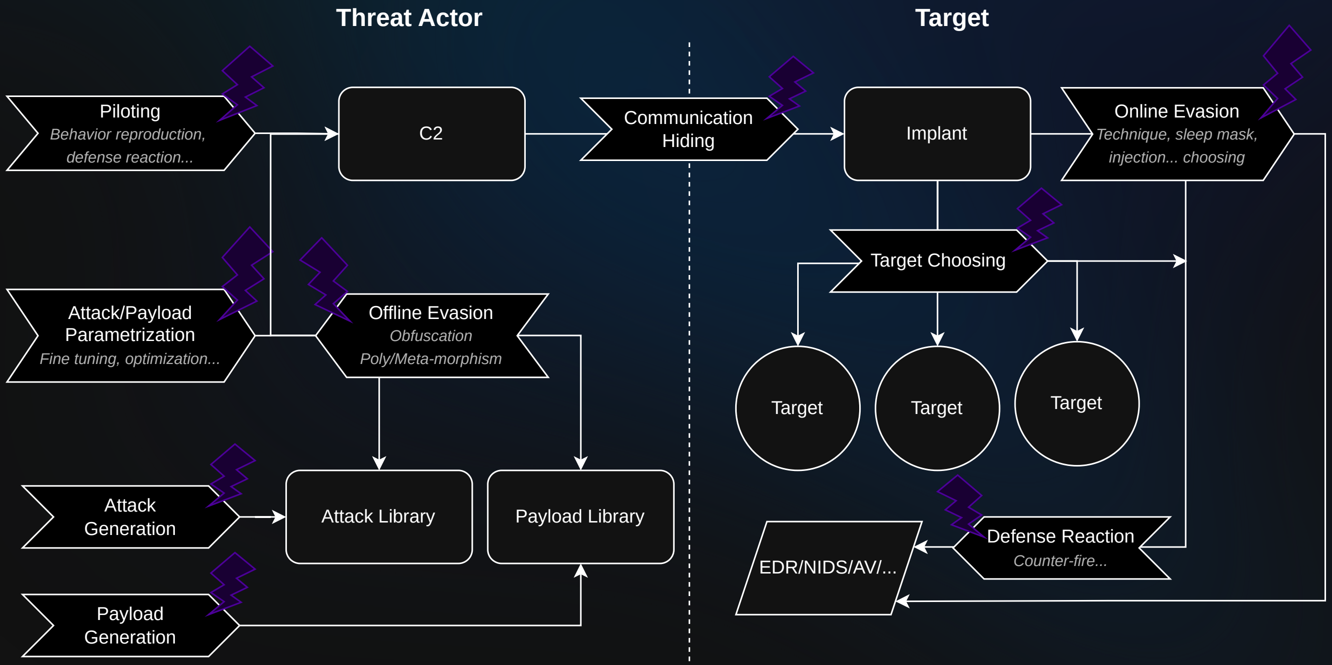

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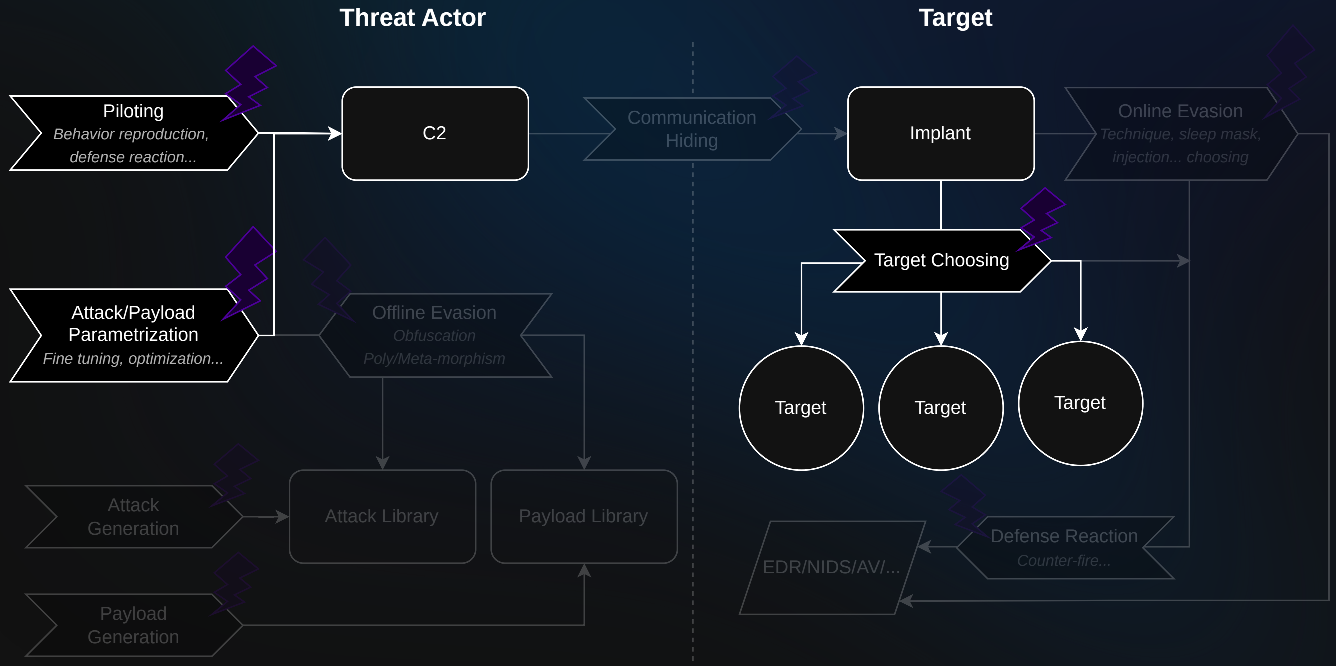

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Not that simple in reality... A lot of AI-related issues.

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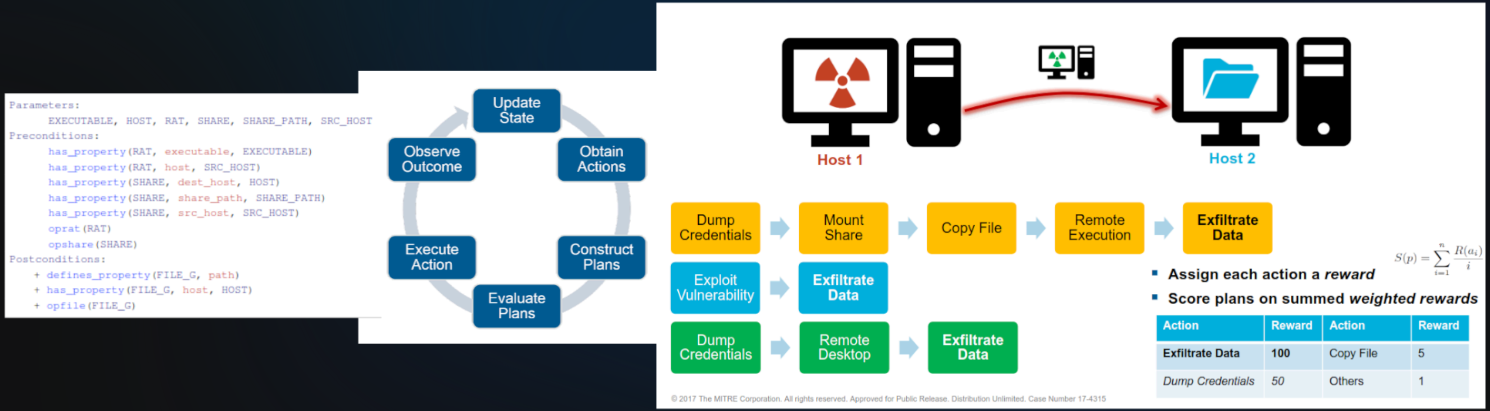

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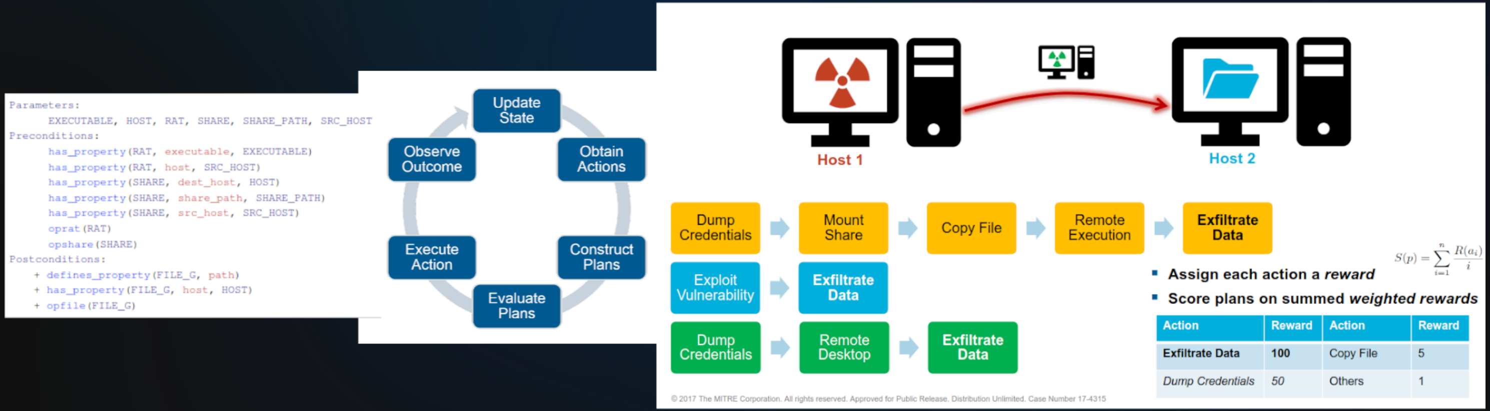

Based on **pre & post conditions**, really basic and not very "smart" system.

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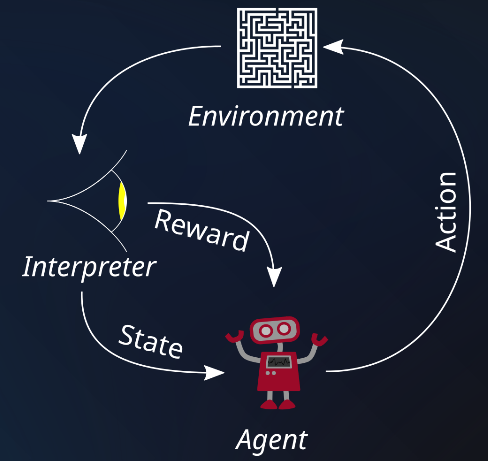

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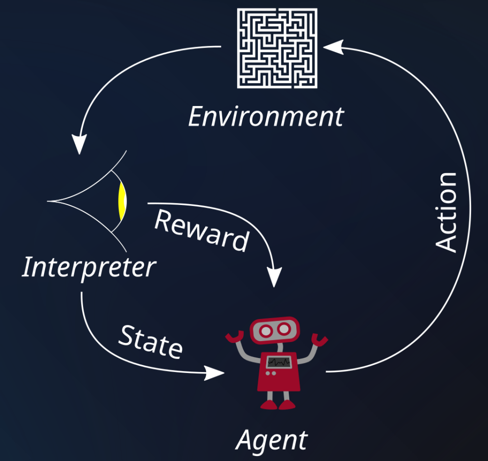

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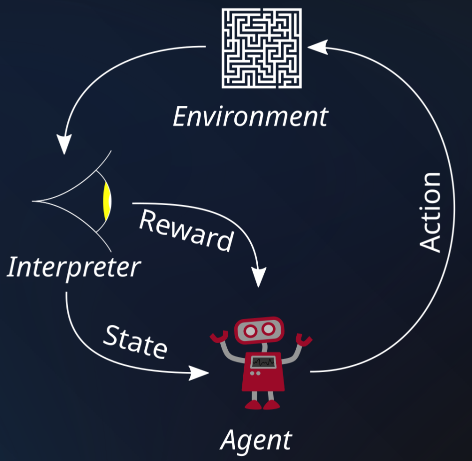
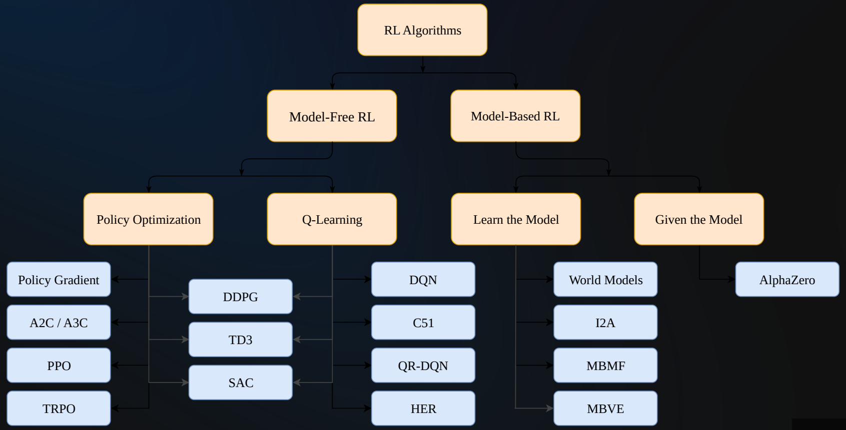
Reinforcement learning is vast:





(OpenAI)

C2 Piloting / RL for Piloting

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RL fit well for C2 piloting:

- S contains all network states (like machines, OSes, open ports...),
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Playing with R make it possible to complexify model behavior (e.g., valorize exploration vs exploitation, take defense into consideration...)

C2 Piloting / RL Environment

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First issue, to use RL you need a training environment that'll simulate (mock) inputs/outputs [2][3]. This is called a simulation environment (or Gym).

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(3)

Most, if not all, are **oversimplifying** the problem, and some doesn't even provide realistic evaluation (emulation, or running in a real IS). For example, none allow **attack parametrisation**. And most are using a probability of failure per action (artificial realism).

C2 Piloting / Some RL Environments

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NASim	2019	Simulation only
CyberBattleSim	2021	Simulation only, Microsoft
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Metasploit is the **ONLY** used C2 across the literature.

C2 Piloting / More RL Agents

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Model	Technique	Complex Behavior	Parametrisation	Generalization	Year
POMDP [4]	POMDP	No	No	No	2013
LD-PenTesting [5]	POMDP	~Defender Behaviour	No	No	2020
EPPTA [6]	POMDP + PPO	No	No	No	2023
AutoRed [7]	POMDP	No	No	GNN	2024

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Multiple issues with these approaches :

- Questionable generalization (except AutoRed),
- Imperfect reward function R/policy π (complexity),
- No attack parametrisation,
- Questionable performances,
- Low quality/high abstraction environments.

C2 Piloting / A Complex Problem

C2 Piloting / A Complex Problem

Multiple questions:

- **One or multiple** models to select the target, the attack and the parameters?
- Does the target selection model **see the whole network**, or just select the target with the best attack?
- Since a network can have a (virtually) **infinite number of machines** (targets), how to construct the input/context for the target selection model?
- How to create an adequate **reward function/policy**?
- How to capture the **complexity** of the problem (like taking into account defense reaction)?
- C2 Piloting is a **planning problem** (with goals & subgoals)?
- On a big network, with a lot of possible actions, each with many parameters, how **not to collapse**?

C2 Piloting / New Approach

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Proposed approach

Issue	Solution	Description
Generalization	GNN / Carrousel	Ingest the network context independently from its size. Learn to retain only interesting information. Context-based ingestion.
Partially Observable	POMDP + Dreamer (*JEPA?*)	Internal environment representation, latent space reasoning.
Complex Behavior	Complex R & Goals	Complexify the reward function. Add goals & subgoals to complexify policies (planning).
C2 Automation	New Specific C2	Create a C2 with automation in mind.
RL Environment	New Emulation First RL Environment	Create a new RL environment centered around emulation (maximum realism).

C2 Piloting / Other Approaches

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Other approaches exist:

- Some people are trying to use **LLMs for C2 piloting** (me! [8]), but also end-to-end OAI. Results are not great, OAI is not really **hallucination-compatible** (e.g., commands needs to be exact, IPs also, impact if the wrong target...).
- RL is not the only learning method: **Self-Supervised Learning** is trending.
- **Heuristics** are not dead.
- **Expert systems** (analogy to the defensive side) should also be explored.

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The dream is to have **end-to-end OAI** (target, attack, parameters choosing with attack generation).

C2 Piloting / Conclusion

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Some "Hot Takes":

- C2 Piloting is **hard**.
- This is not just a **model choice issue**.
- Past literature (minus some exception) are **focusing on the wrong problematic**.
- Linked **use cases** are huge.
- Ask many **fundamental** questions.
- When it will work, the **impact might be important** for defenses.
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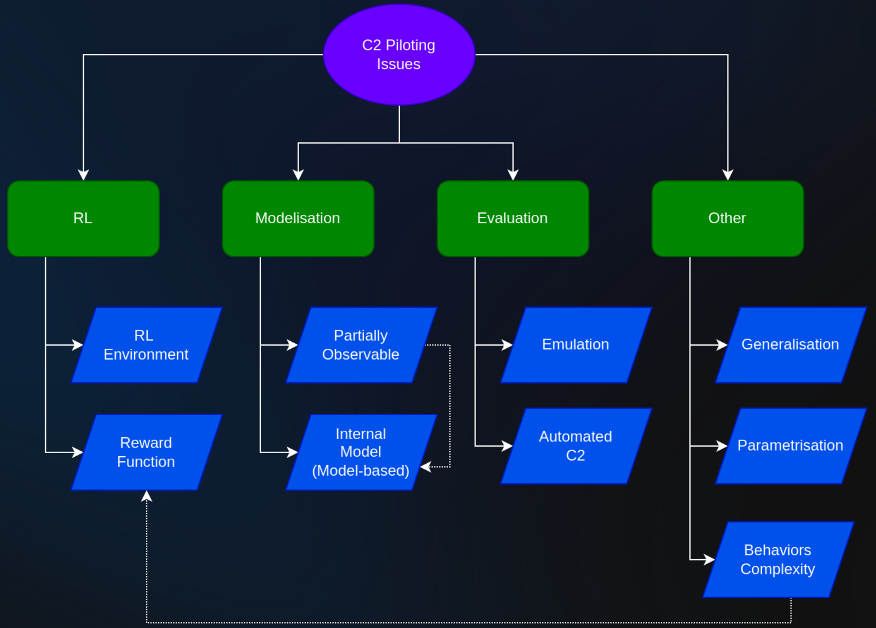

OAI for Evasion

Online & Offline evasion...

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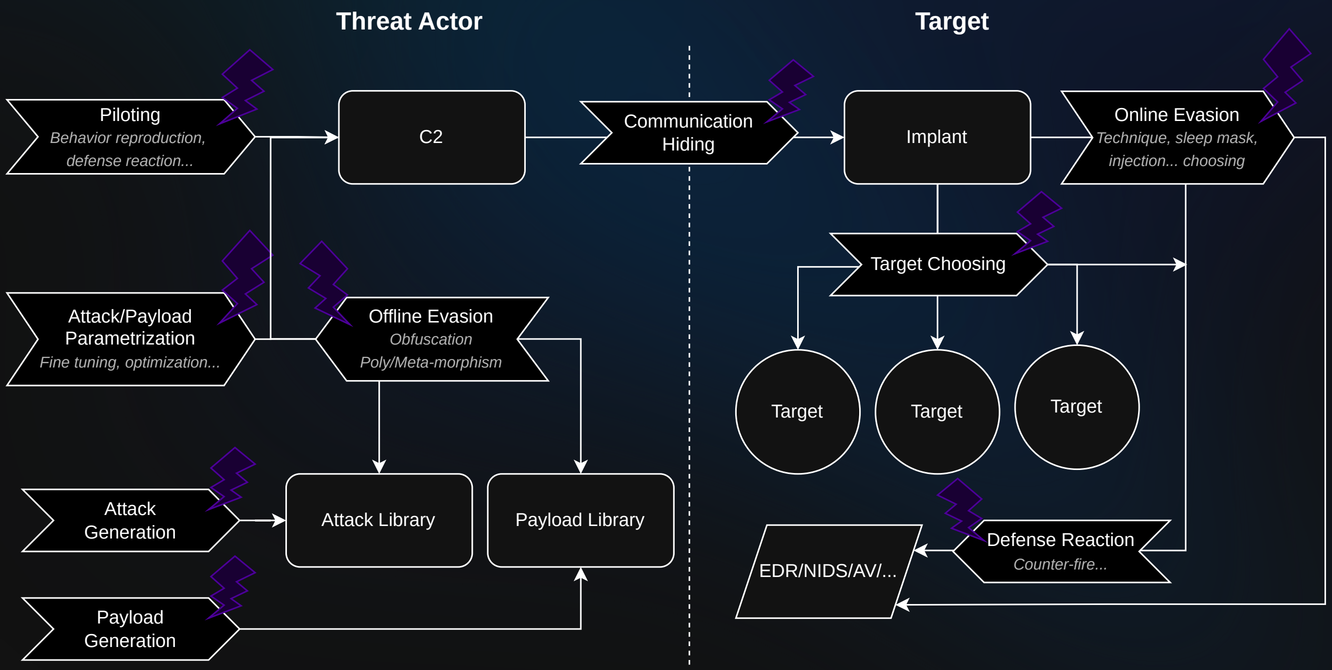

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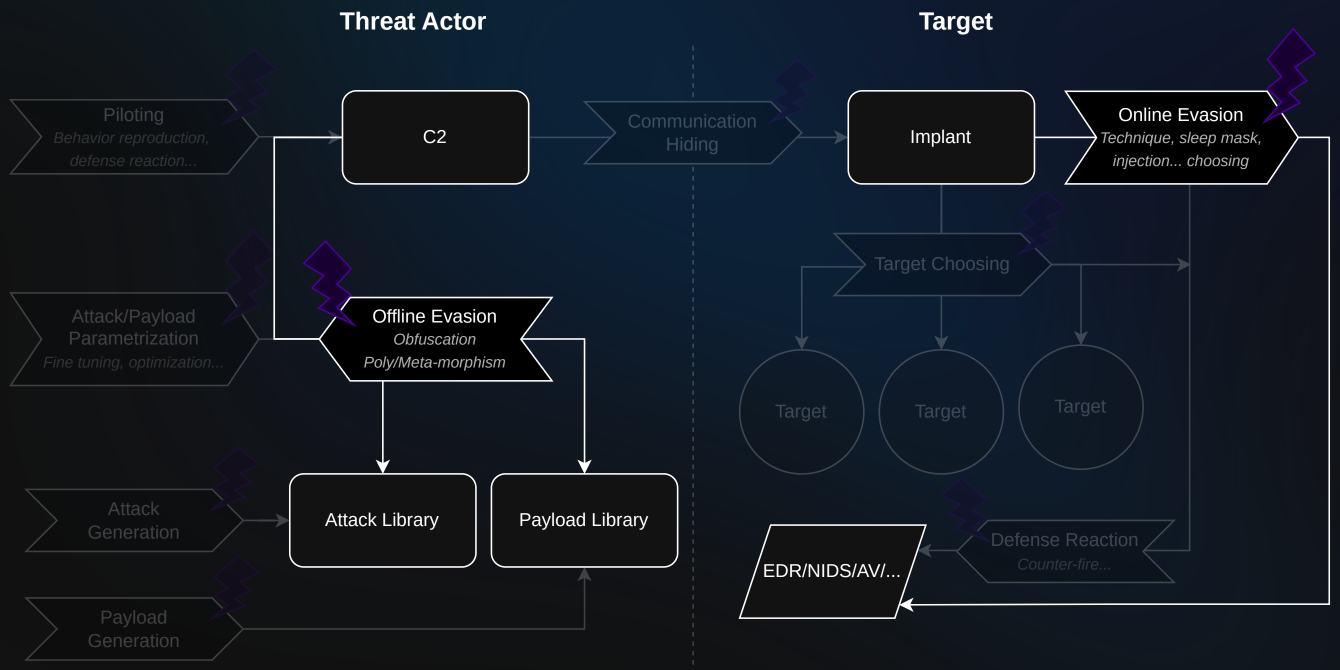

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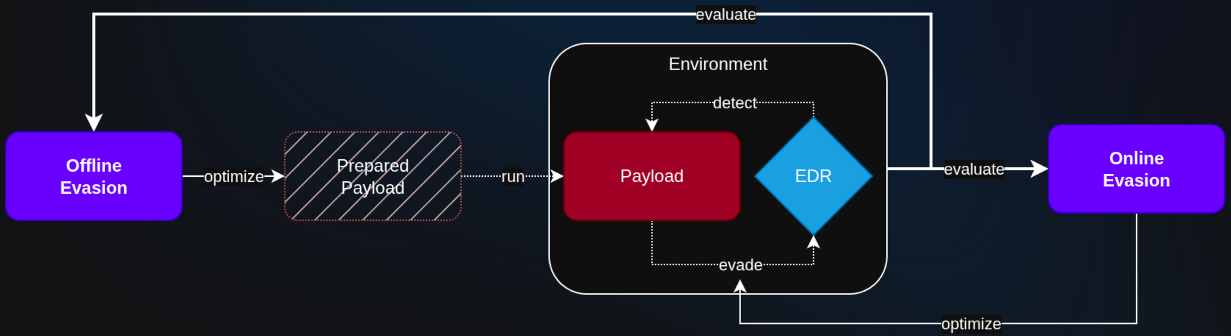

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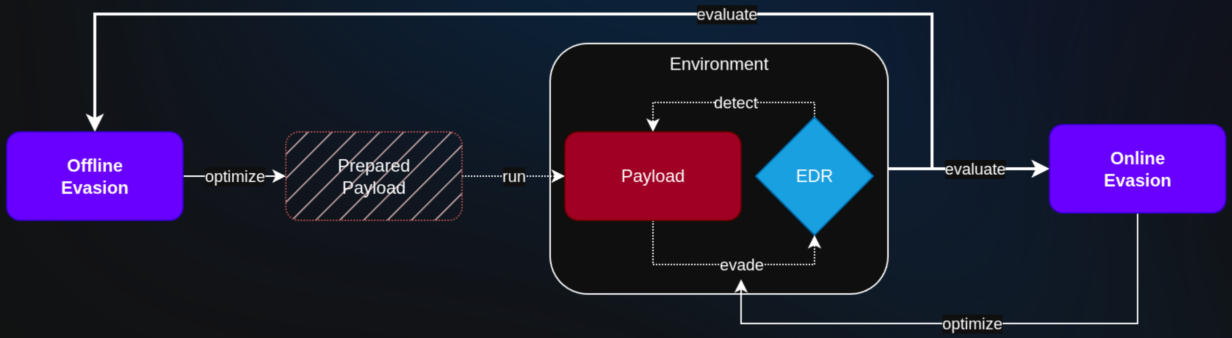

AI can be used to find these combinations and associated parameters, **optimizing evasion**.

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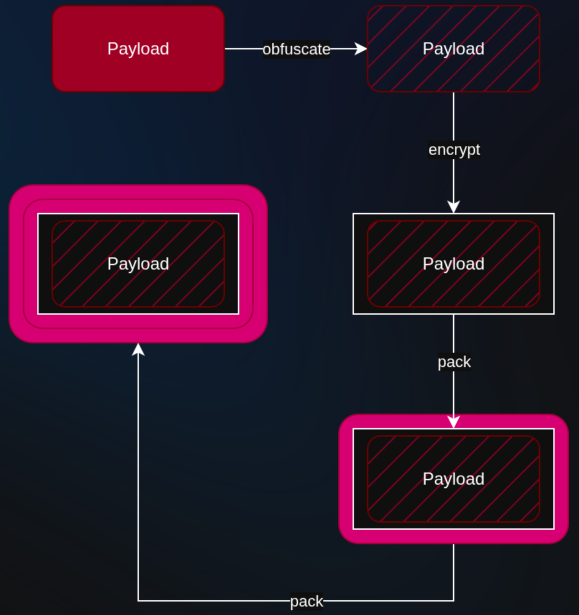

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Automation Surface:

- Call graph obfuscation

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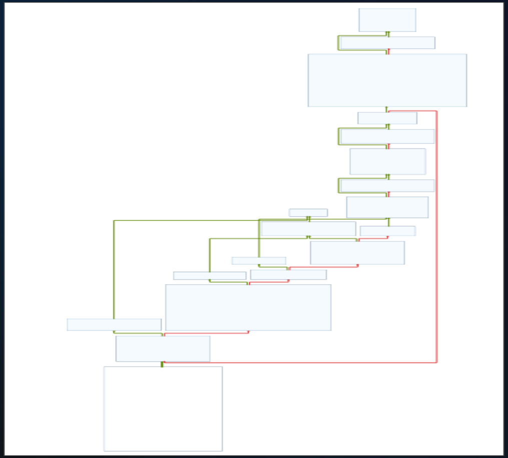

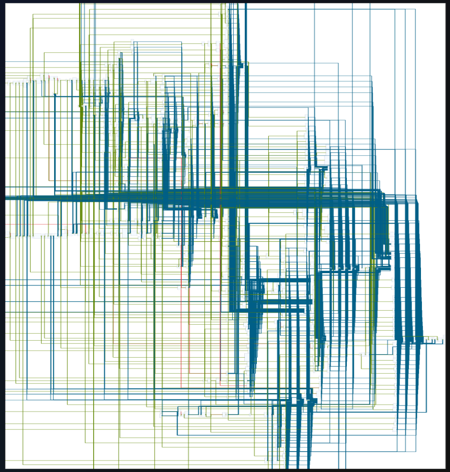

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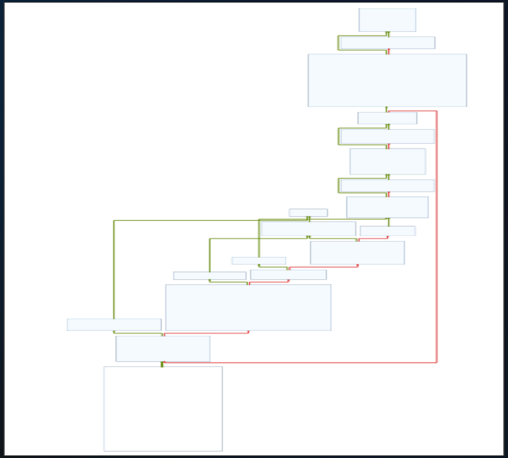

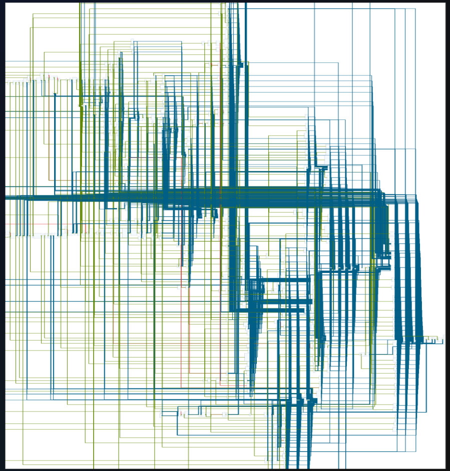

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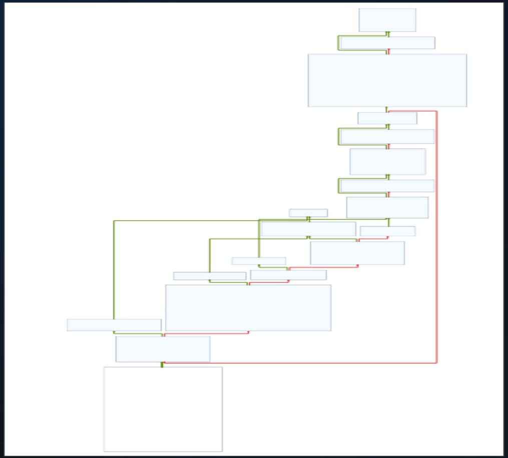

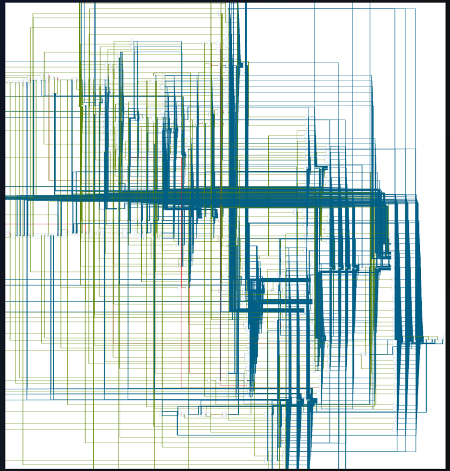

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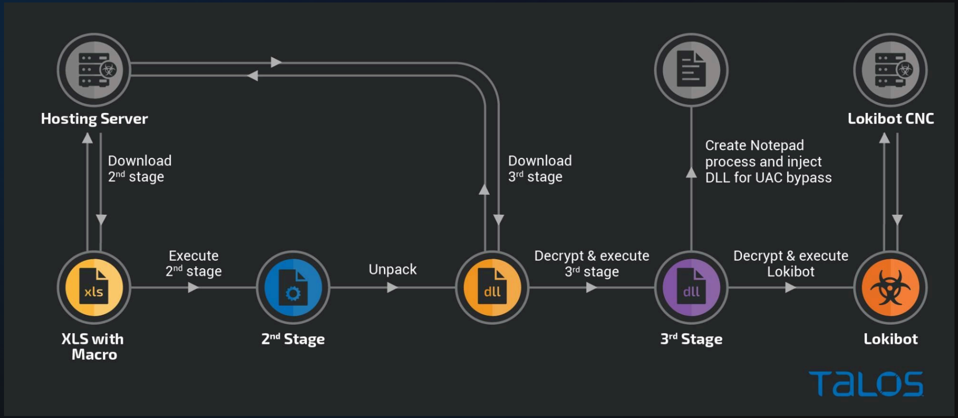

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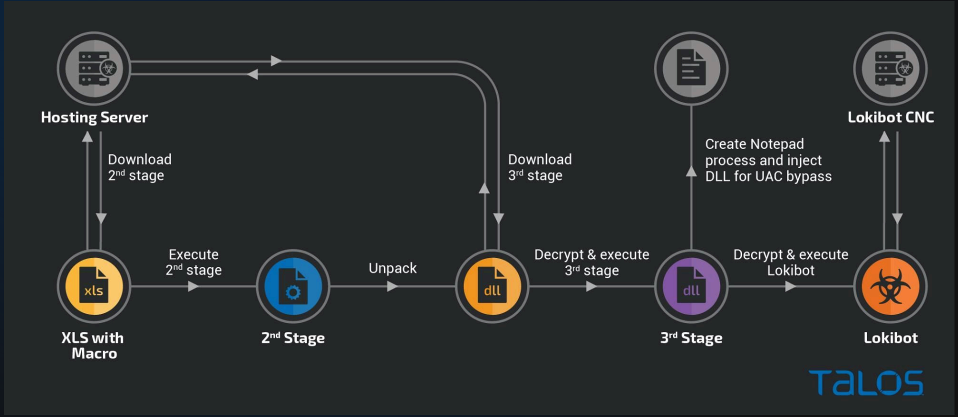

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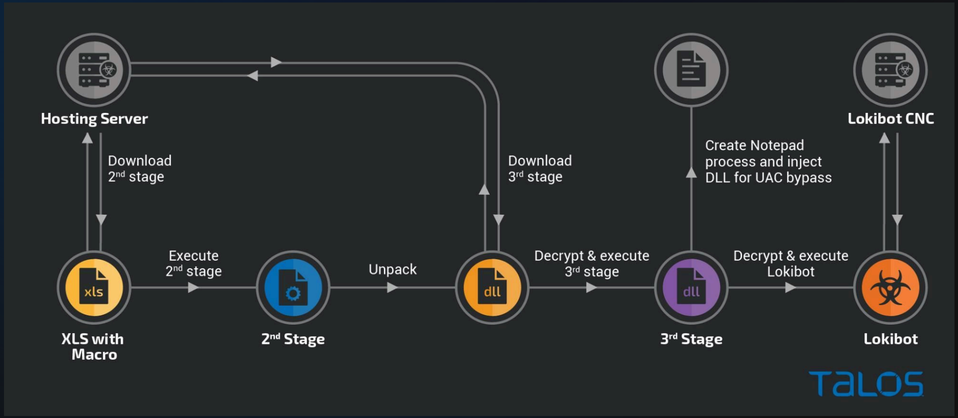

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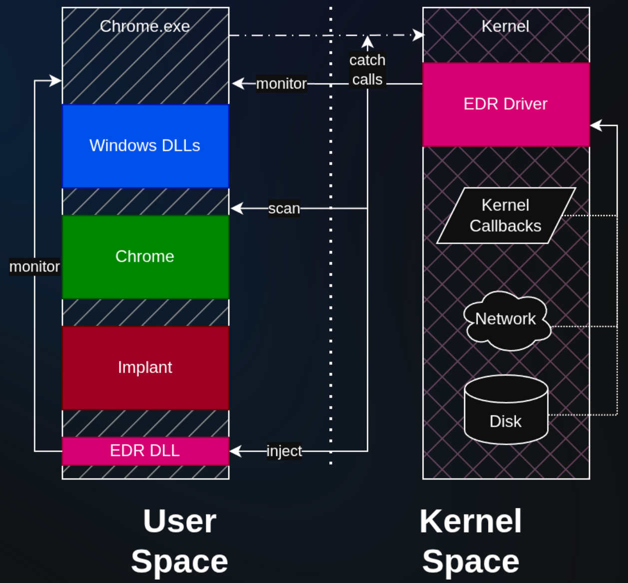

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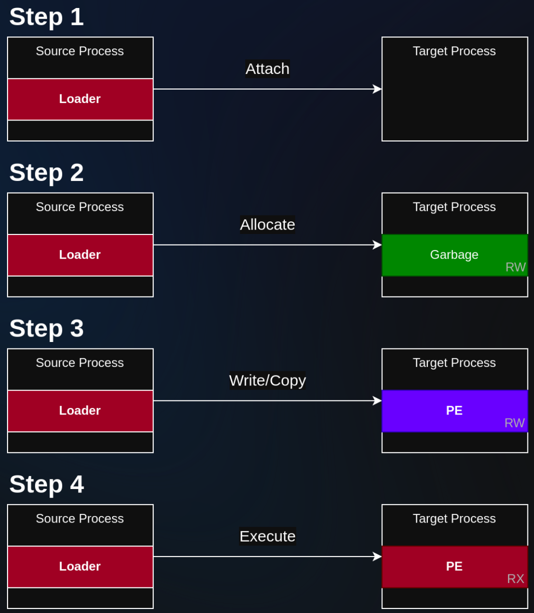

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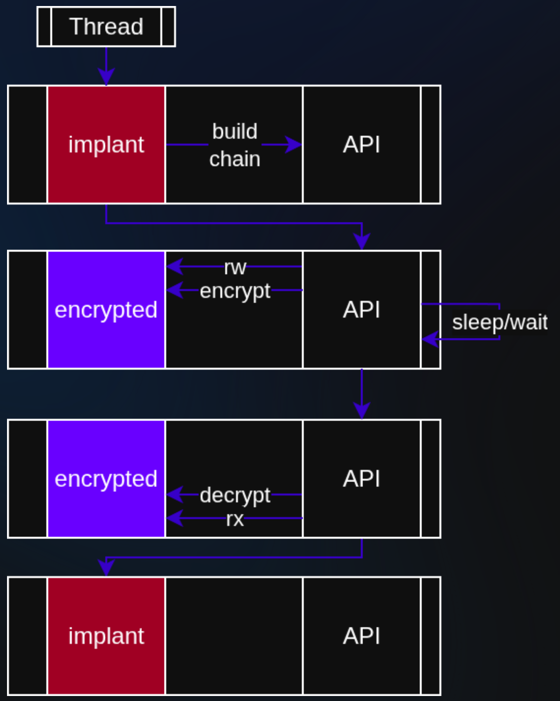

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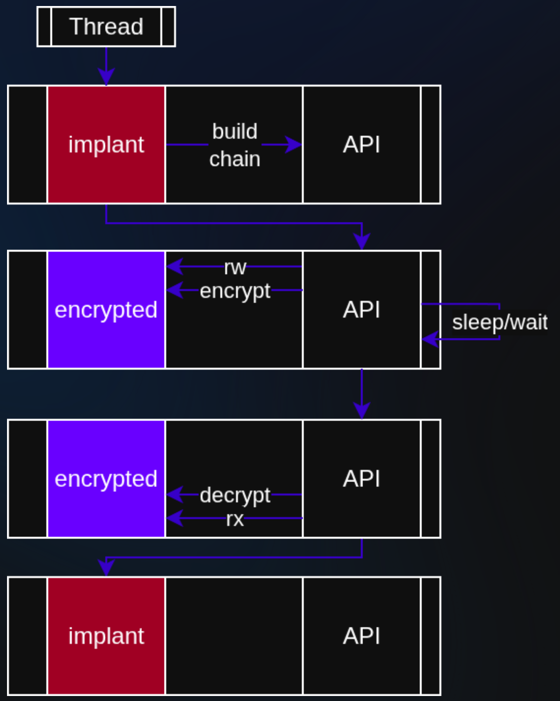

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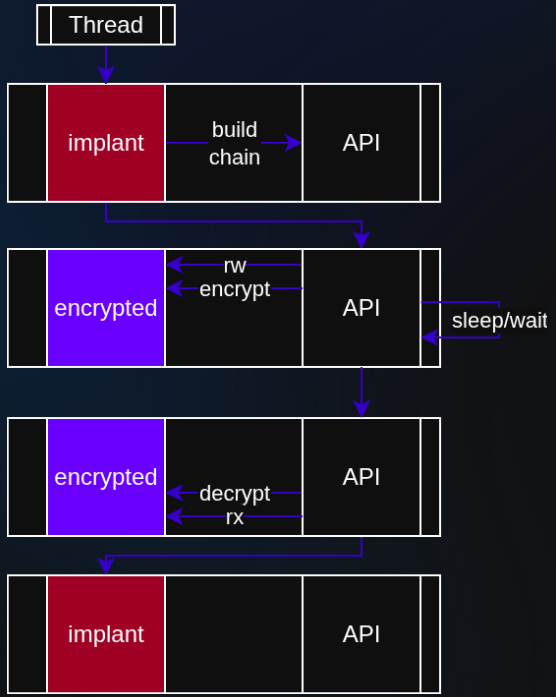

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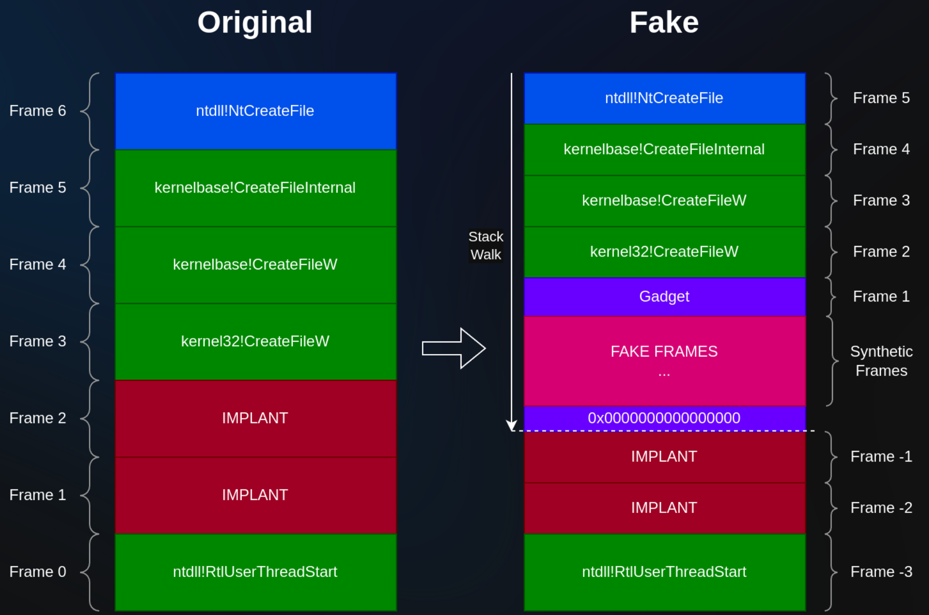

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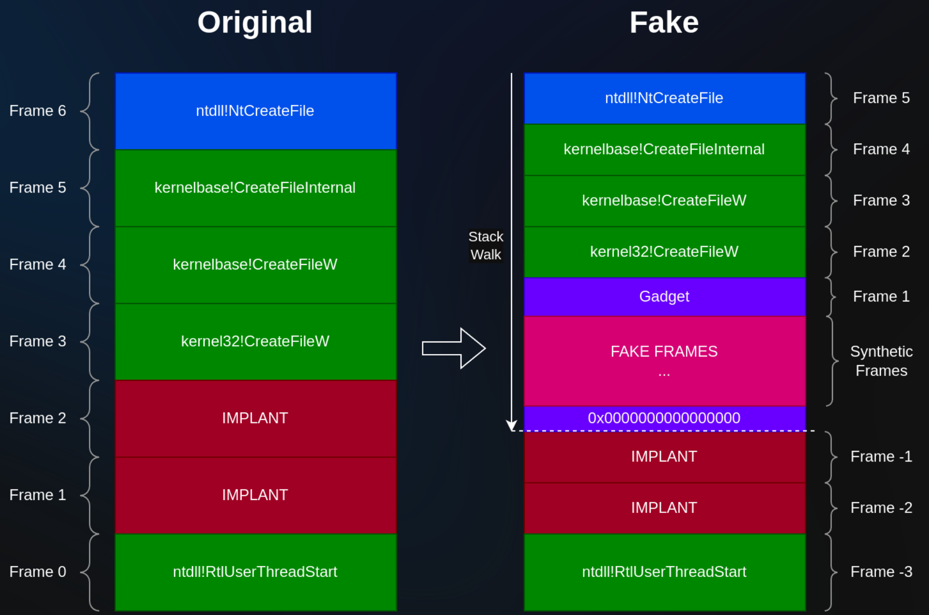

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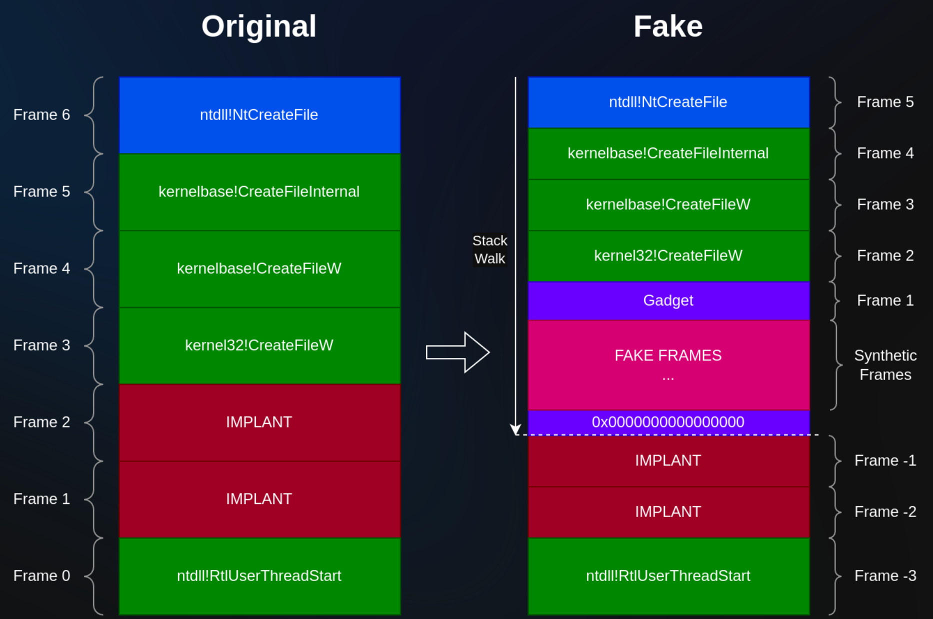

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Product	Call Stack	Process Injection	Metamorphism	Memory Masking
EDR1	Variant 2	"Explorer"	Variant 1	X
EDR2	Variant 2	X	Variant 1	X
EDR2 + Win11	Variant 3	"Google Chrome"	X	Variant 2

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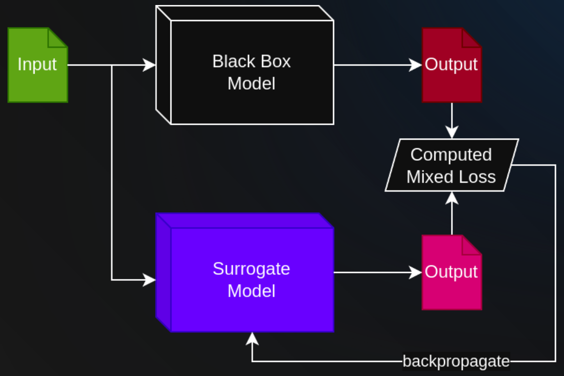

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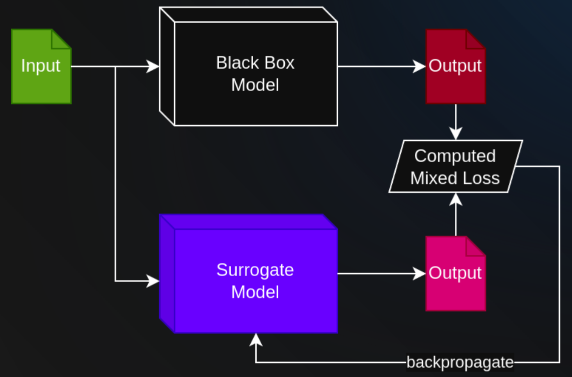

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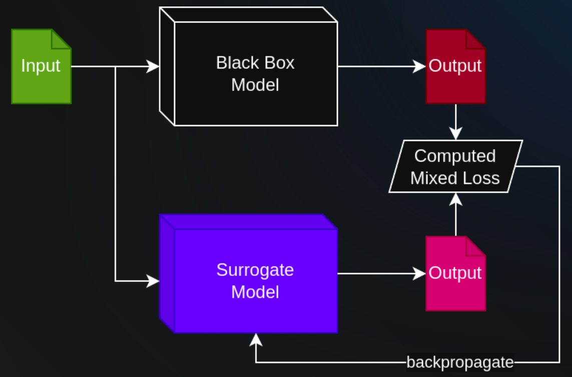

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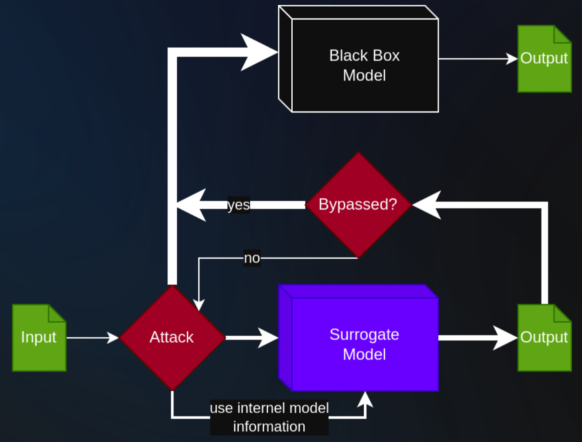

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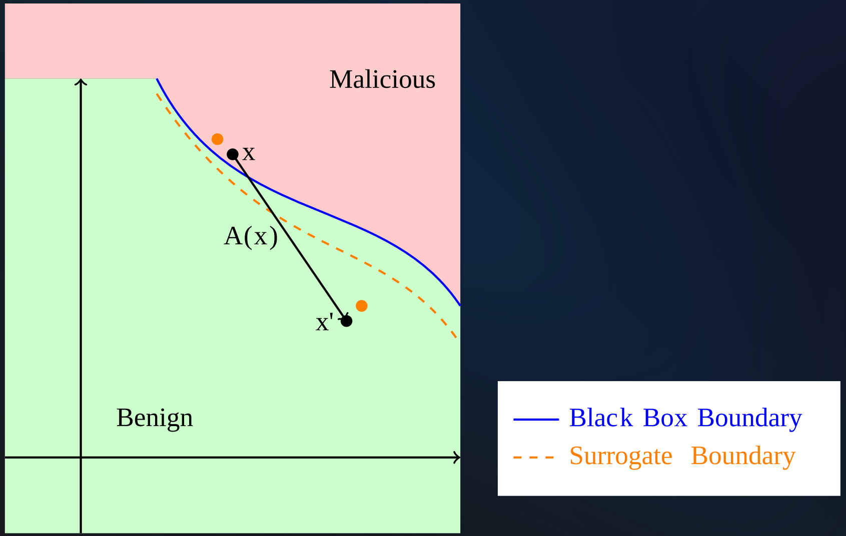
Possible attacks

- Add obfuscation, packing...
- Use process injection, call stack spoofing...
- Mask/Obfuscate memory...

All of these techniques are primitives that we can leverage to build adversarial binaries, using our surrogate model.

Surrogate Model: Visualization



Where $A(x) = \epsilon_{\Omega}(x)$.

Conclusion

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Some "Hot Takes":

- Automation for evasion is **easier** than C2 piloting.
- Not much literature on the subject.
- Might not be explored by anyone?
- Multimodal $>$ Unimodal
- Linked **use cases** are important.
- When it will work, the **impact might be important** for defenses.
- (*LLMs are not the solution*)

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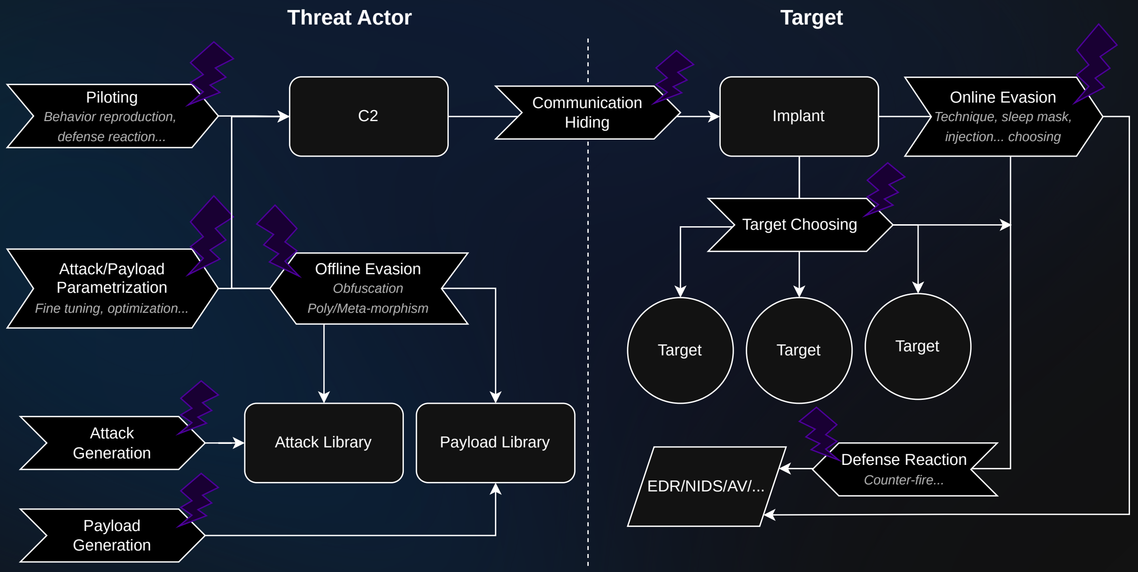

Thanks!

A complete version of this conference is available here https://dorianb.net/Talks/OAI2026/Full

For more https://dorianb.net/

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