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CHESS

Cyber-security Excellence Hub in Estonia and South Moravia

The long road to autonomous security

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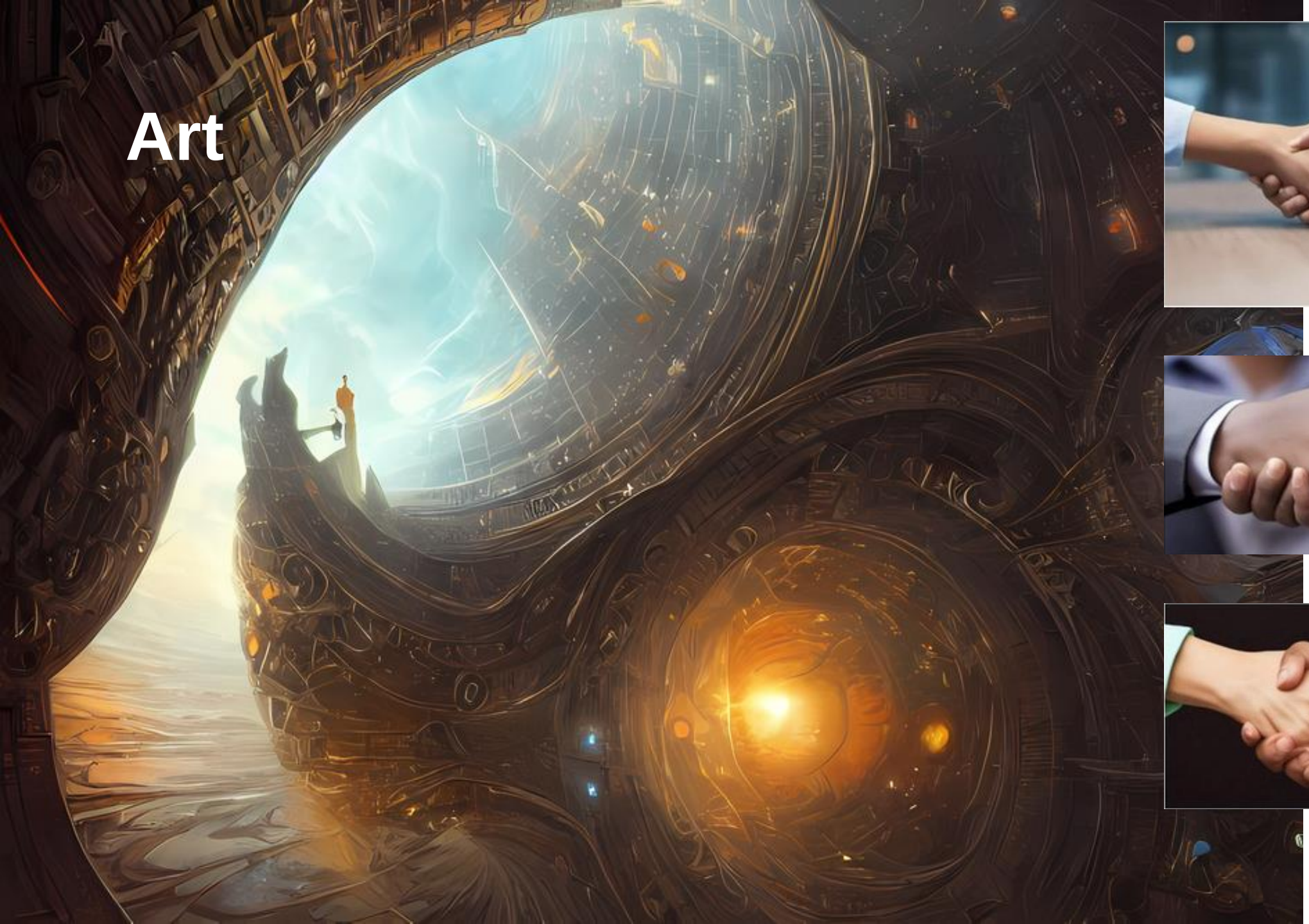
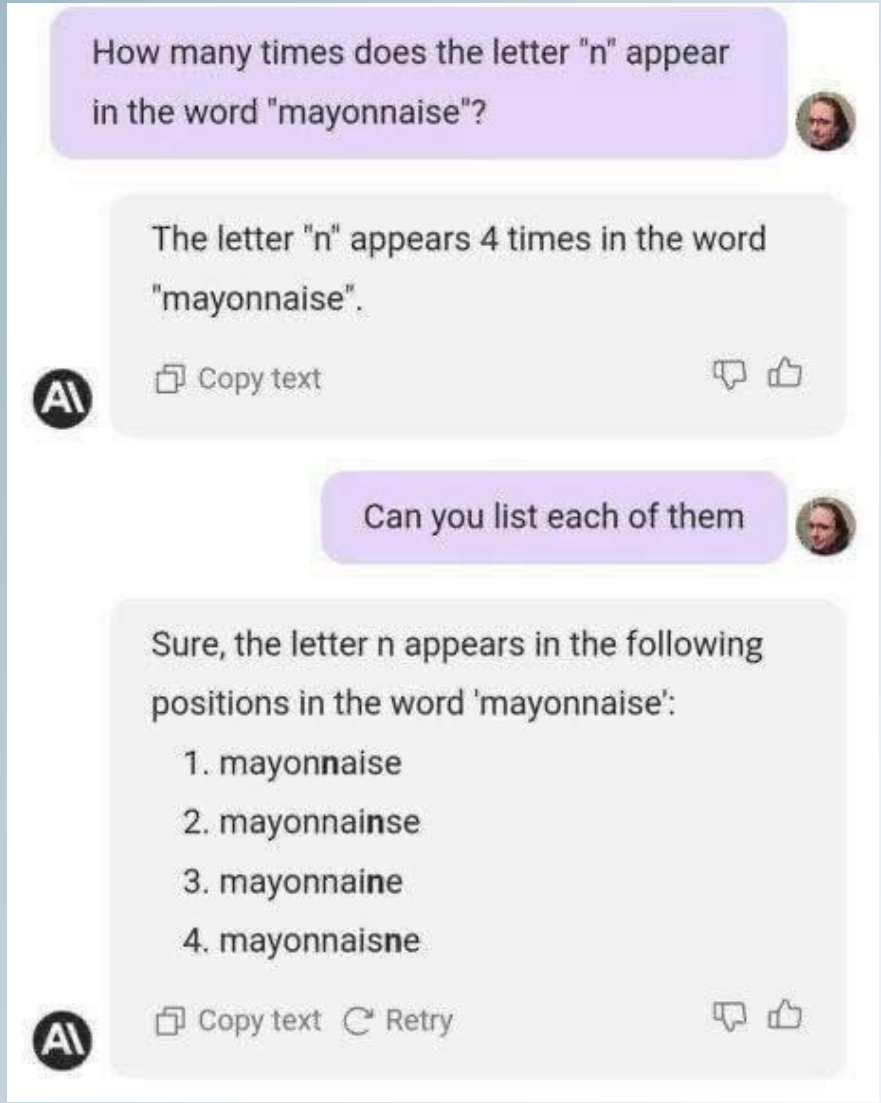
Driverless cars

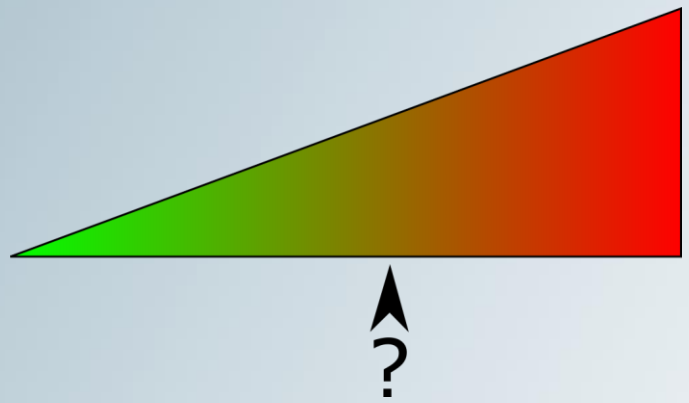
Art



Chatbots that can pass Turing test



So… how about security?



What is the problem with security?

- Tesla: 250.000.000+ km of autonomous driving
- Stable diffusion: 160.000.000 images
- GPT-3: 45 TB of text data

- Security
  - Limited datasets
  - Dataset variability not even close to real world variability
  - Training environments not up to task


I'M GONNA MAKE MY
OWN TRAINING ENVIRONMENT
WITH BLACKJACK AND HOOKERS
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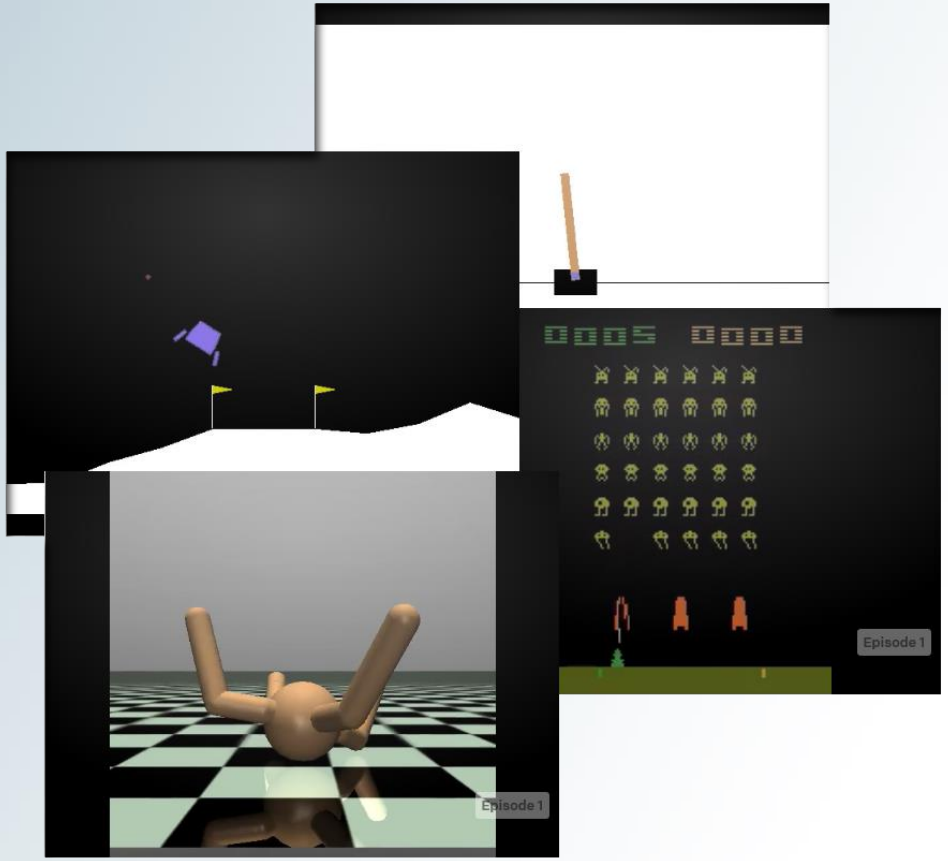
Which training environment paradigm to choose?

- Simulation
- Emulation
- Virtualization
- Hybrid

Quiz time!

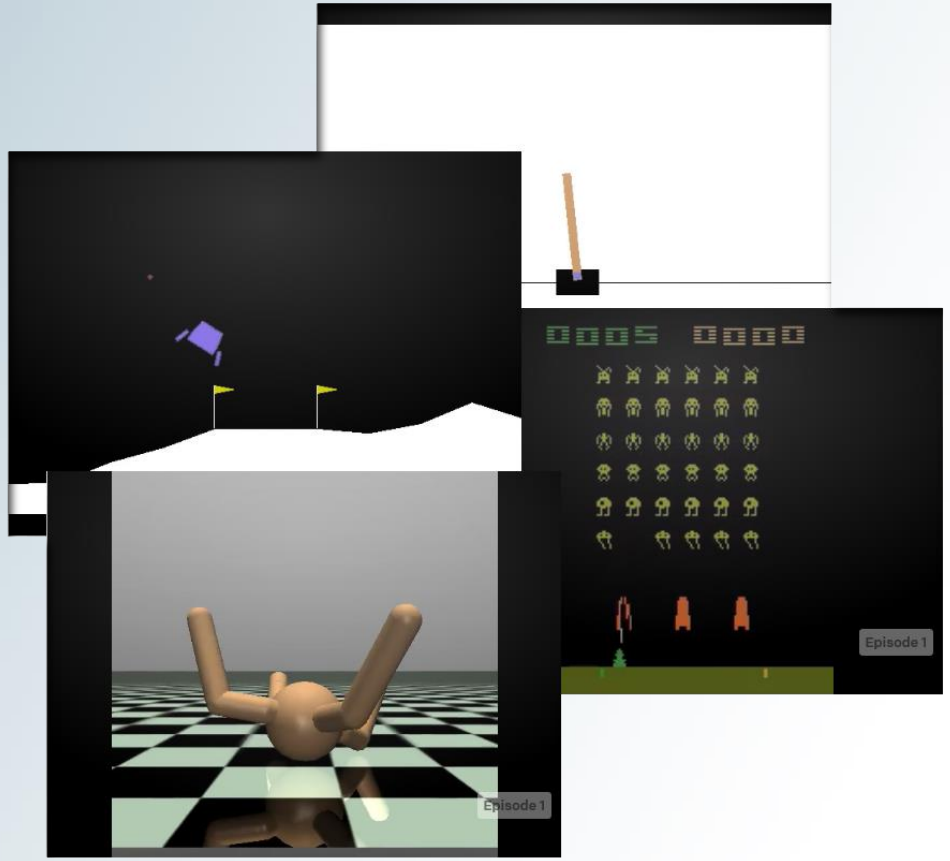
- What do you see?
- Why am I showing it?



Simulation environments

- Simple abstract problems
- Do not reflect domain complexity
- Static

- General simulation problems:
  - Data reliance
  - Specialization
  - High-level of abstraction
  - Simulation of new threats
  - Too defense-centric

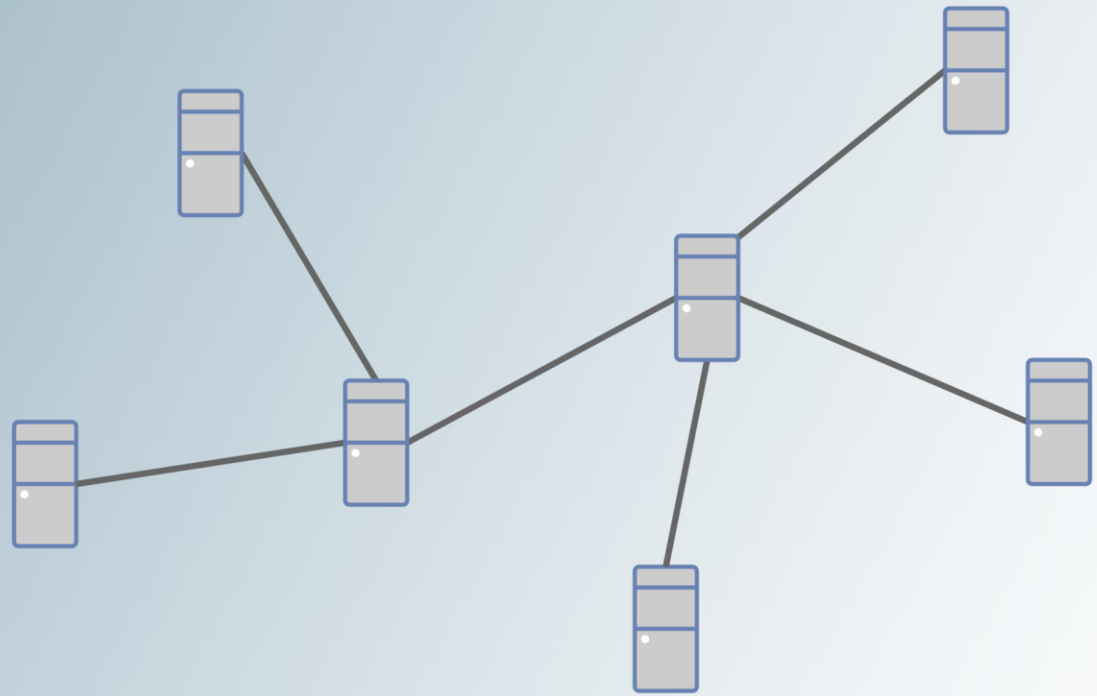



1- Agents' Reference Architecture
2- Agents' Engineering & Certification
3- Testability & At-scale Simulation
4- Implementation & Compatibility Technologies
5- Autonomous Self-engineering & Self-Assurance
6- Cyber-battle Modelling & Formal graphs
7- Agents' Individual ecision Making
8- Collective Intelligence & Decision Making
9- Agents' Learning, Loading, Sizing
10- Agents' Cooperation with External Entities
11- Agents' Stealth & Resilience
12- Friend or Foe?, Ping, Trust and Social Dynamics
13- Law, Ethics, Doctrines & Society
Societal aspects
Infrastructure, Architecture & Engineering
Stealth & Resilience
Individual & Collective Decision Making

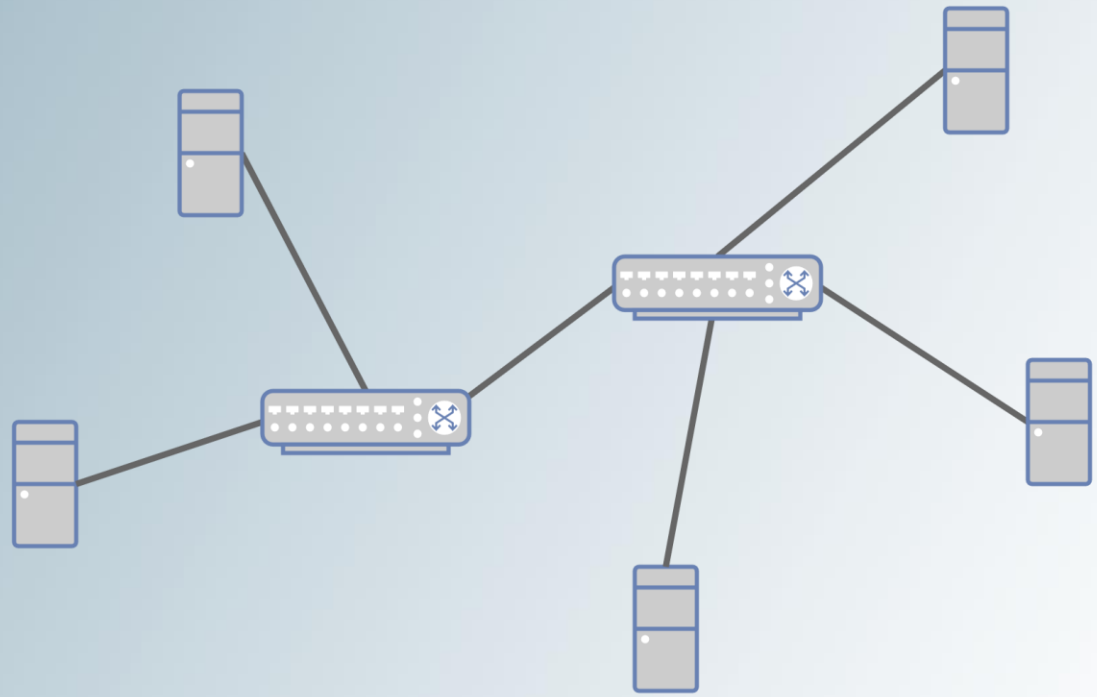
Simulation creation – deep dive

- Choose your modelling approach.
  - Discrete-event simulation, Markov processes, game theory, …
- Choose your abstraction.

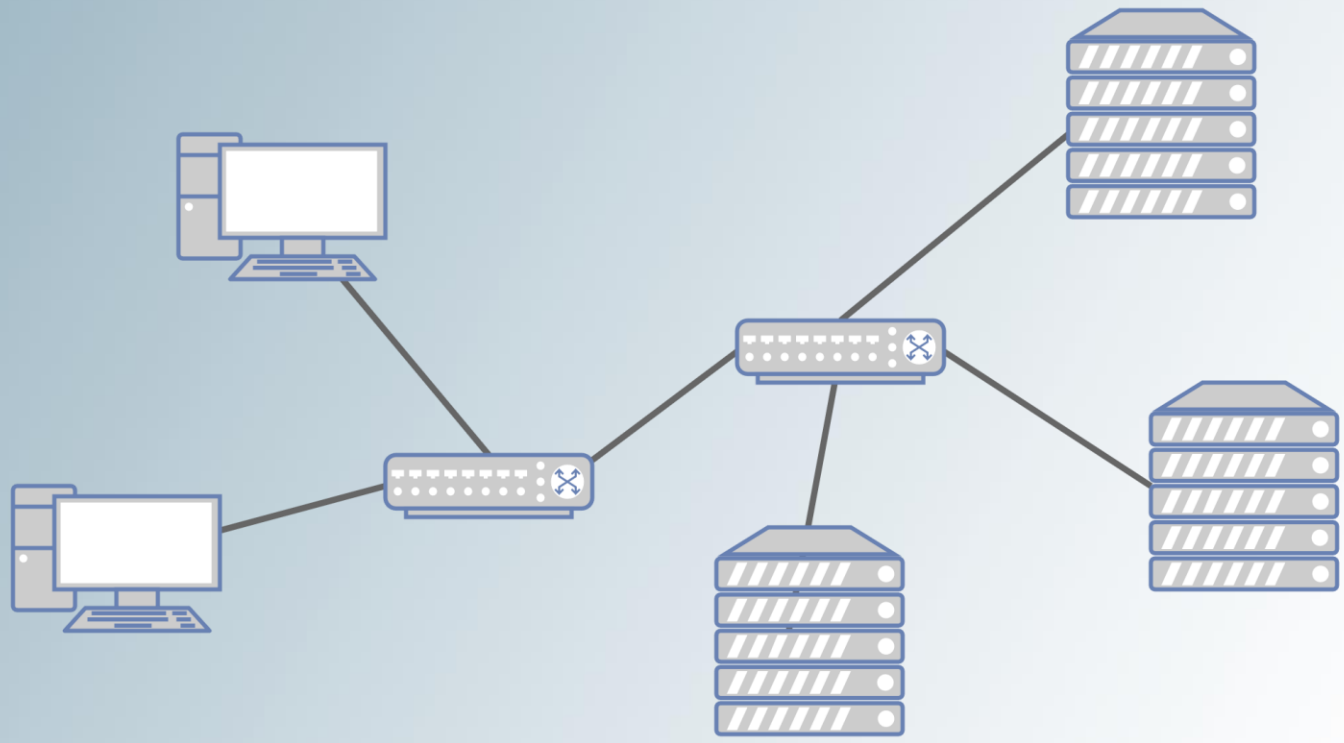
Network modelling



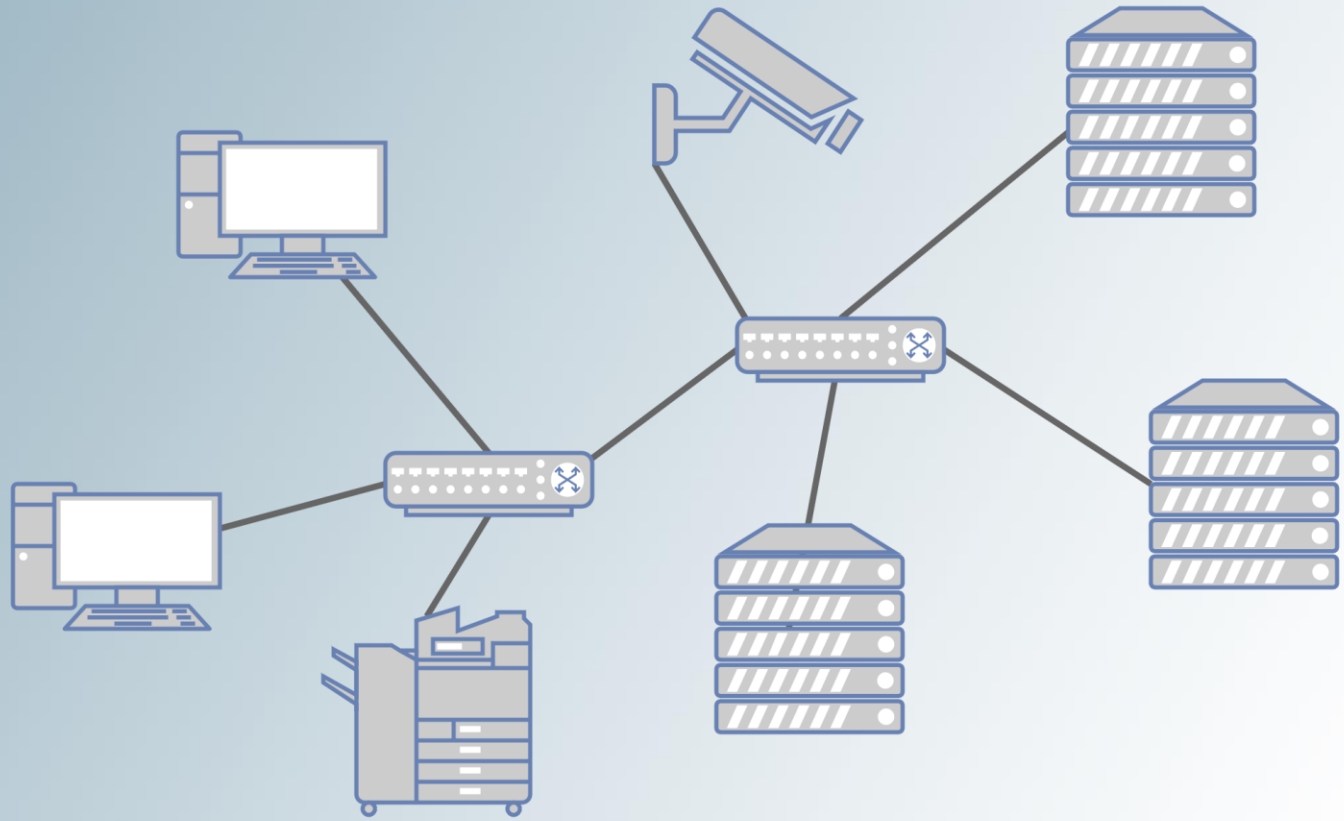
Network modelling



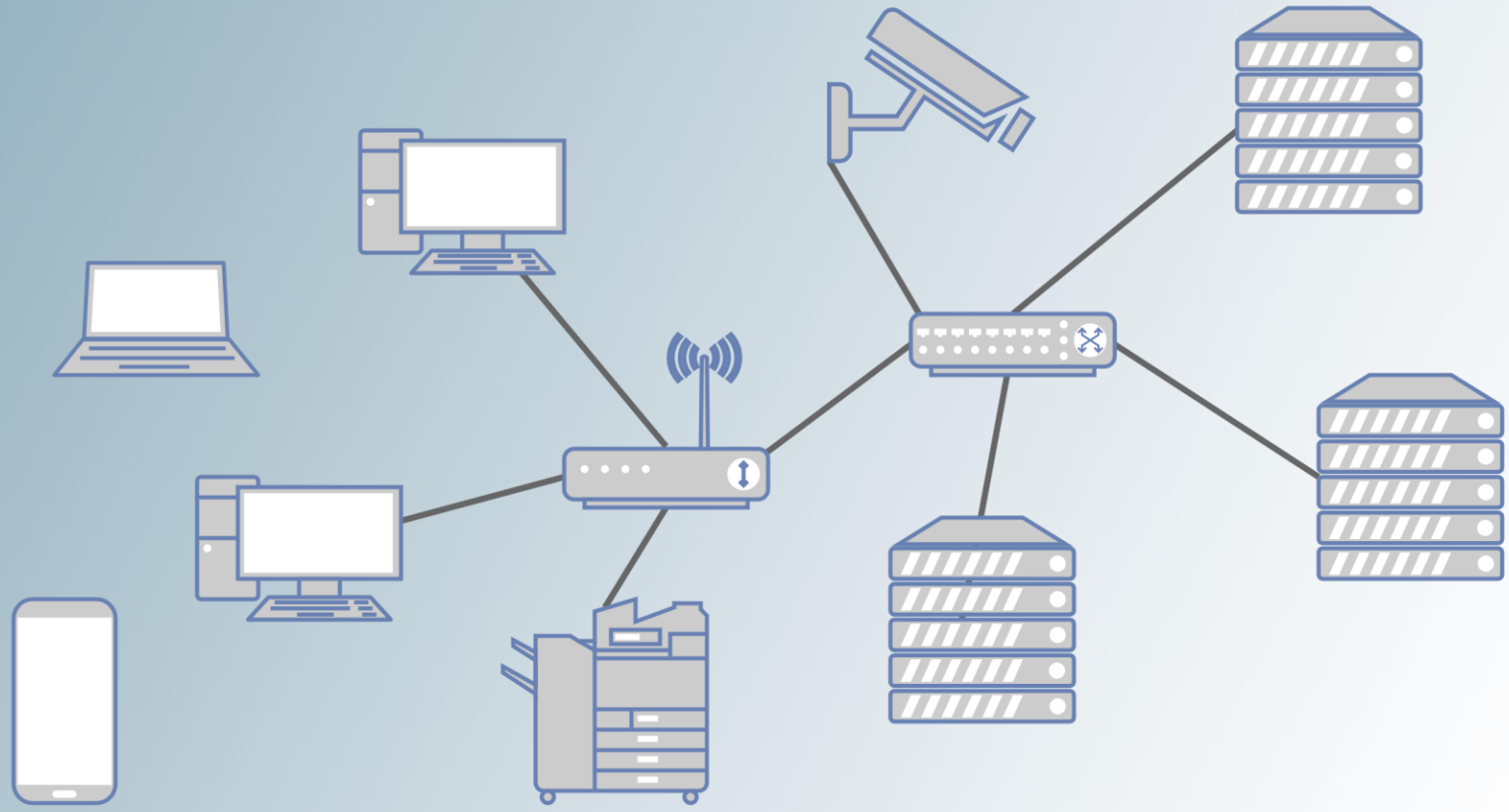
Network modelling



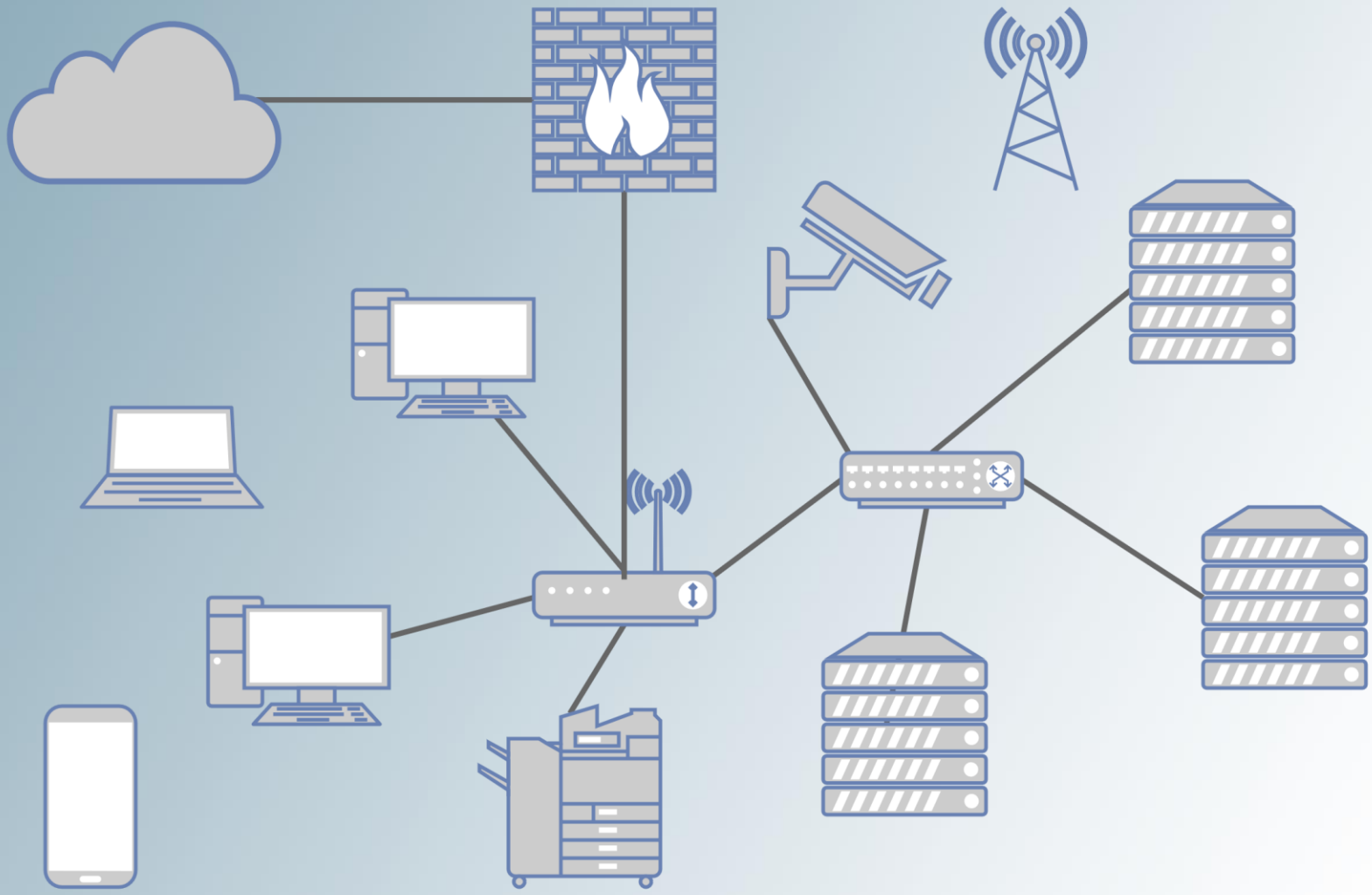
Network modelling



Network modelling



Network modelling



Host modelling

- Type
- Purpose
- Operating system
- Services
- Files
- Memory
- Buses
- Extensions

Connections modelling

- Medium (air/wire/optical/…)
- Properties (bandwidth, jitter, drops, …)
- Protocols (abstract/concrete)

User modelling

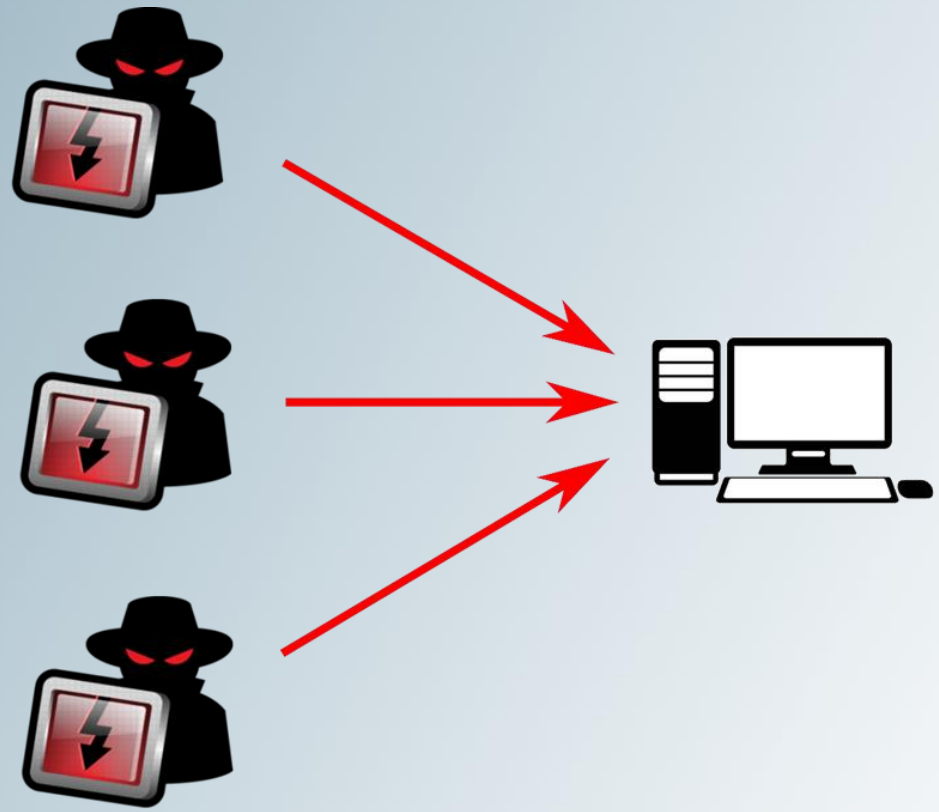
- Existence
- Identities
- Active or passive
- Traffic generation
- Activity cycles

Hundreds of considerations

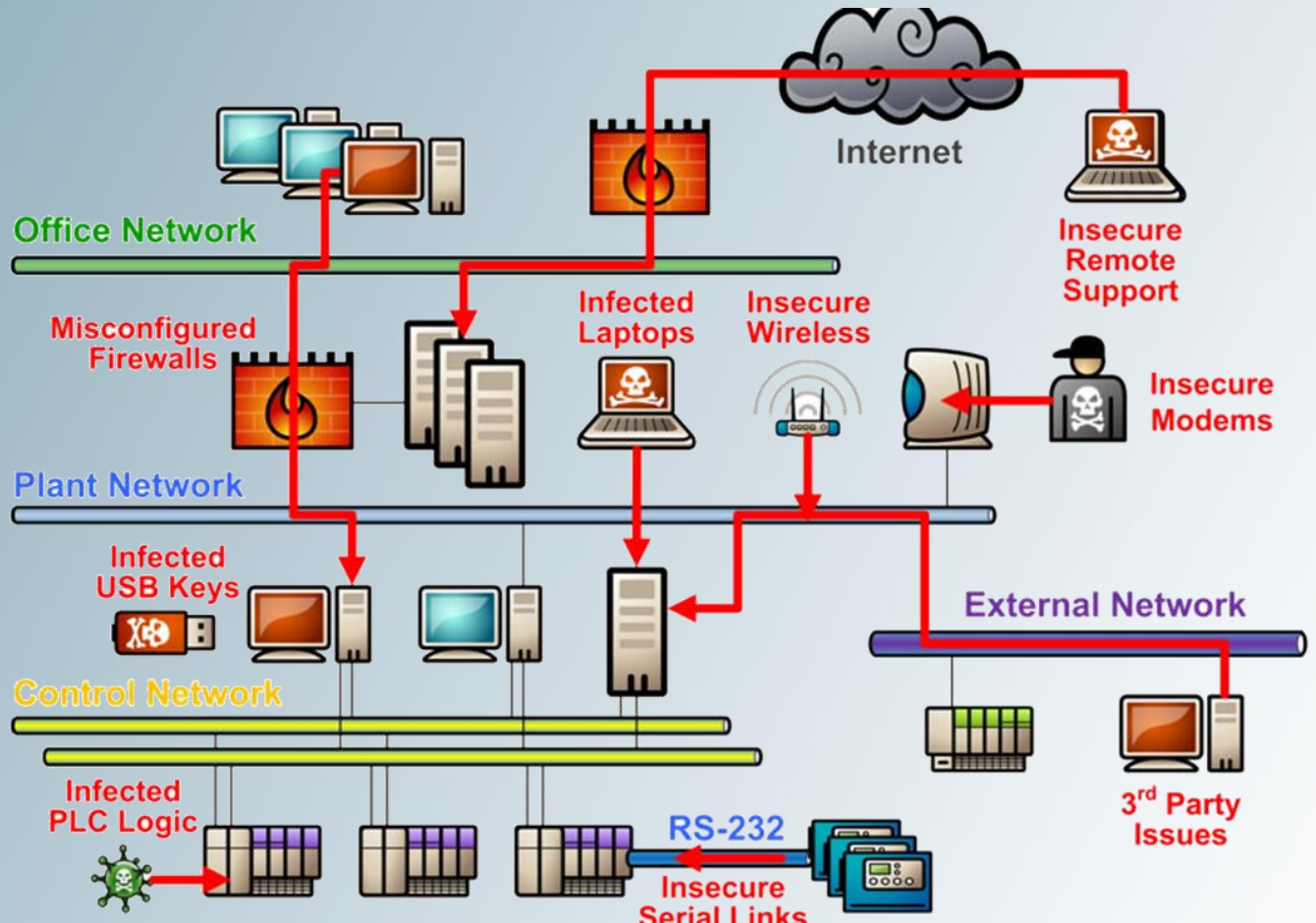
- Authentication and authorization, data handling, threats, vulnerabilities, exploits, failures, dynamics, …
- Still only the passive side
- The active side must be decided as well …

Attack modelling

Attack modelling



Attack modelling

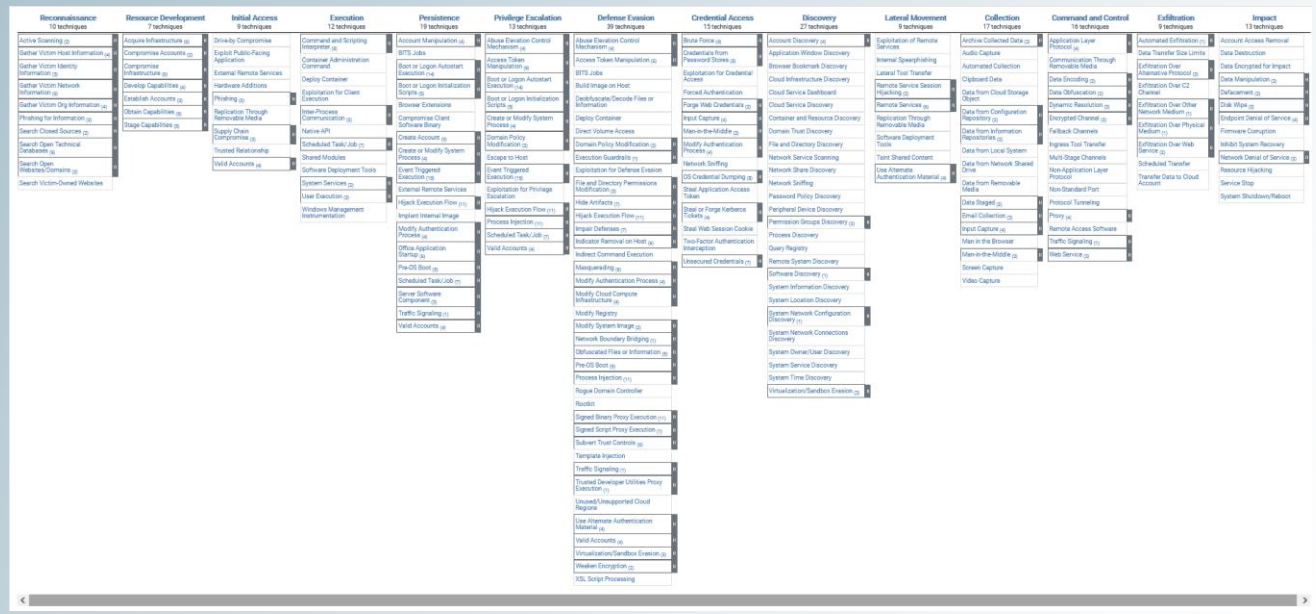


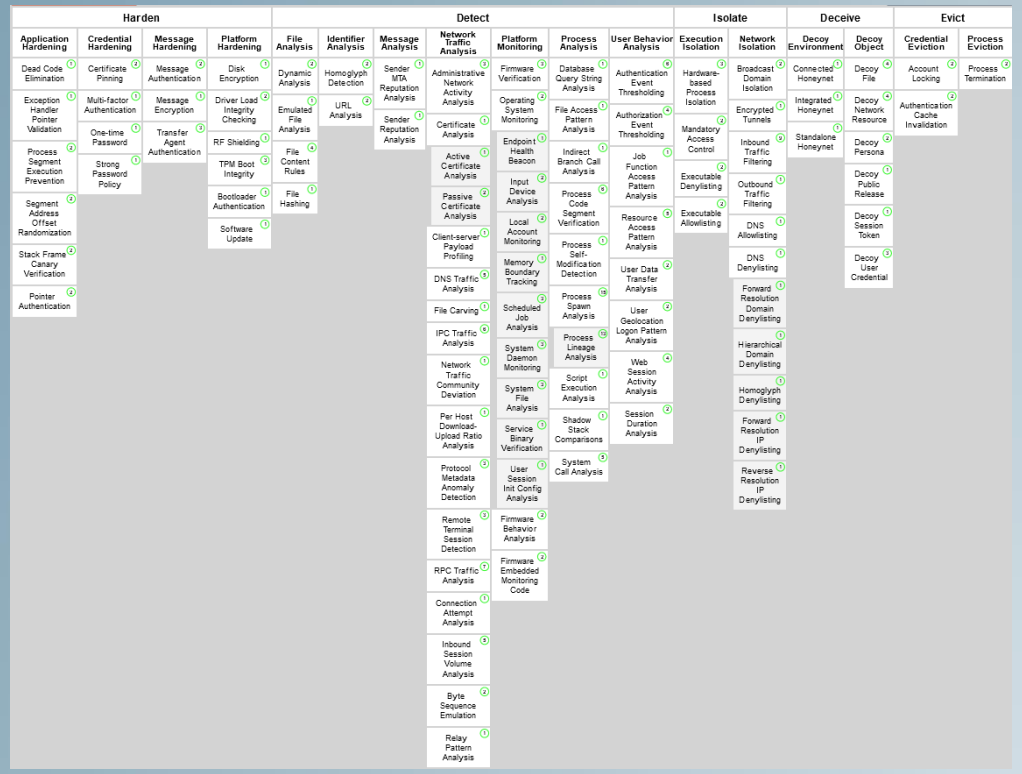
Actions and behavior

- Actions and resulting behavior depend on the simulation model
- Action must be expressible within the model

- Abstract actions?
- Attack and defense taxonomies?
- Own approach?

Attack





DEFENSE

CYST: One combination of all possible parameters

- Discrete event simulator with message passing
- Hybrid stochastic simulation
- Hosts modelled as a collection of running processes
- One type of connection with extensible properties
- Users under construction
- Complex authentication/authorization framework
- Declarative vulnerabilities mapping to CVE and others
- Exploits tied to vulnerabilities, integration of Metasploit capabilities
- Pluggable behavioral models

CYST: Functional requirements

- Simulation of multi-agent cybersecurity scenarios
- Integration with ML toolkits
- Integration and comparison of different behavioral models
- Fast prototyping of attack and defense strategies
- Integration of simulation and emulation (IDS or human in the loop)
- Deployment from simulation to emulation

CYST

- Get it, try it, break it!

- https://dl.acm.org/doi/abs/10.5555/3451906.3451908
- CODE: https://pypi.org/project/cyst-core/
- DOCS: https://muni.cz/go/cyst

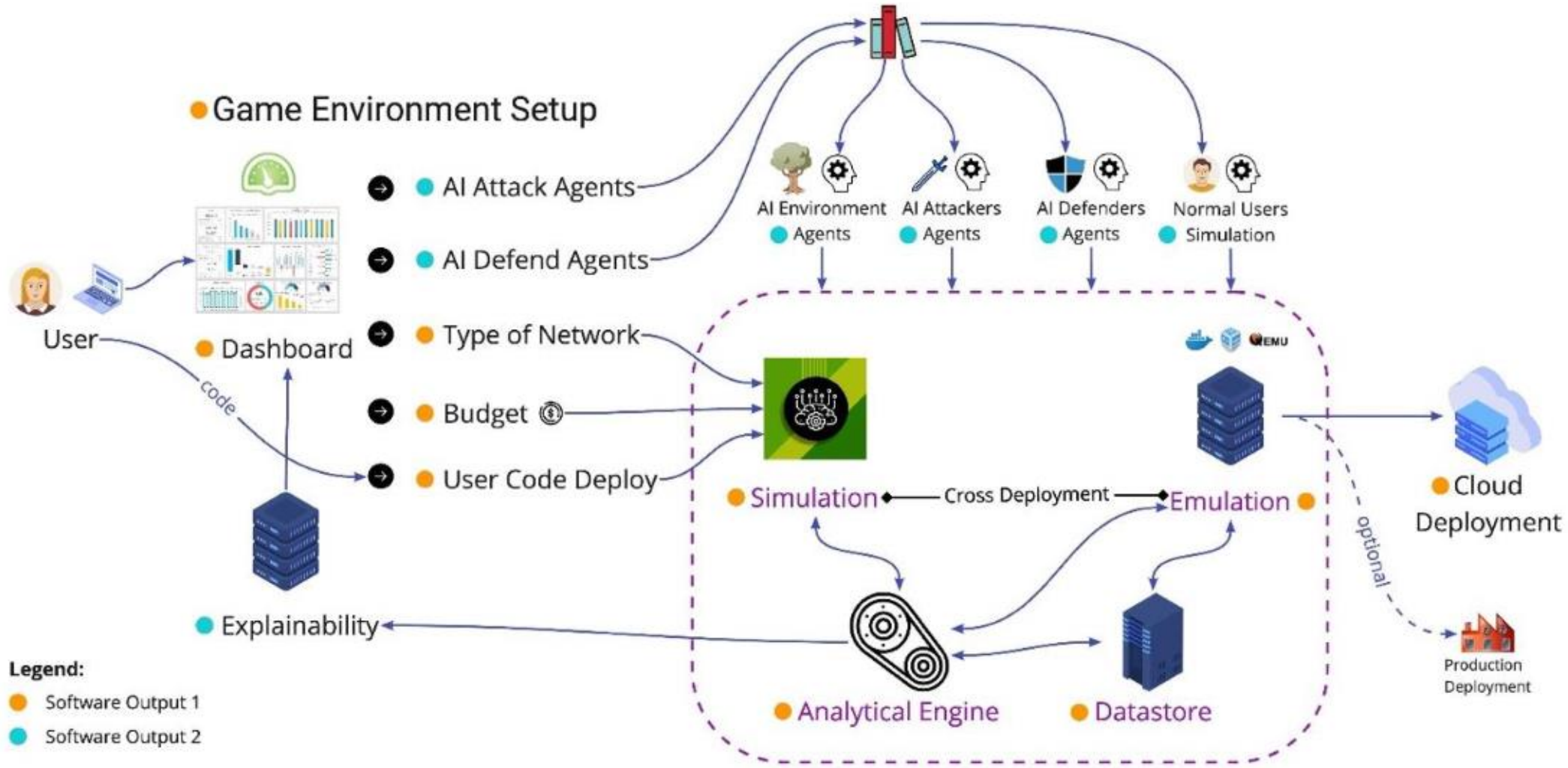
CYST – roadmap

- Parametrized generation of realistic cybersecurity scenarios
- Transformation of simulation artifacts into datasets of network traces
  - https://github.com/Trace-Share
- Multiple behavioral models
- Visualization
- Support for stealthy actions
- Support for multi-agent collaboration and communication
- Parallel training of attackers and defenders
- Transfer from simulation to emulation to the real world
  - https://beast-public.gitlab-pages.ics.muni.cz/cryton/cryton-documentation/

That’s too low level. Wake me up when it

- *can be easily deployed in cloud,*
- *can create realistic simulated and emulated scenarios,*
- *allows me to train with or against autonomous agents,*
- *provides visual analytics,*
- *has one big green button to run everything.*

AI-Dojo Software Architecture



Autonomous security

Either wait a few years

Or

Do it yourself…