Carnegie Mellon University
Software Engineering Institute

Cyber Range Research and Development

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Agenda

- Big Picture
- Our Three-Month Target

Cyber Range Research and Development

Big Picture

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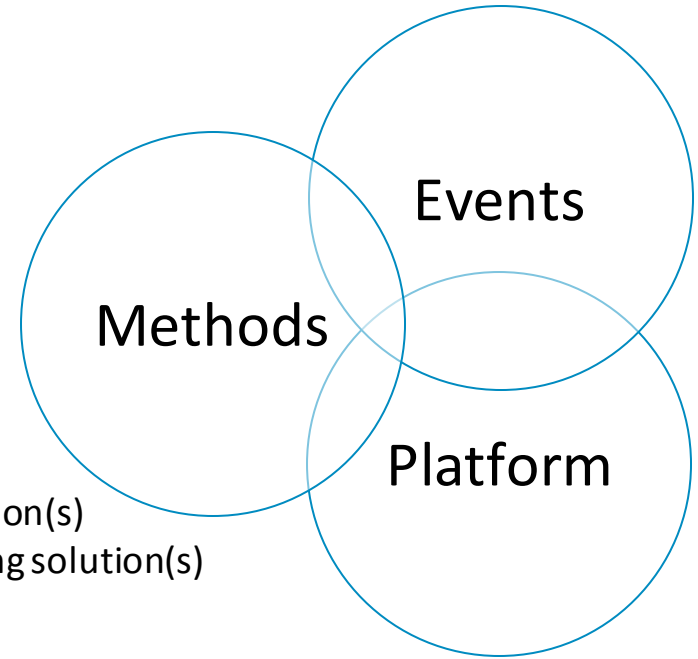
Focus

The **research and development** of **cyber-range solutions** to **operational-readiness challenges**.



Our Role

Trusted advisor:

- Framing challenge(s)
- Analyzing potential solution(s)
- Prototyping and exercising solution(s)
- Transitioning solution(s)

Decrease Costs

- Automate Creation

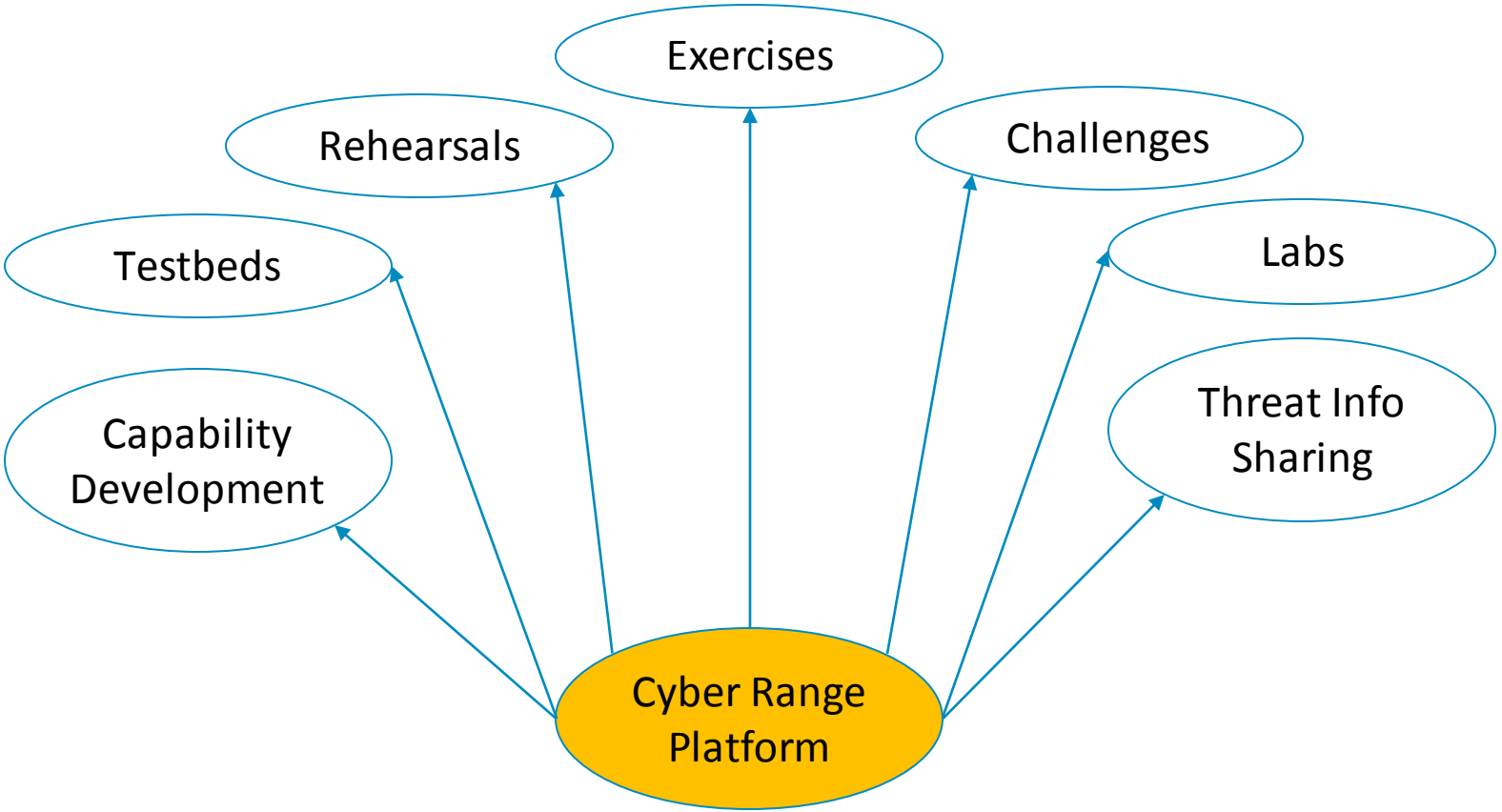
Increase Quality

- Better experiences

Increase Availability

- Maximize Access

Scope of Impact



Challenges

Achievable Using:

Modular Open System Approach
API-First Design

Open Source Software

Microservice Architecture

Agile / DevSecOps

Containerization

Everything as Code

Hypervisor Agnostic

Cyber Range Research and Development

Our Three-Month Target

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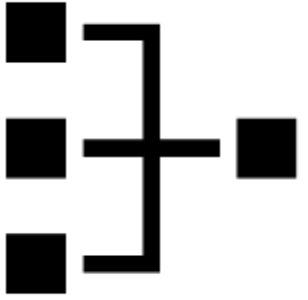
LLM / Generative AI

Scenario-Event Content

Non-Player Character
Realism / Complexity

Infrastructure-as-Code



Generating Scenario Content

- **Objective**: LLM generates scenario to achieve objectives

Line of Effort	Event Objectives	Overall Scenario	Organization & Character Profiles	Master Scenario Event List	NPC Scenario Artifacts
1a	Developer	Developer	Developer	Developer	LLM
1b	Developer	Developer	Developer	LLM	LLM
1c	Developer	Developer	LLM	LLM	LLM
1d	Developer	LLM	LLM	LLM	LLM

* Scenario content generated prior to STARTX

Generating NPC Depth

- **Objective**: LLM generates realistic NPC interactions and decisions *

Line of Effort	NPC Action	NPC Interactions	NPC Role Player Responses	NPC Responses
2a	Developer	Developer	Developer	LLM
2b	Developer	Developer	LLM	LLM
2c	Developer	LLM	LLM	LLM
2d	LLM	LLM	LLM	LLM

* based on relationships, knowledge, and beliefs animated while exercising

Generating Infrastructure-as-Code Configurations

- **Objective**: LLM generates Terraform configurations

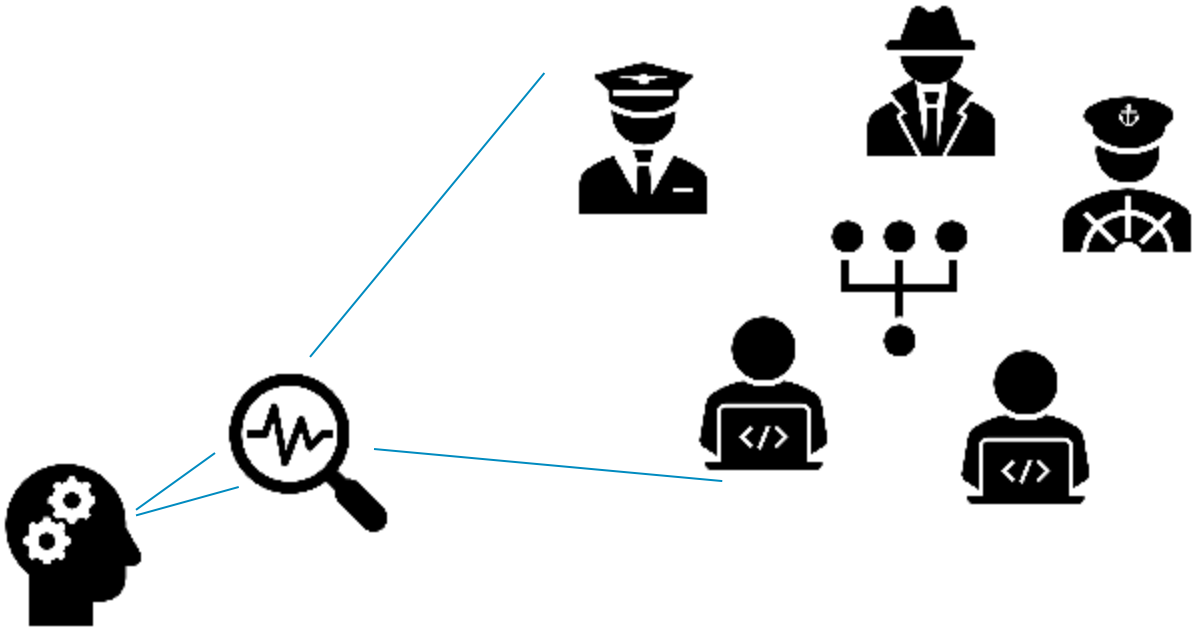
Line of Effort	Terraform Code Modification**	Terraform Module Creation*	Terraform Module Migration*	Terraform Error Code Corrections*
3a	Developer	Developer	Developer	LLM
3b	Developer	Developer	LLM	LLM
3c	Developer	LLM	LLM	LLM
3d	LLM	LLM	LLM	LLM

* Scenario content generated prior to STARTX
** Topology modifications generated during exercise

Other LLM Targets

- Optimize existing Kubernetes and Helm chart configurations
- Generate unit tests and code documentation
- Analyze code for vulnerabilities
- Automate/enhance monitoring of Kubernetes environment
- Automate creation of vulnerable web apps for training
- Create interactive phishing responses

Operational Readiness Testbeds



Key: Cost-Effective, Realistic Exercising Capabilities with/by Operators

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Go Deeper

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The “Range” Problem

Lack of ability to:

Partner on platform software development ⇨ use open-source software

Evolve platform components ⇨ use modular, API-first design

Extend the platform ⇨ integrate available open-source applications

Customize the platform ⇨ select only desired components

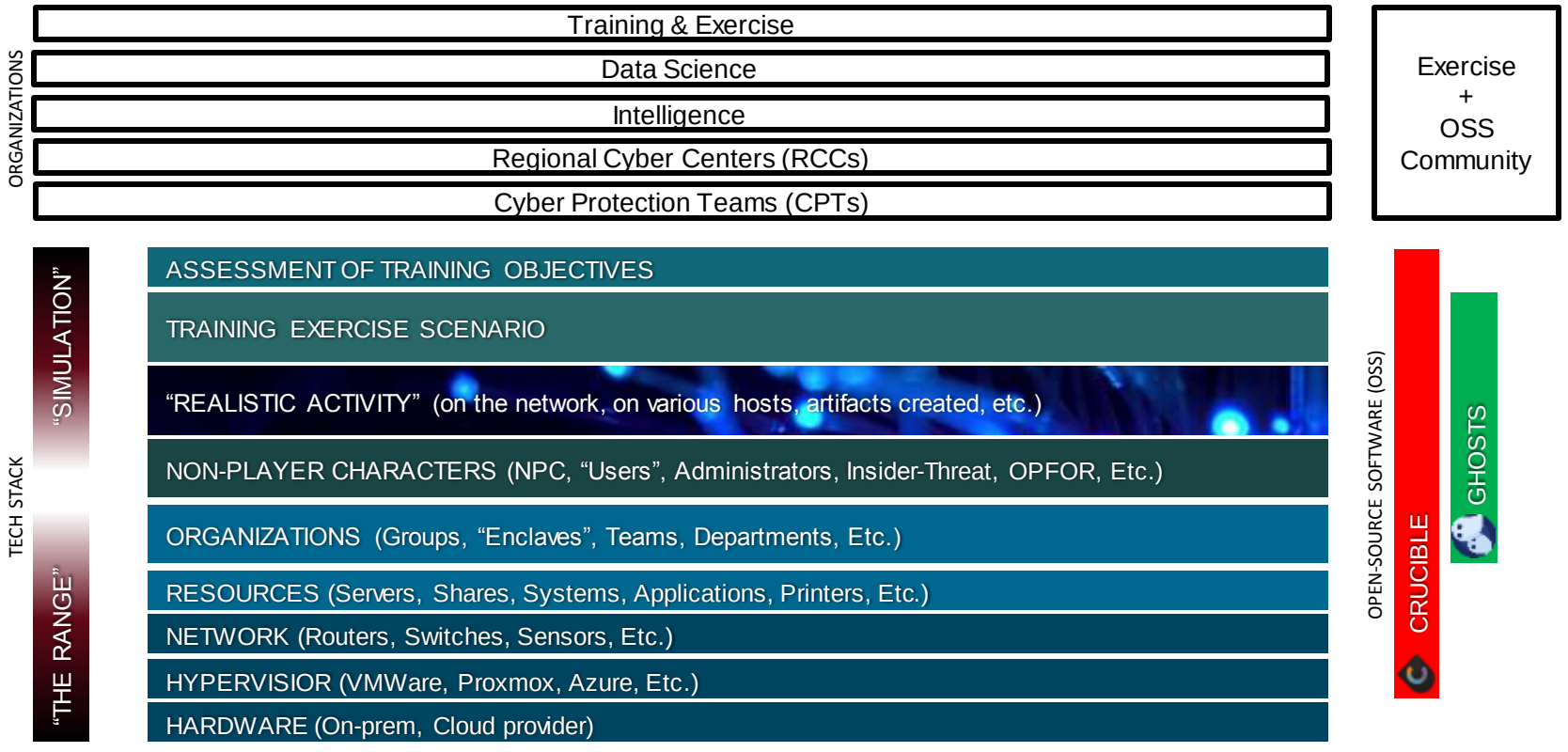
Reuse content ⇨ use Packer, Terraform, Ansible ‘infrastructure-as-code’ software

Interoperate ⇨ focus on open-standards

Deploy to different hypervisors ⇨ leverage Terraform resource providers

Share Information ⇨ adopt a federated, decentralized architecture

Cyber Range Ecosystem



Crucible

- an open-source application framework for cyber modeling and simulation
- design, deploy, and manage cyber events
- https://cmu-sei.github.io/crucible/

GHOSTS

- an open-source application framework for animating non-player characters
- design, deploy, and manage NPCs
- https://cmu-sei.github.io/GHOSTS/

VALKYRIE FRAMEWORK

- an open source suite of data science tools
- enables hunt teams to locate & identify threats hidden in network traffic
- https://github.com/cmu-sei/Valkyrie_Framework

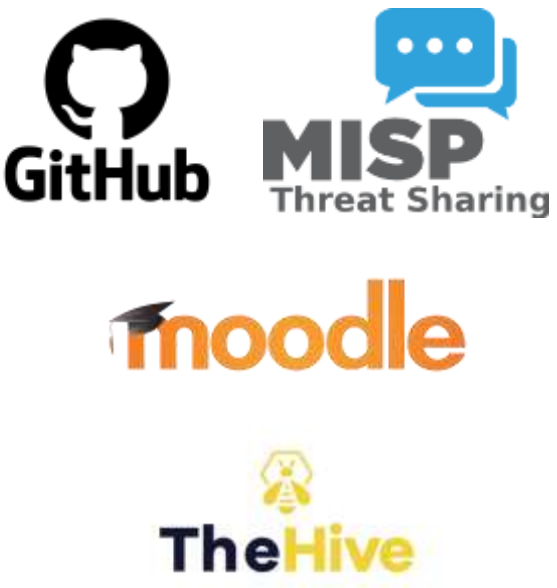
BEACON HUNTRESS

- an open-source machine-learning analytic
- identifies malicious network beacons

Cyber Range Integrations

Deployment and Configuration

Sharing and Assessment



Platform Infrastructure

Open-Source Cyber-Range Value-Proposition

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DoD prefers:

- **Control**: DoD can examine, change, use Crucible & GHOSTS for any purpose
  - **Partner Buy-In**: partners can share ownership and be fully invested
- **Training**: DoD can pay once for development of effective Crucible & GHOSTS training
  - **Cost-Effective**: Broad-access fosters broad-adoption and use
- **Security**: DoD has ability to inspect and improve Crucible & GHOSTS code
- **Stability**: DoD avoids risk of proprietary-code 'abandonment' on long-term projects
  - **Standardization**: open-standards for information sharing and capacity building
- **Community**: can produce, test, use, promote, and affect 'their' Crucible & GHOSTS
  - **Interoperability**: partners can easily cooperate with each other on using Crucible & GHOSTS