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Invite the Chaos Monkey: Test Effect Payloads for Tuning ICS Incident Response

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Changing the World's Energy Future

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CYBERCORE integration center

INVITE THE CHAOS MONKEY

TEST EFFECT PAYLOADS FOR TUNING ICS INCIDENT RESPONSE

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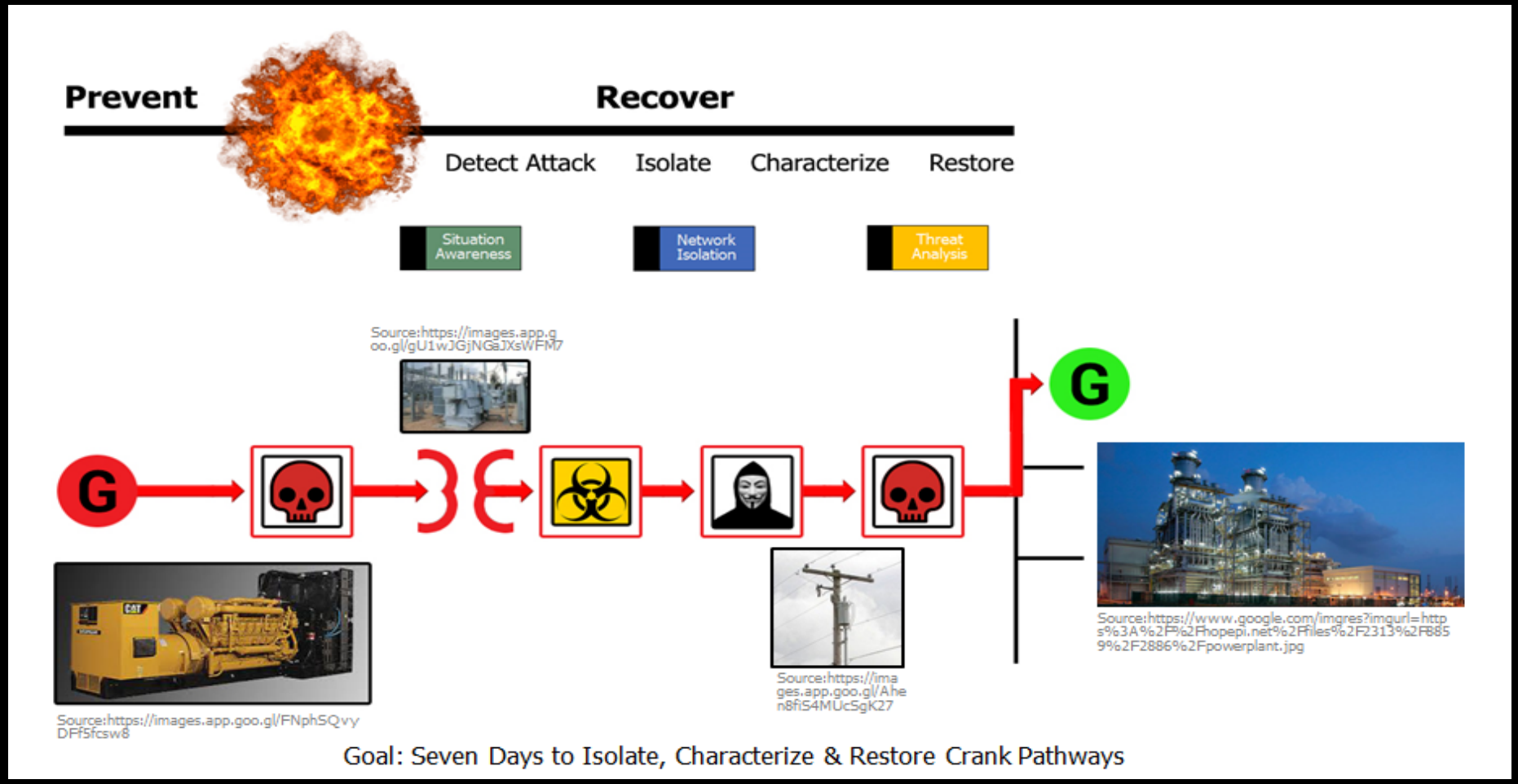
INL Idaho National Laboratory

Overview

- Summary of DARPA RADICS
- Meet the Monkeys (A history of Netflix)
- Test Effect Payloads (A DARPA RADICS Concept)
- Developing a strategy for Test Effect Payloads in Critical Infrastructure

RADICS Program Objective and Goal

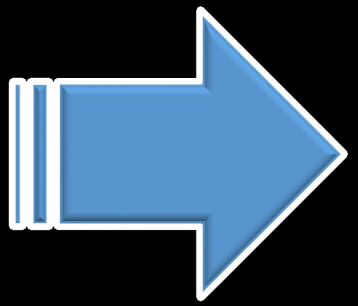
Objective: Enable black start recovery of the power grid amidst a cyber-attack on the energy sector's critical infrastructure.



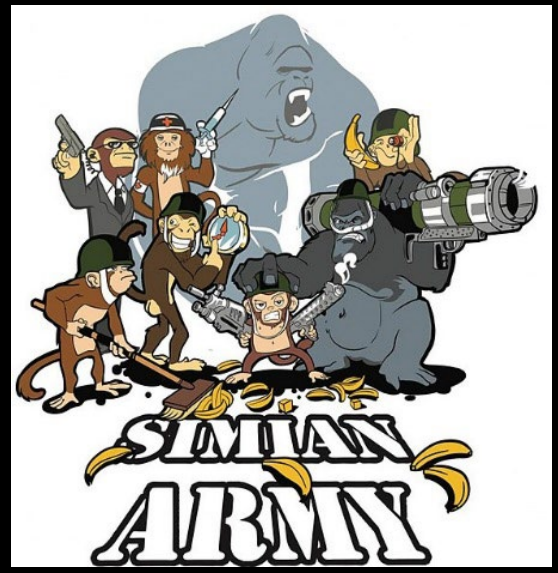
RADICS Exercise Assumptions

- Live ongoing cyber attack
  - Assets and network are owned by attacker
  - Attacker can prevent typical “Black Start” restoration
- Reflashing and restoration are not a viable solution
- Operating in manual mode is not a long-term option
- Defenders are detecting attacker tools and “reclaiming” territory

First, a Case Study in Resilience - Netflix



Meet the Monkeys



- Chaos Monkey - Instance fails
- Chaos Gorilla - Data center fails
- Latency Monkey – Introduces Lag
- Doctor Monkey – Repair “sick” instances
- Janitor Monkey – Clean up resources
- Conformity Monkey – Instance follows rules
- Security Monkey – Known vulnerabilities
- 10-18 Monkey – Internationalization
- *Others* …
- Chaos Toolkit – Toolkit for cloud

Chaos Engineering vs. Normal Testing

Chaos Monkey

- Inside business operations
- In production
- Pseudo-random
- Failure modes
- Experiments
- Enhance resilience
- Embrace failure

Normal Testing

- Outside business operations
- In development/test
- Scripted
- Requirements
- Tests
- Eliminate weaknesses
- Prevent failure

https://medium.com/netflix-techblog/the-netflix-simian-army-16e57fbab116
https://www.gremlin.com/chaos-monkey/

RADICS Exercises (Overview)

Simulate black start recovery of a crank path amidst a cyber attack on the power infrastructure to enable grid restart operations

Sounds a lot like Chaos Engineering

Chaos Engineering

- Inside business operations
- In production
- Pseudo-random
- Failure modes
- Experiments
- Enhance resilience
- Embrace failure

RADICS

✓Blackstart process

✓ Operational systems

? Scenario scripted

✓Extended regional power outage

✓Research effort

✓Recovery resilience

✓Systems compromised

Test Effect Payloads

- Realistic effects
  - Highly coupled to system
  - Operational model
  - Security model
- Avoid
  - Damage to devices
  - Unintended consequences
- Could be:
  - Misconfigurations
  - Spurious traffic
  - Executable programs

TEPS ARE NOT VULNERABILITIES

- Create observable effects on systems and networks.
  - NOT vulnerabilities or exploits
  - Presumptive access
  - Use system capabilities
- Not entire cyber kill chain
- Can represent net effect of combined attack stages
- Can represent physical effects
- Tunable for specific effects and behaviors
- Can be installed and removed through automated means
  - Automation requires development of infrastructure

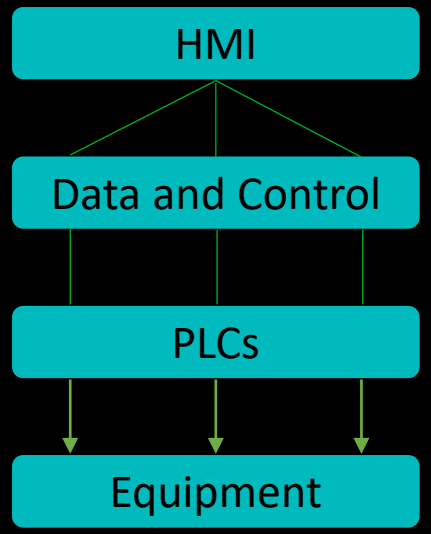
TEP Examples

- New Host on Network
  - Sends DNP3 traffic to other hosts
  - Attempts telnet sessions to other hosts
- HMI Data poisoning
  - Uses structured text
  - Change voltages reported to HMI
  - DOES NOT AFFECT REAL DATA, ONLY HMI
- Relay Misconfiguration
  - Trigger overcurrent trip

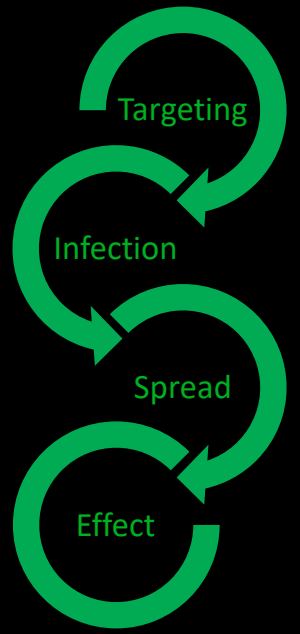
Designing a TEP Campaign

- Phase 1: Consequence-based Engineering

Define High-Consequence Outcomes



Identify Related Systems

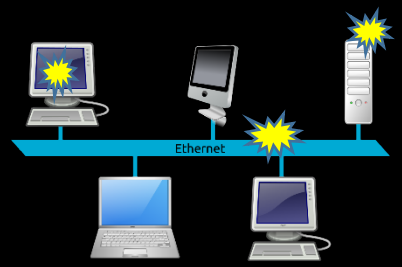


Define Kill Chain

Define Observables

Designing a TEP Campaign

- Phase 2: Design Experiment



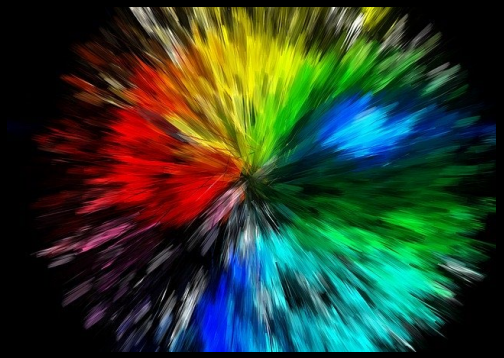
Define Expected Behaviors

Define Expected Experiment Results

Plan Experiment Elements including Automation and Timing

Designing a TEP Campaign

- Phase 3: Construct and Run Experiment



Blast Radius Analysis

Construct Test Effect Payloads

Run Experiments!

Considerations for Success

- Think small - Be exact
- Minimize blast radius
- Tune People, Processes and Tools
- Test as close to production as possible
- For high-consequence systems, consider ‘paper’ TEP’s
  - Validate with additional small-scale experiments
- For non-production environments, consider a full killchain experiment

Next Steps

- Interested in going further?
  - DARPA exhibit upstairs