MI-LXC: A Small-Scale Internet-Like Environment for Network Security Teaching

François Lesueur[1,2] (francois.lesueur@insa-lyon.fr / @FLesueur)

Camille Noûs[2] (camille.nous@cogitamus.fr / @NousCamille)

https://github.com/flesueur/mi-lxc

ETACS, August 17, 2021

[1]INSA Lyon, Département Télécommunications, Services et Usages, CITI, DynaMid

[2]Laboratoire Cogitamus

Problem Statement and Objective

- *Network* security requires a (large) network of hosts
- Creating, maintaining and distributing this large network is difficult

Core requirements

- Lightweight: Should run on students' laptops
- Maintainable: Should be manageable by a (very) small team
- Representative: Should allow to run realistic scenarios

Existing solutions

- Network-centered (GNS3, Mininet, ...) do not fit realistic services
- Docker-based (Labtainers, Kathara, ...) do not simulate whole operating systems
- VM-based cyberranges (ADLES, KYPO, ...) require large resources

MI-LXC

Mini-Internet using LXC ?

- A framework to build virtual infrastructures
  - *Infrastructure-as-code*
  - LXC containers
  - Maintainable, versionnable, SLOC-scalable, lightweight
- A reference topology simulating a *mini-internet*
  - Core services: DNS, SMTP, HTTP, ...
  - BGP routing among independent AS
  - A prerequisite to practice network/internet security
- Some security practical works (in French)
  - Certification Authorities (ACME)
  - Network intrusion
  - Network segmentation
  - IDS

A framework to build virtual infrastructures

Topology specification

Target infrastructure specification

- Global topology in *global.json*
- AS local topologies in different *local.json*
- Bash provisioning for each host

Template mechanism

- AS templates
- Host templates

A reference topology simulating a *mini-internet*

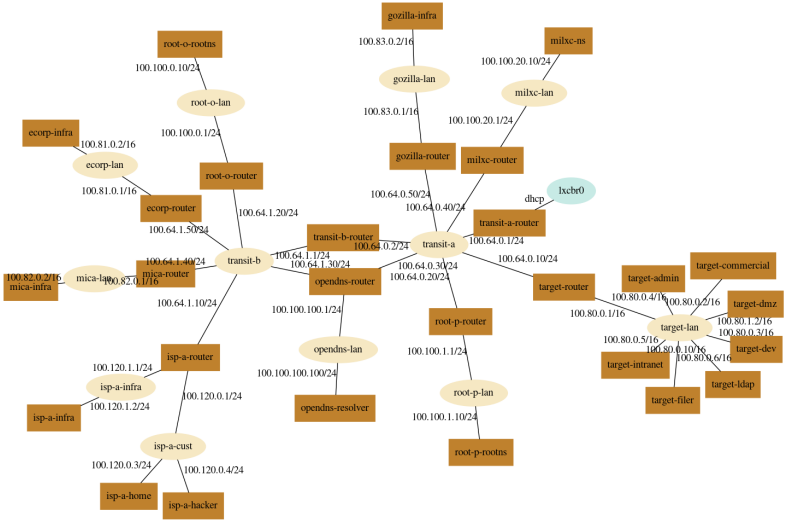
What is simulated ?

Internet roots *(personal view...)*

- Interconnection of Autonomous Systems (AS)
- Through multi-path routing (transit, peering, BGP)
- Using some standardized protocols (BGP, HTTP, SMTP, ...)
- In an orchestrated/federated organization (IANA, ICANN, IETF, ...)

Topology

- 11 AS (transit + edge)
- BGP routing
- Alternative DNS root
- An internal TLD (.milxc)
- Some DNS zone xyz.milxc
- SMTP, IMAP, HTTP
- Graphical mail clients
- Suricata, OSSEC, Prelude, SmallStep CA...



Result

Some figures

- 28 containers, 12 network bridges, 6GB HDD, 2GB RAM
- 1000 Python lines (framework), 1000 Bash lines (provisioning), 300 JSON lines (topology)

So it is...

- Versionable
- SLOC-scalable
- Lightweight
- Maintainable

Training examples

HTTPS / CA

Attack model

- HTTP connection
- BGP hijacking (or DNS, MitM)

ACME CA deployment

- CA generation (Smallstep)
- Certificate request
- CA integration in the trust store
- Browser update

Remaining risk

- Attack during the certification

What's next ?

What is working ?

- This infrastructure with 4 trainings
- Quite stable (thanks to all my students ;-))
- Licensed under AGPL: `https://github.com/flesueur/mi-lxc`

Perspectives

- New scenarios ?
- Some (legit) background noise ?
- Some other security tools (MISP, hunting) ?
- Some other network tools (netem, dynamips) ?
- Other OS (Windows via VM) ?

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