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Asset Management – Seminar

PA211 Advanced Topics of Cyber Security

September 20, 2022

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Goals of this tutorial

- Become acquainted with
  - **Asset discovery** using network scanners, IP flow, and system logs
  - Netbox **asset inventory**
  - Common Platform **Enumeration**
  - **ELK** stack and Kibana user interface

Prerequisites

Prerequisites – I

1. Run **`pa211_setup`** command on a school computer.
2. Change your working directory to the clone of repository from the previous week `https://gitlab.fi.muni.cz/cybersec/pa211/management.git`
3. Run **`git pull`**.
4. Change directory to **`dist`**. This directory should contain **`Vagrantfile`**.
5. Run **`vagrant up`**.
6. You can **log to the Kali host `student`** using credentials `kali:kali`. You may need to **login twice**.

Prerequisites – II

- Verify that all network services are accessible:
  1. **`http://localhost:8000`** for **Netbox asset inventory** (credentials are *admin:admin*),
  2. **`http://elk:5601`** for **Kibana user interface** from **student**.
- Use **port forwarding** command to access services from your host:
  1. `vagrant ssh elk -- -L 5601:localhost:5601`
  2. `vagrant ssh student -- -L 8000:localhost:8000`
- Access from your host **is faster** and **more comfortable**
  - Access the services using **`http://localhost:<port>`**
- In a case of issues, look into **docker logs** for containers

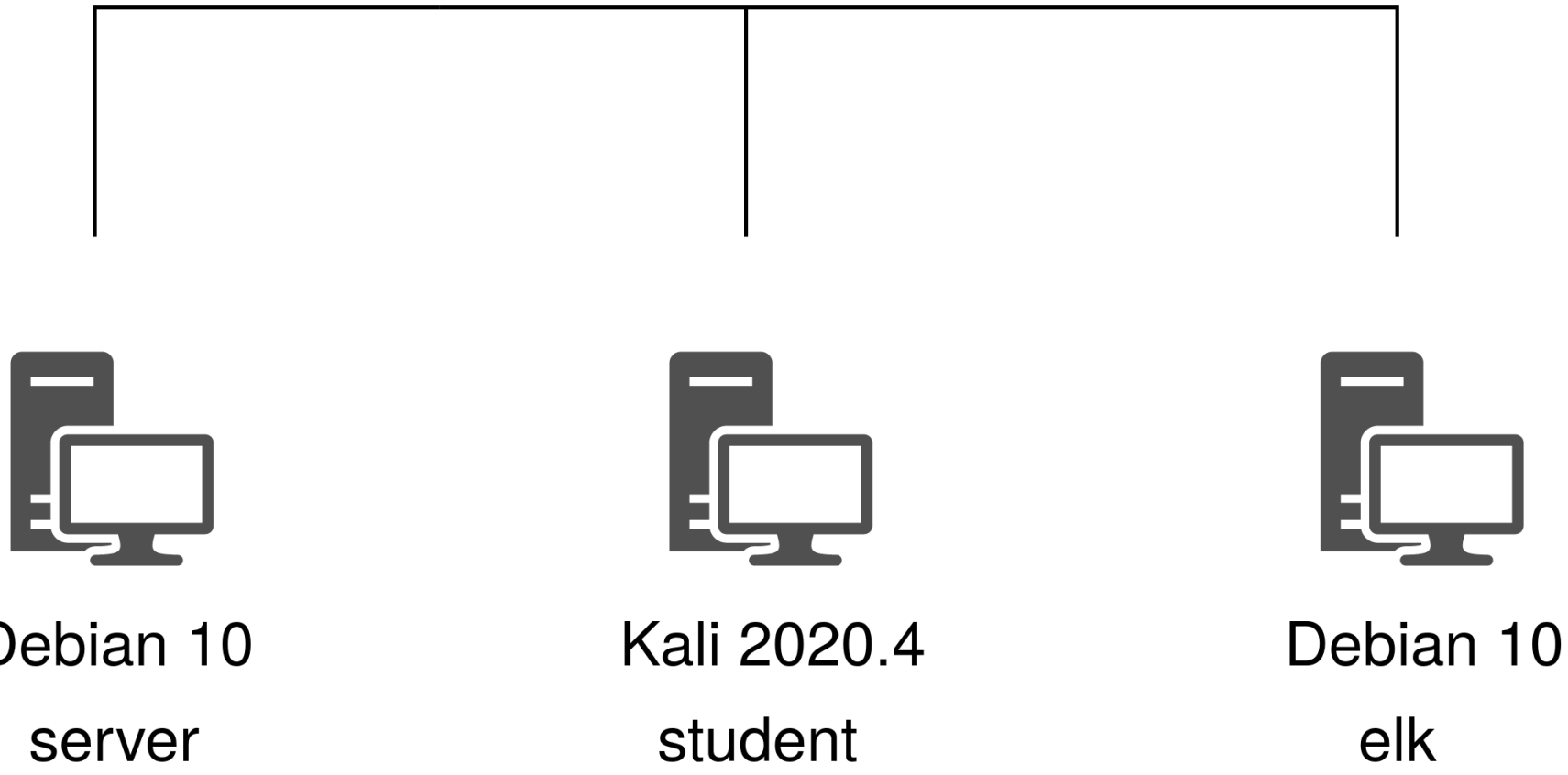
Troubleshooting – I

- **Destroy** and **create** a virtual machine:
  - `vagrant destroy <machine_name> -f`
  - `Vagrant up <machine_name>`
- **Rerun** ansible tasks, if ansible script **failed**:
  - `vagrant provision <machine_name>`
- **Start all** containers:
  - `sudo docker start $(sudo docker ps -aq)`
- **List all** (not only running) containers:
  - `sudo docker container ls -a`

Troubleshooting – II

- List **open ports** on device:
  - `sudo netstat -tulpn`
- **Check logs** of a specific **container** for issues:
  - `sudo docker logs <container_id>`

Topology



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Nmap network scanner

Task 1 – asset discovery using Nmap

IP address of your Kali machine **`student`** is **`10.1.26.23`**. Use Nmap scanner to enumerate

- **hosts in the subnet** of your PC having the same first three parts of IP address,
- their **open ports**, **network services**, and **operating systems**.

In other words, accomplish horizontal and vertical scan. Documentation is available on [1].

Solution 1

- **Several solutions**
  - `nmap 10.1.26.23/24 -sV`
  - `nmap 10.1.26.23/24 -A`
- **IP addresses**
  - `10.1.26.2 (server)`
  - `10.1.26.9 (elk)`
  - `10.1.26.23 (student)`
- **Services**
- **OS Linux**
  - For each IP address

```
└─$ nmap 10.1.26.23/24 -sV
Starting Nmap 7.92 ( https://nmap.org ) at 2022-09-16 13:38 CEST
Nmap scan report for server (10.1.26.2)
Host is up (0.00083s latency).
Not shown: 999 closed tcp ports (conn-refused)
PORT   STATE SERVICE VERSION
22/tcp open  ssh     OpenSSH 7.9p1 Debian 10+deb10u2 (protocol 2.0)
Service Info: OS: Linux; CPE: cpe:/o:linux:linux_kernel

Nmap scan report for elk (10.1.26.9)
Host is up (0.00081s latency).
Not shown: 998 closed tcp ports (conn-refused)
PORT     STATE SERVICE VERSION
22/tcp   open  ssh     OpenSSH 7.9p1 Debian 10+deb10u2 (protocol 2.0)
9200/tcp open  http    Elasticsearch REST API 7.12.1 (name: es01; clus
r-cluster; Lucene 8.8.0)
Service Info: OS: Linux; CPE: cpe:/o:linux:linux_kernel

Nmap scan report for student (10.1.26.23)
Host is up (0.00077s latency).
Not shown: 997 closed tcp ports (conn-refused)
PORT     STATE SERVICE  VERSION
22/tcp   open  ssh      OpenSSH 9.0p1 Debian 1 (protocol 2.0)
5900/tcp open  vnc      VNC (protocol 3.8)
8000/tcp open  http-alt Unit/1.27.0
```

Optional: Task 2 – asset identification

Use Nmap for **banner grabbing** and **OS fingerprinting**.

a) SSH versions from the previous task were very long. **Determine service banner of SSH service** on server (`10.1.26.2`) using appropriate Nmap's script.

b) Show results of **OS detection** using Nmap's **verbose** output option for **10.1.26.23**. Find the appropriate **TCP / IP stack fingerprint** in the output.

Optional: Solution 2 a)

- Nmap **internally** uses banner grabbing
  - `nmap --script=banner 10.1.26.2`
- Outputs from Task 1 and Task 2a) are **almost identical**

```
PORT   STATE SERVICE VERSION
22/tcp open  ssh     OpenSSH 7.9p1 Debian 10+deb10u2 (protocol 2.0)
```

```
PORT   STATE SERVICE
22/tcp open  ssh
|_banner: SSH-2.0-OpenSSH_7.9p1 Debian-10+deb10u2
```

Optional: Solution 2 b)

- Nmap **internally** uses TCP/IP **fingerprints** for **OS detection**
  - `sudo nmap -O 10.1.26.23 -vv`
- Parts of the **fingerprint** (e.g., SCAN, SEQ, WIN) are **explained** in [1]

```
OS CPE: cpe:/o:linux:linux_kernel:2.6.32
OS details: Linux 2.6.32
TCP/IP fingerprint:
OS:SCAN(V=7.91%E=4%D=9/7%OT=22%CT=1%CU=44371%PV=Y%DS=0%DC=L%G=Y%TM=63185A72
OS:%P=x86_64-pc-linux-gnu)SEQ(SP=108%GCD=1%ISR=109%TI=Z%CI=Z%II=I%TS=A)OPS(
OS:O1=MFFD7ST11NW7%O2=MFFD7ST11NW7%O3=MFFD7NNT11NW7%O4=MFFD7ST11NW7%O5=MFFD
OS:7ST11NW7%O6=MFFD7ST11)WIN(W1=FFCB%W2=FFCB%W3=FFCB%W4=FFCB%W5=FFCB%W6=FFC
OS:B)ECN(R=Y%DF=Y%T=40%W=FFD7%O=MFFD7NNSNW7%CC=Y%Q=)T1(R=Y%DF=Y%T=40%S=O%A=
OS:S+%F=AS%RD=0%Q=)T2(R=N)T3(R=N)T4(R=Y%DF=Y%T=40%W=0%S=A%A=Z%F=R%O=%RD=0%Q
OS:=)T5(R=Y%DF=Y%T=40%W=0%S=Z%A=S+%F=AR%O=%RD=0%Q=)T6(R=Y%DF=Y%T=40%W=0%S=A
OS:%A=Z%F=R%O=%RD=0%Q=)T7(R=Y%DF=Y%T=40%W=0%S=Z%A=S+%F=AR%O=%RD=0%Q=)U1(R=Y
OS:%DF=N%T=40%IPL=164%UN=0%RIPL=G%RID=G%RIPCK=G%RUCK=G%RUD=G)IE(R=Y%DFI=N%T
OS:=40%CD=S)
```


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Common Platform Enumeration

- **Describes classes** of applications, operating systems, and hardware devices

cpe:2.3:<part>:<vendor>:<product>:<version>:<update>:<edition>:<language>:<sw_edition>:<target_sw>:<target_hw>:<other>

Task 3 – CPE

Nmap can output CPE identifiers of operating systems.

a) Find **CPE match strings** present in the output of previous Nmap commands. Was there anything interesting about the **length of CPE identifiers**?

b) What CPE match string returned Nmap for Debian operating system?

Task 3 – solution

a) Nmap outputs **fields up to version** (see Solution 1)

b) String contains only ***linux_kernel*** **instead of d*ebian_linux***
   - ***Minor*** imprecisions can appear
   - We **cannot** reveal all information about OS **from the outside**

Examples from the NVD:

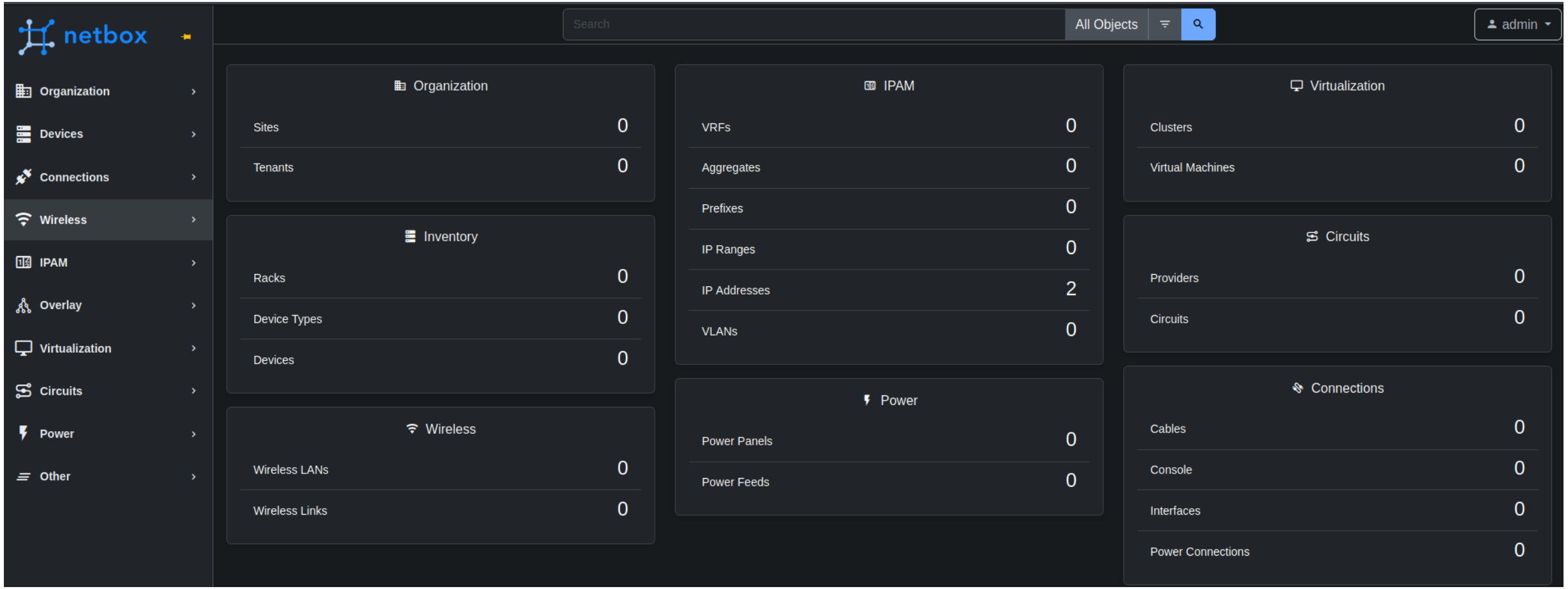
- **both** are specified as CPEs – **[1]**, **[2]**
- **other** Linux operating systems – **[3]**
- Debian **without** Linux kernel – **[4]**

Netbox asset inventory

Netbox asset inventory

- **IP address management (IPAM)**
  - planning, tracking, and managing **IP address space**
  - **Netbox**: IP addresses, prefixes, ASNs (Autonomous System Number), and other
- **Data center infrastructure management (DCIM)**
  - Manages **hardware** inside of **data centers** – energy, equipment, floor space
  - **Netbox**: devices, facilities, power consumption, and other
- Can be accessed via **REST API** and using **Python client** [1]
- **Public demo** [2], **repository** [3], and its **documentation** [4]

Netbox asset inventory – main menu



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Task 4 – IPAM

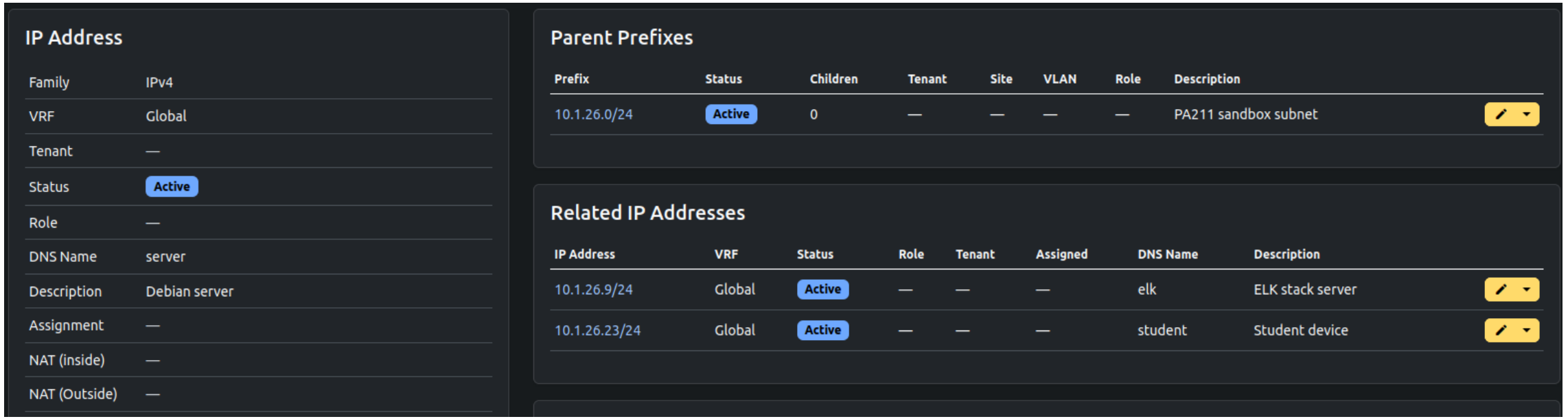
Create essential **IPAM items** in the Netbox asset inventory.

a) Fill information about hosts (**IP addresses, hostnames, prefixes**) to the asset inventory. For other fields, fill in only information that you are sure about. Otherwise, use **default options** or None value.

b) What **novel functionality** compared to an ad-hoc list of assets (e.g., Excel sheet) does the **asset inventory** provide?

Solution 4 a)

- Should be similar to **screenshots**
- **Detailed view** of `10.1.26.2/24`:



IP Address

Family	IPv4
VRF	Global
Tenant	—
Status	Active
Role	—
DNS Name	server
Description	Debian server
Assignment	—
NAT (inside)	—
NAT (Outside)	—

Parent Prefixes

Prefix	Status	Children	Tenant	Site	VLAN	Role	Description
10.1.26.0/24	Active	0	—	—	—	—	PA211 sandbox subnet

Related IP Addresses

IP Address	VRF	Status	Role	Tenant	Assigned	DNS Name	Description
10.1.26.9/24	Global	Active	—	—	—	elk	ELK stack server
10.1.26.23/24	Global	Active	—	—	—	student	Student device

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Solution 4 a), b)

- **List of IP addresses** from Task a) is in Figure
- Asset inventory **automates manual tasks**
  - **Example:** assignment of IP addresses to subnet

IP Address	VRF	Status	Role	Tenant	Assigned	DNS Name	Description
10.1.26.2/24	Global	Active	—	—	—	server	Debian server
10.1.26.9/24	Global	Active	—	—	—	elk	ELK stack server
10.1.26.23/24	Global	Active	—	—	—	student	Student device

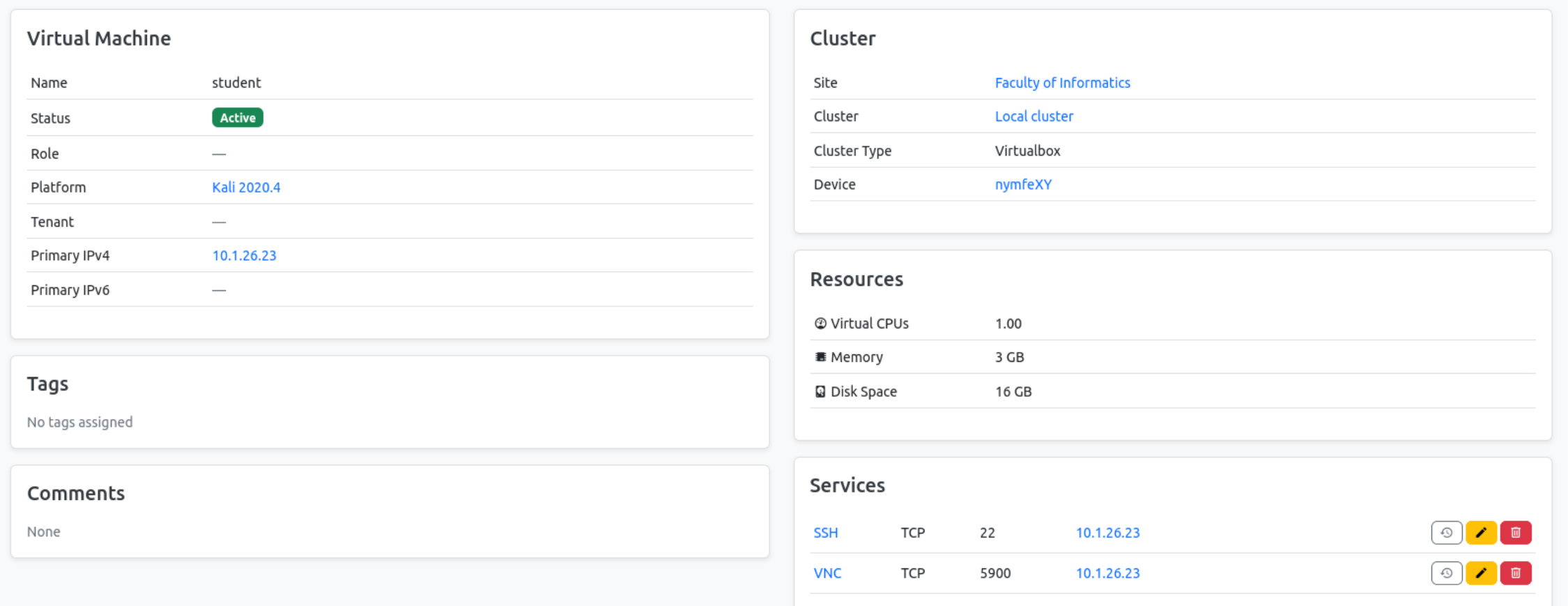
Task 5 – DCIM

Netbox provides support for **virtual machines** and **devices**.

a) Fill in necessary information about **virtual machine** `student` (**10.1.26.23**) and its **network services**.

b) Optional: How would you fill in **necessary information** about your **device** `nymfeXY`?

Solution 5 a) – virtual machine



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Solution 5 a) – interface

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Solution 5 a) – interface and services

- Assigning **IP address** to a **virtual machine**
  - **Create an interface** of a virtual machine
  - The **`ifconfig` command** reveals the network **interface** name **(`eth1`)** for `10.1.26.23`
  - An IP address is **assigned** to the interface in **IPAM part** of menu during **creation** or **editing**
  - **The form** for editing the IP address contains the section **Interface Assignment**
- Use the **custom option** for creating services

Optional: Solution b)

Netbox is much **network-centric** and we have **non-racked** device. Device will have **name** `nymfeXY`, **platform** Ubuntu 22.04, some **manufacturer** and **model**. **Site** could be Faculty of Informatics, **location** PA211's room. A lot of fields will be **empty** because we do not have **knowledge about hardware**. See **public demo** for inspiration [1].

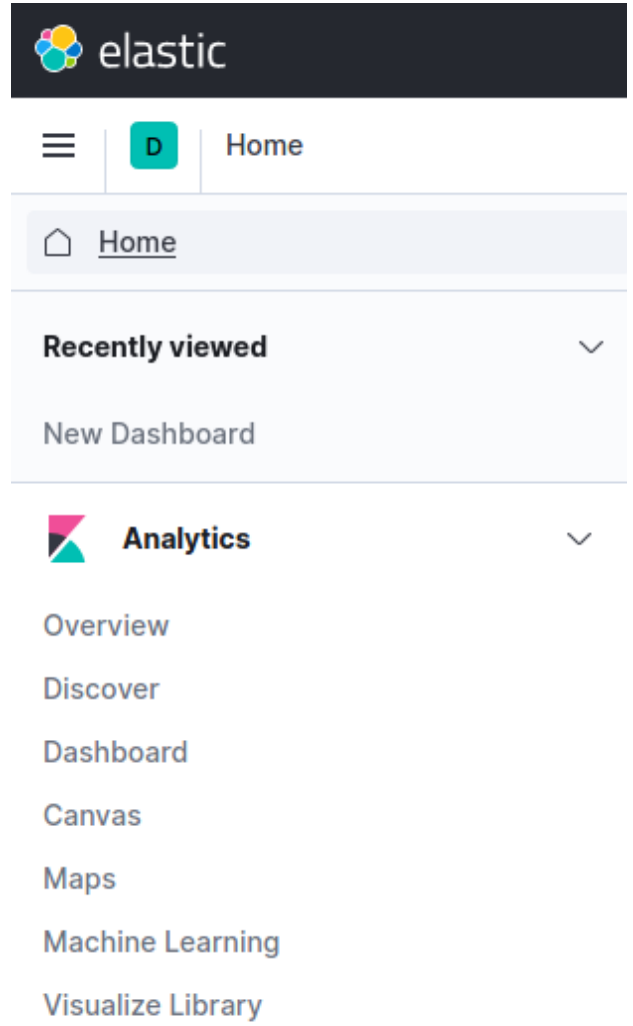
Elasticsearch and Kibana

ELK stack

- Acronym for three **open-source** projects:
  - **Elasticsearch** – RESTful **search** and analytical **engine**
  - **Kibana** – **visualizes data** from Elasticsearch
  - **Logstash** – **processing pipeline** that ingests data from multiple sources, transforms them, and sends to Elasticsearch
- **Beats** – lightweight single-purpose **data shippers**
- One of use cases is **security**
  - **Elastic SIEM** to prevent, detect, and respond to threats

Kibana – main menu

- **Quick start tutorial** for the most recent version of **Kibana** on [1]
- **Analytical** section in menu
  - **Discover** section
  - **Dashboard** section



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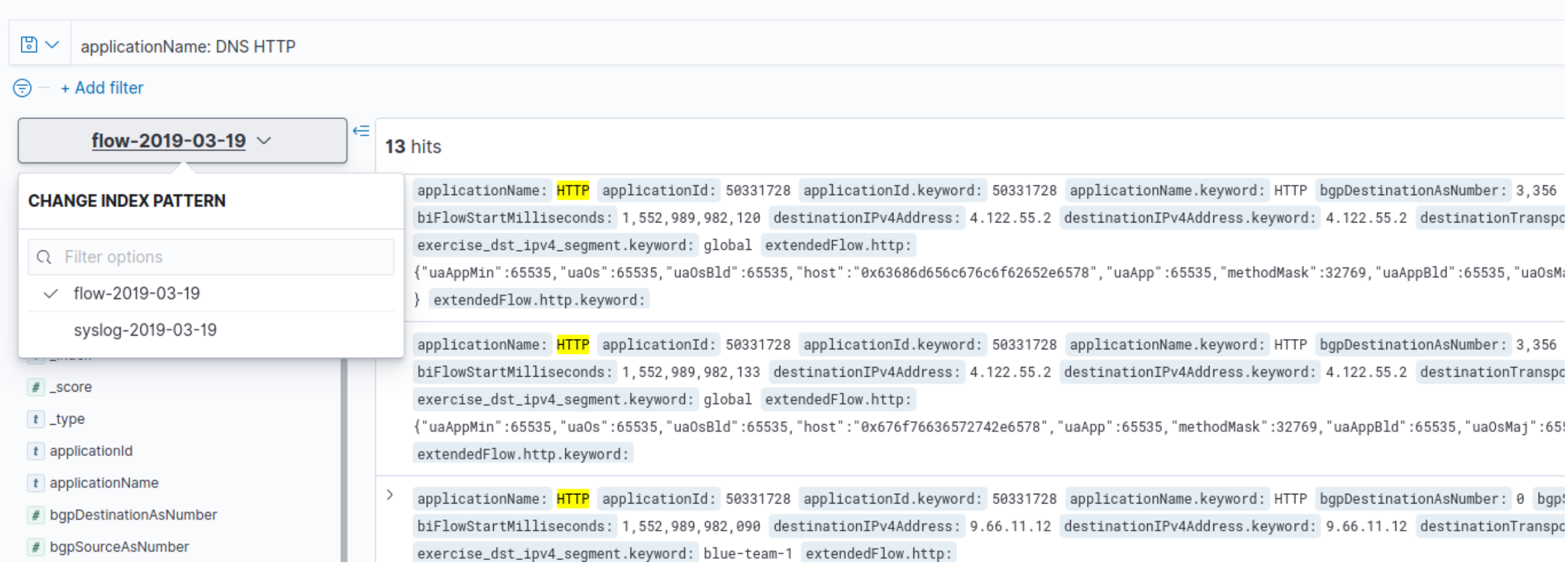
Discover section in Kibana – I



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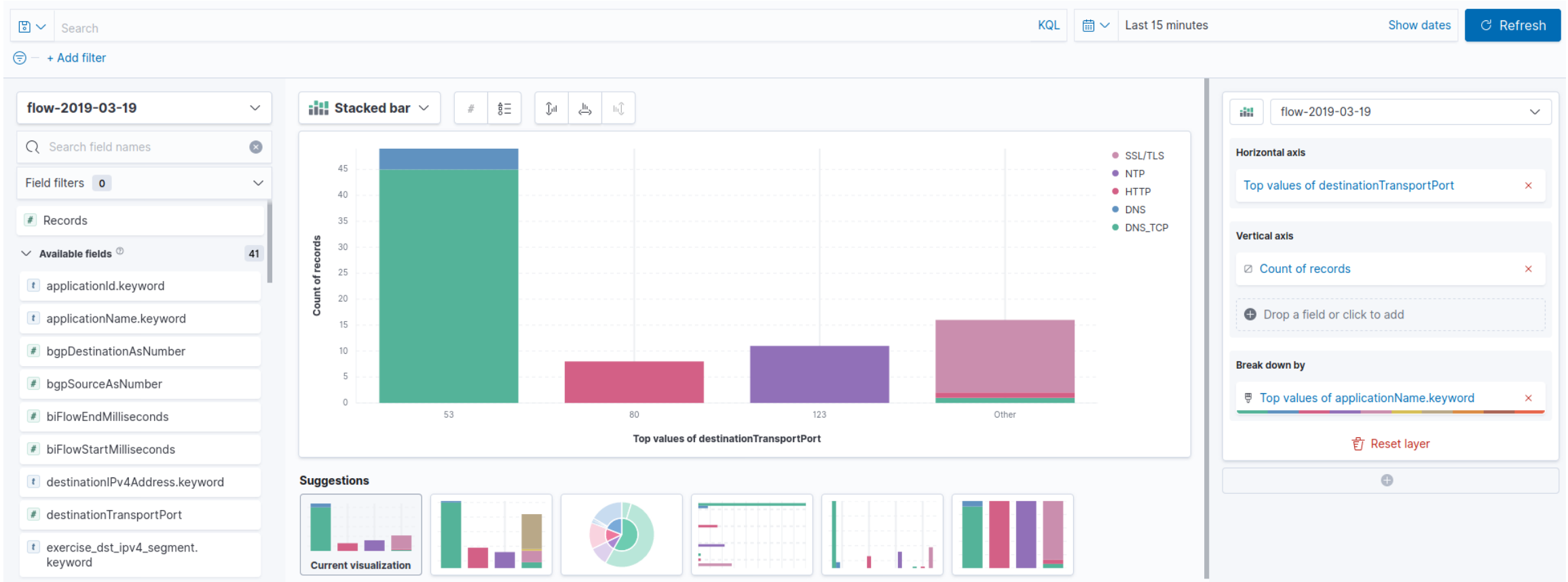
Discover section in Kibana – II

- Lists all entries in specific **index patterns**
- Uses queries in **Kibana Query Language (KQL)**
- **KQL**
  - Data **field name** is followed by **:** and **values separated by spaces**
  - Other parts can be added using **and** / **or keywords**
  - Kibana **automatically suggests** options for your query

Dashboard in Kibana – I

- **Lens** – dashboard panel **recommended** for most users
- Provides several **chart types**
- Possibility to **correlate several fields** in one chart
- **Video tutorial** about Kibana Lens by Elastic **[1]**
- Lens panel **can be saved** and modified later

Dashboard in Kibana – II



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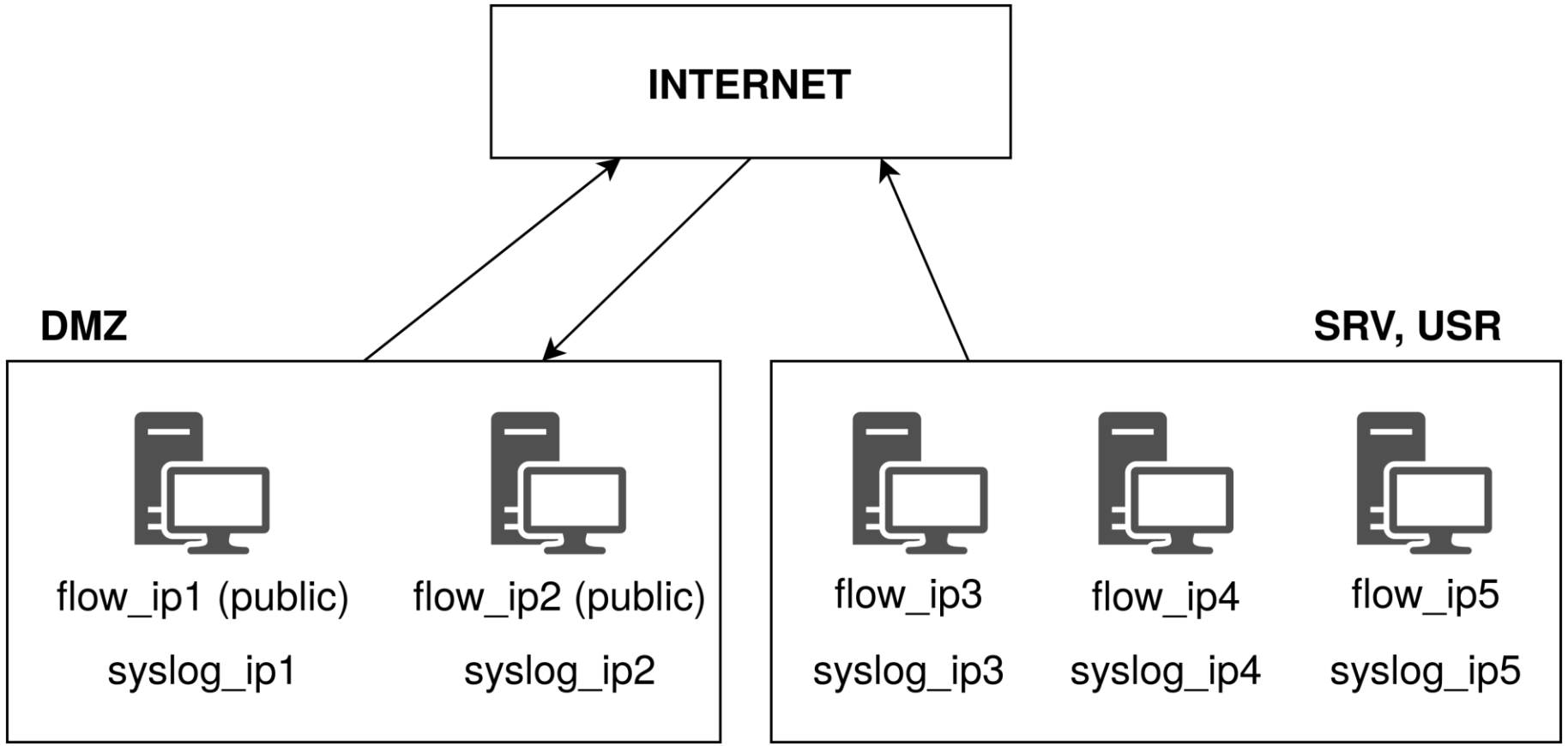
Task 6 – multiple data sources (description)

- Your network subnet contains **5 devices**
- Identify their properties using captured **IP flow** and **syslog** dataset
- **IP flow dataset**
  - Source and destination **IP addresses** and **ports**
  - Protocol, timestamp, and other information
- **Syslog dataset**
  - Host IP
  - Hostname
  - Timestamp and other information

Task 6 – topology



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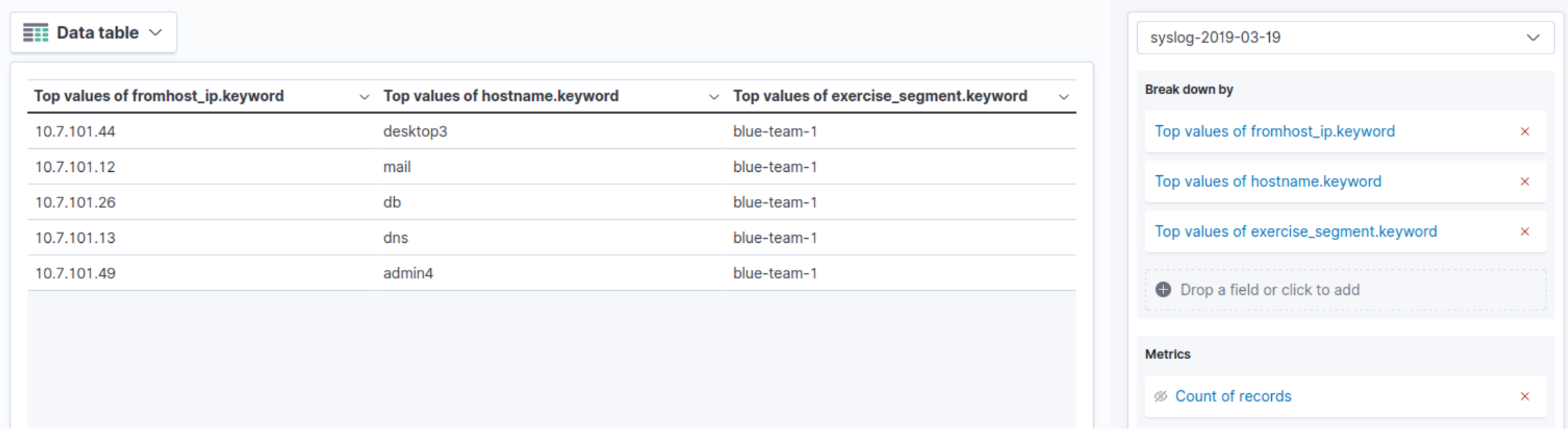
Task 6 – IP addresses

a) Determine IP addresses from **syslog dataset** for each device. Add only their **IP addresses, hostnames,** and **name of** /24 network **subnet** to the inventory.

b) IP flow dataset contains **different IP addresses** than syslog dataset. **Determine** two **IP addresses** of devices from DMZ zone and the other three IP addresses. **Hint: arrows** in Figure containing topology denote **direction of communication** captured in **IP flow** dataset.

Solution 6 a)



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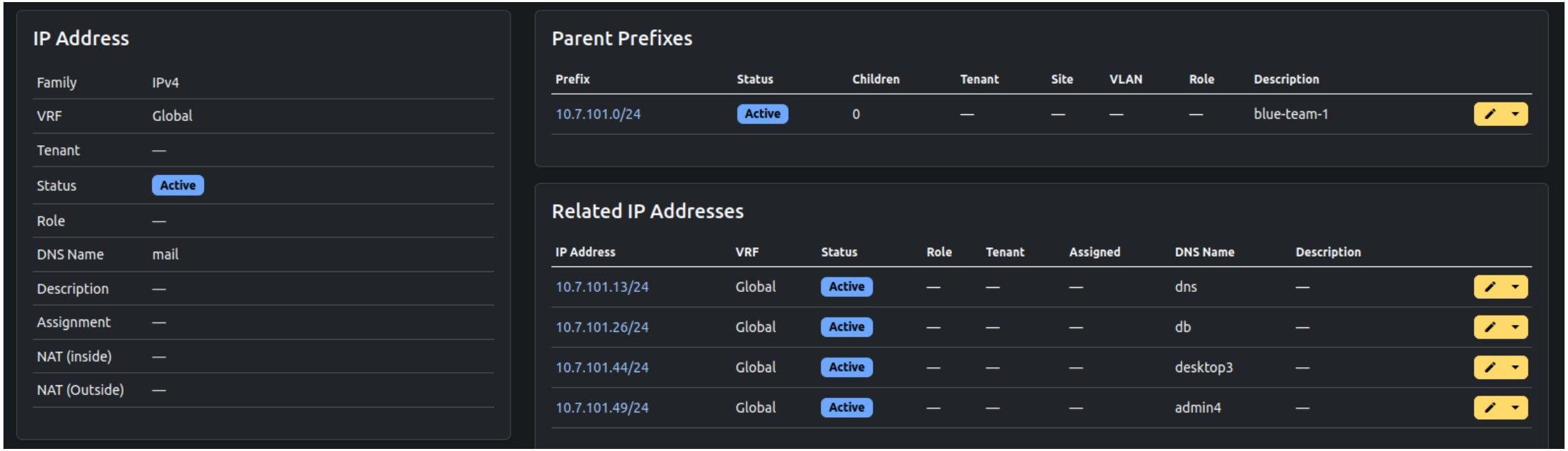
Solution 6 a)



IP Address

Family	IPv4
VRF	Global
Tenant	—
Status	Active
Role	—
DNS Name	mail
Description	—
Assignment	—
NAT (inside)	—
NAT (Outside)	—

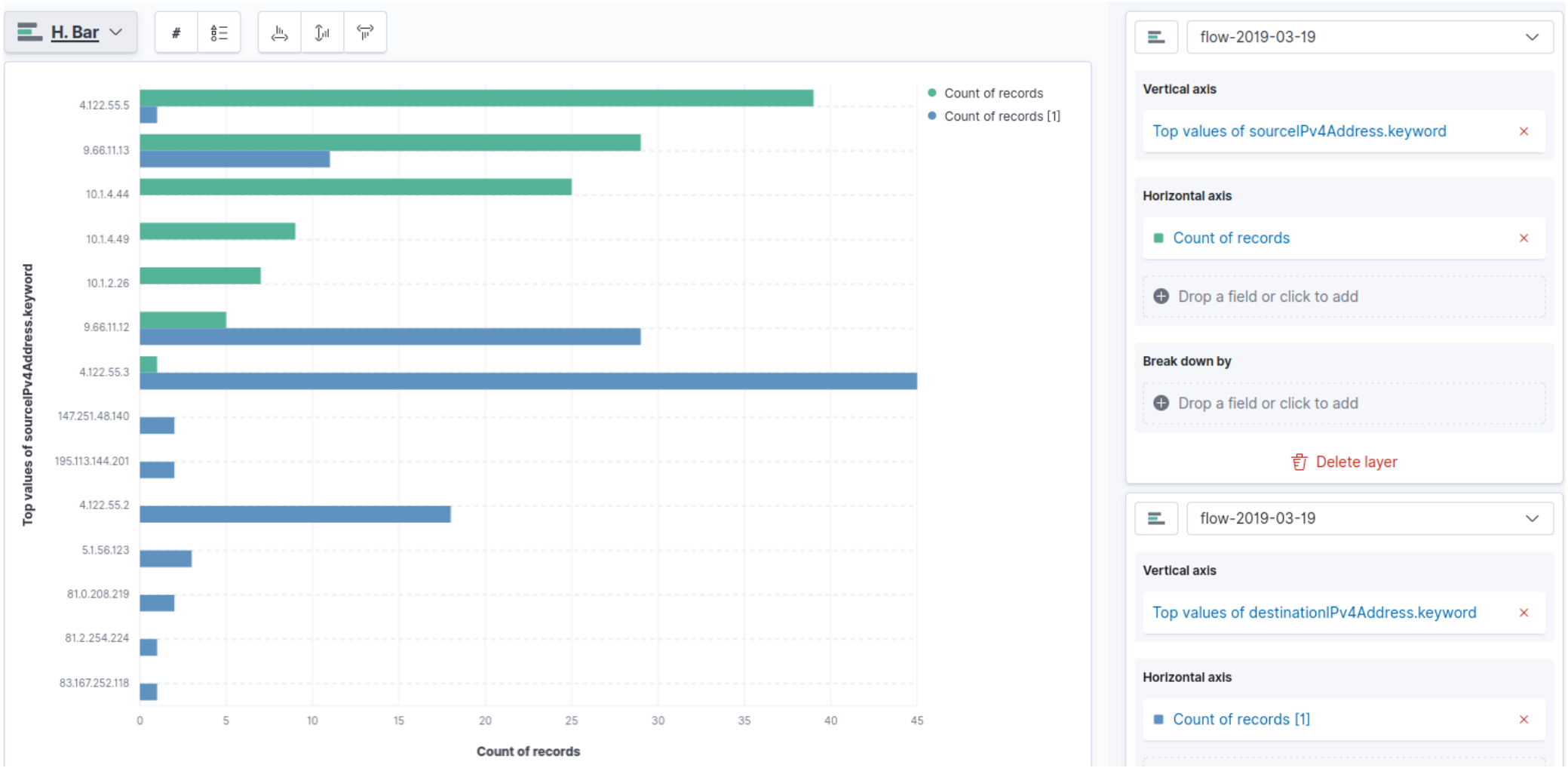
Parent Prefixes

Prefix	Status	Children	Tenant	Site	VLAN	Role	Description
10.7.101.0/24	Active	0	—	—	—	—	blue-team-1

Related IP Addresses

IP Address	VRF	Status	Role	Tenant	Assigned	DNS Name	Description
10.7.101.13/24	Global	Active	—	—	—	dns	—
10.7.101.26/24	Global	Active	—	—	—	db	—
10.7.101.44/24	Global	Active	—	—	—	desktop3	—
10.7.101.49/24	Global	Active	—	—	—	admin4	—

Solution 6 b) – I



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Solution 6 b) – II

- Consider the **direction** of communication
- **Two** devices from DMZ can be **sources** and **destinations** of communication
- **Three** devices from SRV and USR are **only sources** of communication
- Source IP addresses contain **three groups** based on **prefixes**
  - `4.122.55.5, 4.122.55.3`
  - `9.66.11.12, 9.66.11.13`
  - `10.1.4.26, 10.1.4.44, 10.1.4.49`

Solution 6 b) – III

- **Only the third** group does not contain **destination IP addresses**
- The **first** and the **second** group contain **also destination** addresses
- **Destination** IP addresses contain the address **`4.122.55.2`**
  - It has the **same prefix** as the **first** group
- **DMZ zone** contains only **two** devices
  - Its **IP addresses** belong to the **second** group
- **DMZ IP addresses:** `9.66.11.12, 9.66.11.13`
- **SRV, USR IP addresses:** `10.1.4.26, 10.1.4.44, 10.1.4.49`

Task 7 – merging data

a) For two devices from **demilitarized zone**, determine their **public IP address** from IP flow dataset and **IP address from syslog dataset** according to the most relevant **ports, service names,** or **function** in the network.

b) **Optional:** Store both IP addresses in Netbox using NAT (Network Address Translation).

c) **Optional:** You obtained **alert about incident** from some IP address. The asset inventory directly provides contact to device's owner. What other sources of data would you use if you do not have asset inventory?

Solution 7 a) – I

- **Query:**
  - `destinationIPv4Address : 9.66.11.12 or destinationIPv4Address : 9.66.11.13`
- **Destination ports**:
  - `9.66.11.13` mainly 53,
  - `9.66.11.12` uses mainly ports for transmission of emails [1]
- **Hostnames** from syslog: `mail, dns, db, desktop3, admin4`
- Possible to use also **application names** and **messages** from syslog

Solution 7 a) – II

- **Results:**
  - `10.7.101.12` and `9.66.11.12`, **hostname:** `mail`
  - `10.7.101.13` and `9.66.11.13`, **hostname**: `dns`

Optional: Solution 7 b)

IP Address	VRF	Status	Role	Tenant	Assigned	DNS Name	Description	NAT (Inside)	NAT (Outside)
9.66.11.12/24	Global	Active	—	—	—	mail	—	10.7.101.12/24	—
9.66.11.13/24	Global	Active	—	—	—	dns	—	10.7.101.13/24	—
10.7.101.12/24	Global	Active	—	—	—	mail	—	—	9.66.11.12/24
10.7.101.13/24	Global	Active	—	—	—	dns	—	—	9.66.11.13/24
10.7.101.26/24	Global	Active	—	—	—	db	—	—	—
10.7.101.44/24	Global	Active	—	—	—	desktop3	—	—	—
10.7.101.49/24	Global	Active	—	—	—	admin4	—	—	—

Optional: Solution 7 c)

- Asset inventory provides all information for **quick access**
- Example source are **authentication logs**
  - Contain **IP address** and **login name**
  - Login names must be **unified**, e.g., **UČO** for **eduroam**

How was it today?

Please fill in an **anonymous** exit ticket:

https://muni.cz/go/pa211-22-02

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