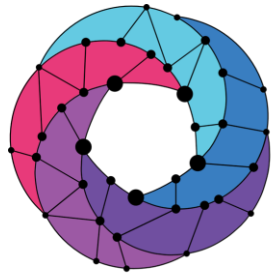

Open Source MANO by ETSI

Leveraging OSM virtual networking in Kubernetes clusters

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Key Takeaways

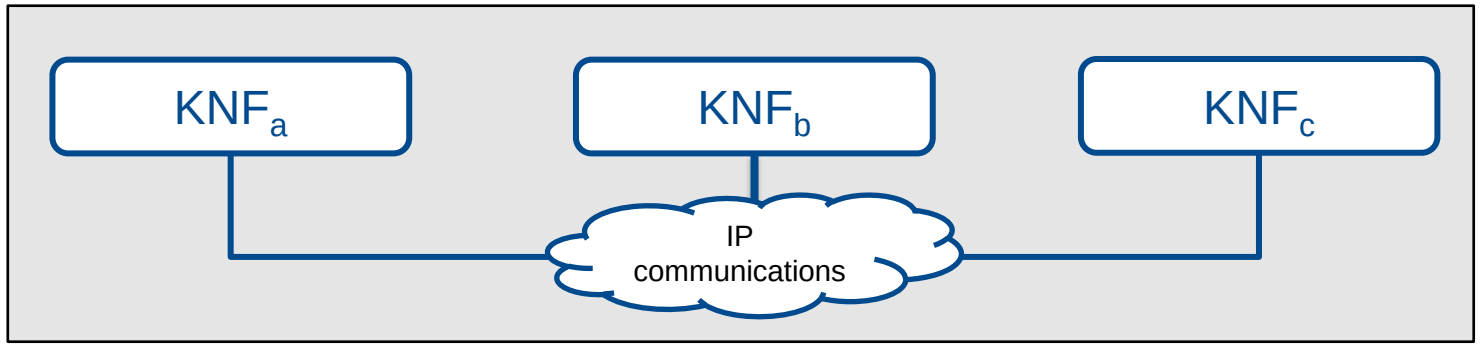
This PoC demonstrates that, with a set of specific adaptations, OSM can manage virtual networks on Kubernetes (K8s) clusters, satisfying the connectivity requirements of network services composed by Kubernetes Network Functions (KNFs), as they are defined in their corresponding service descriptors.

- OSM supports the deployment of KNFs in a K8s cluster. This is achieved with helm [1] charts.
- In this PoC, the L2S-M* [2] K8s operator is used to create and manage the virtual networks inside the K8s cluster. This operator takes advantage of Software Defined Networking (SDN) technologies to create virtual networks, which can be allocated to KNFs and support their data exchange.
- This PoC details the different steps involved in the deployment of a network service composed of several KNFs where different virtual networks enable the communication among them. In particular, the service included in this PoC is based on a Content Delivery Network (CDN).
- One of the insights obtained in this PoC is that the potential of OSM virtual networking cannot be completely exploited in K8s. The OSM community is addressing this with the design and implementation of an OSM feature that enables the connectivity among KNFs using SDN technologies (feature 10921 [3])
- The PoC is totally based on open-source technologies (i.e., OSM, K8s, helm and L2S-M).

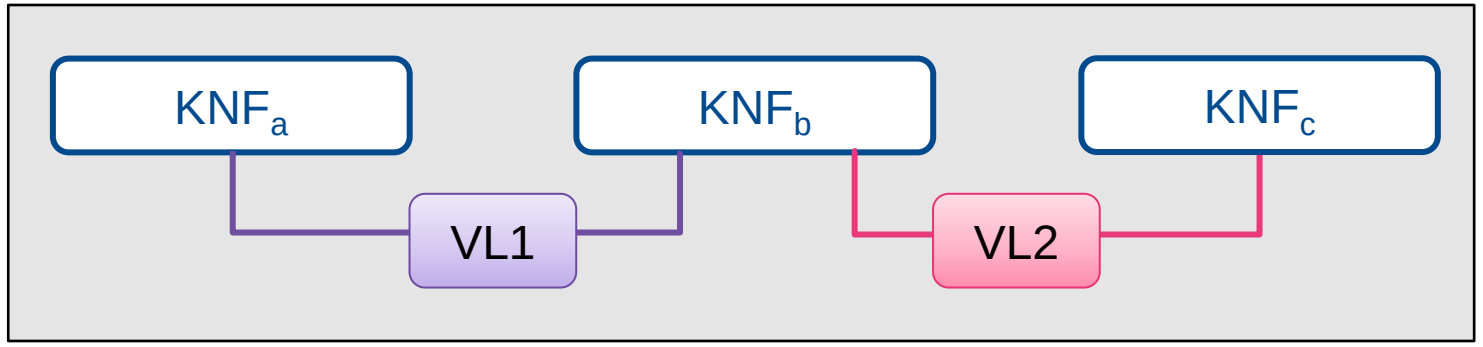
* http://l2sm.io

KNF Connectivity in K8s Clusters

What we have:



What we want:

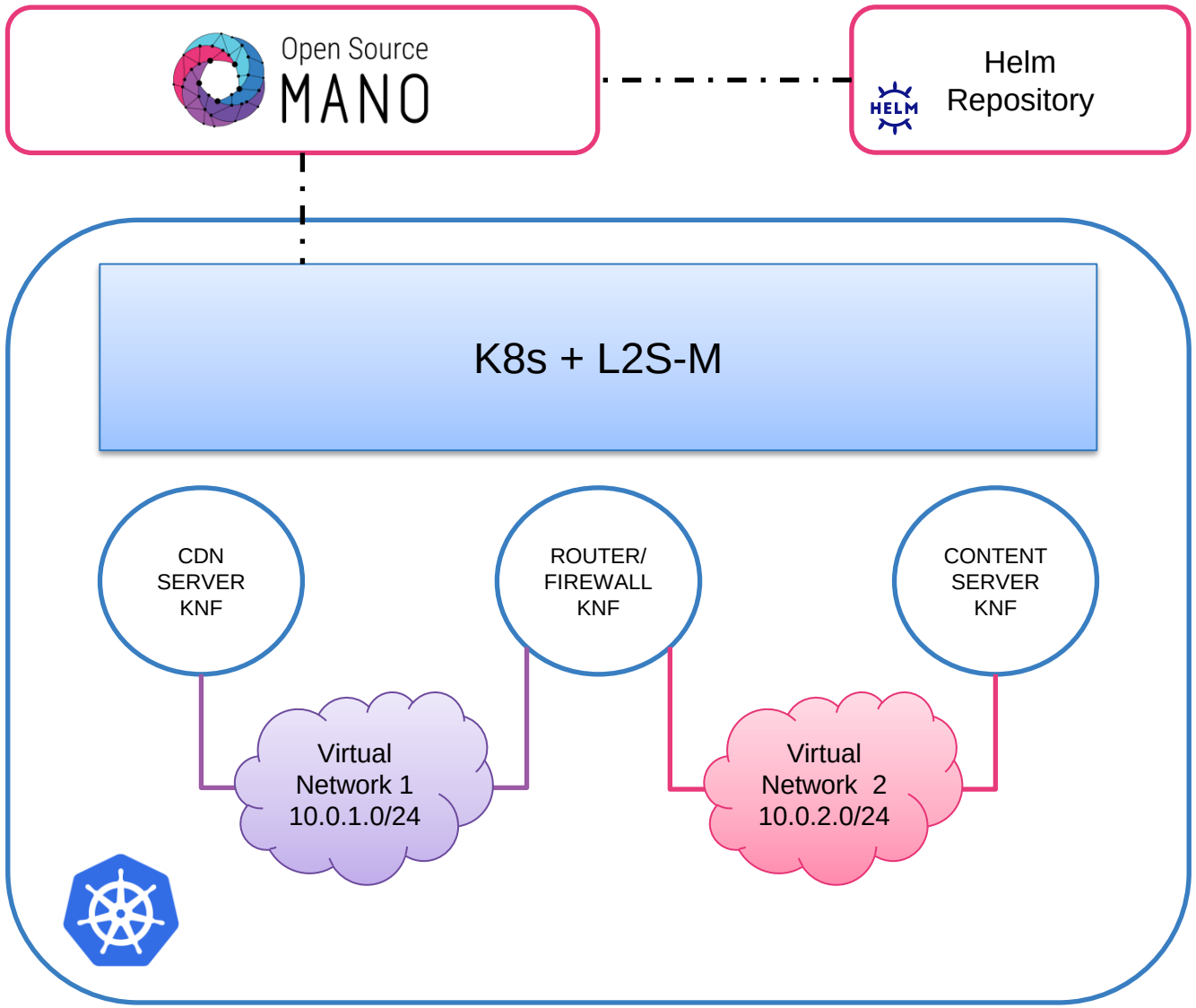


PoC Scenario: Content Delivery Network (CDN) Service

Network service to securely distribute multimedia content over a K8s infrastructure. A cache KNF periodically retrieves content from a multimedia server to bring the content closer to the users.

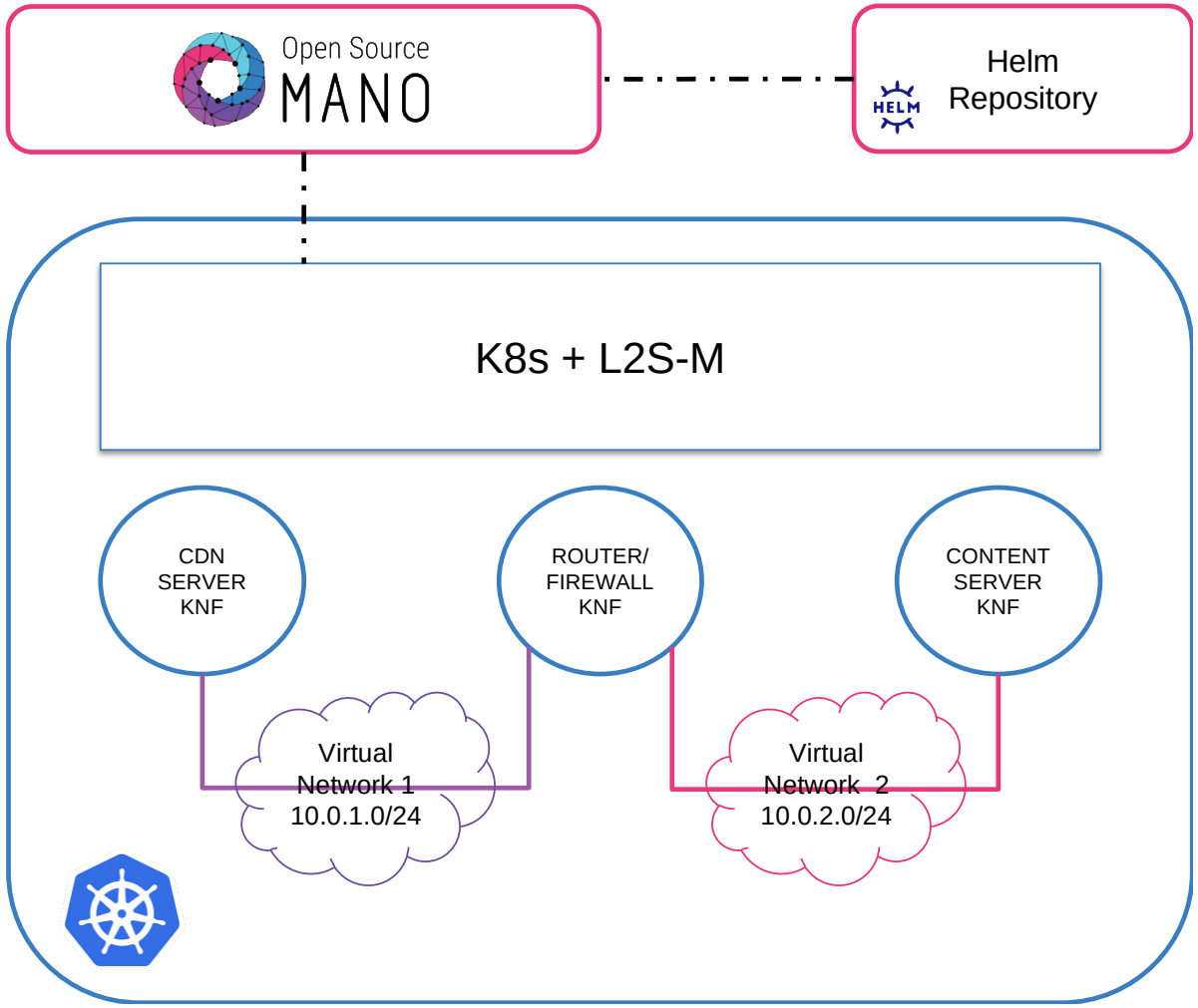
All the descriptors and relevant files used in this scenario are available here:

https://vm-images.netcom.it.uc3m.es/OSM-PoC-2023/



CDN Network service elements

- **Content Server KNF:** Nginx [4] server that hosts multimedia content to be downloaded from the users.
- **Router/Firewall KNF:** Controls the network access to the content server and supports routing functionalities to enable the transmission of information from the Content Server KNF to the CDN server KNF.
- **CDN server KNF:** Pulls multimedia files from the content server. These files can later be retrieved by external users.



CDN Network service elements

1. Create the VN using helm (since OSM does not support creating them in the cluster)

```
helm install my-first-osm-net uc3m/my-first-osm-net
helm install my-second-osm-net uc3m/my-second-osm-net
```

2. Instantiate the network service using OSM

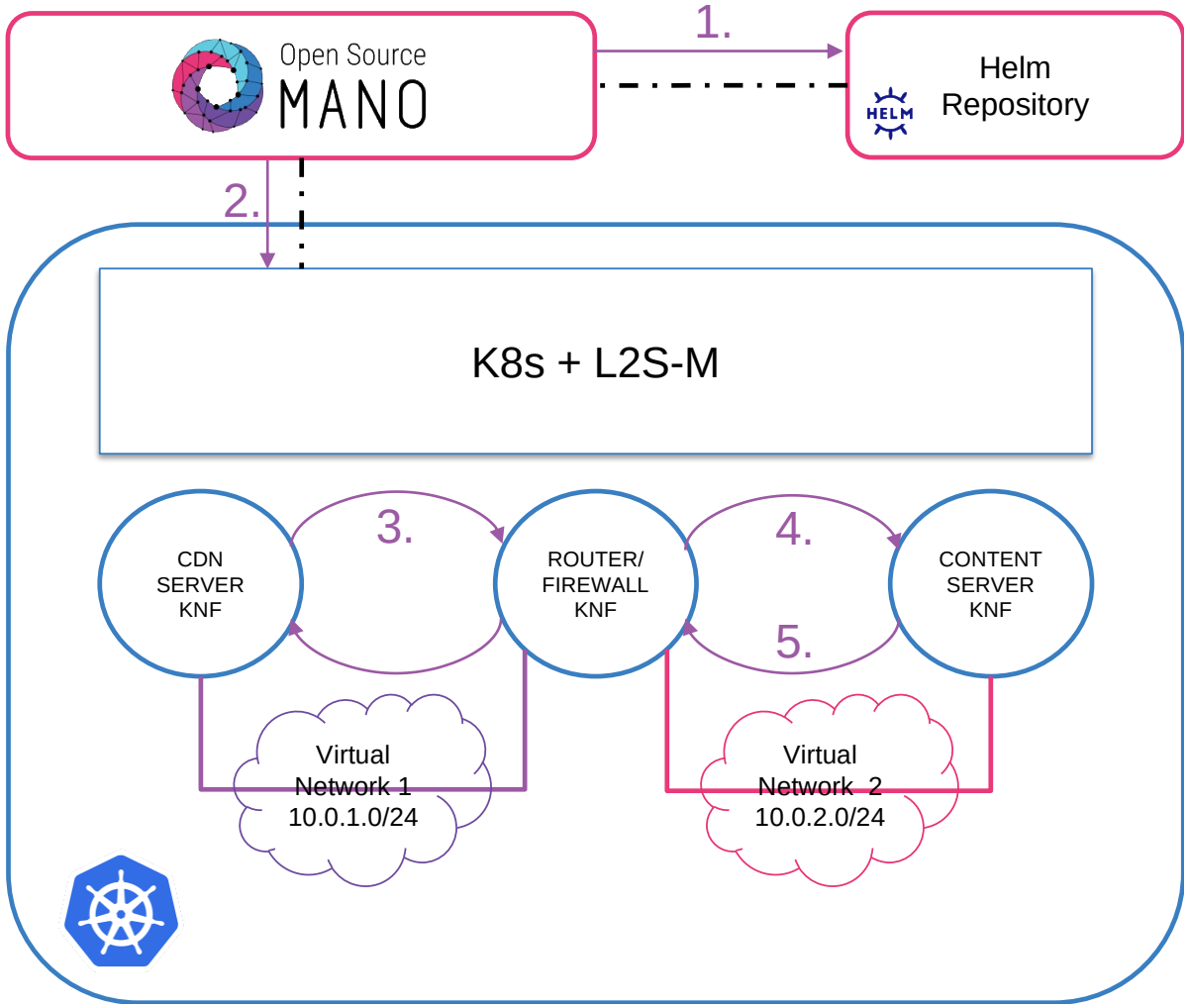
```
osm ns-create --ns_name vod-service-deployment --
nsd_name vod_service_ns --vim_account dummy-vim
```

3. Cache KNF downloads a video file through an HTTP request.

```
curl http://10.0.2.10:80/video-content-file.avi --
      output video.avi --limit-rate 200k
```

4. Router KNF redirects the request to the content server

5. The content server starts sending the content to the cache, storing it in its file system.



CDN Network service cut-off scenario

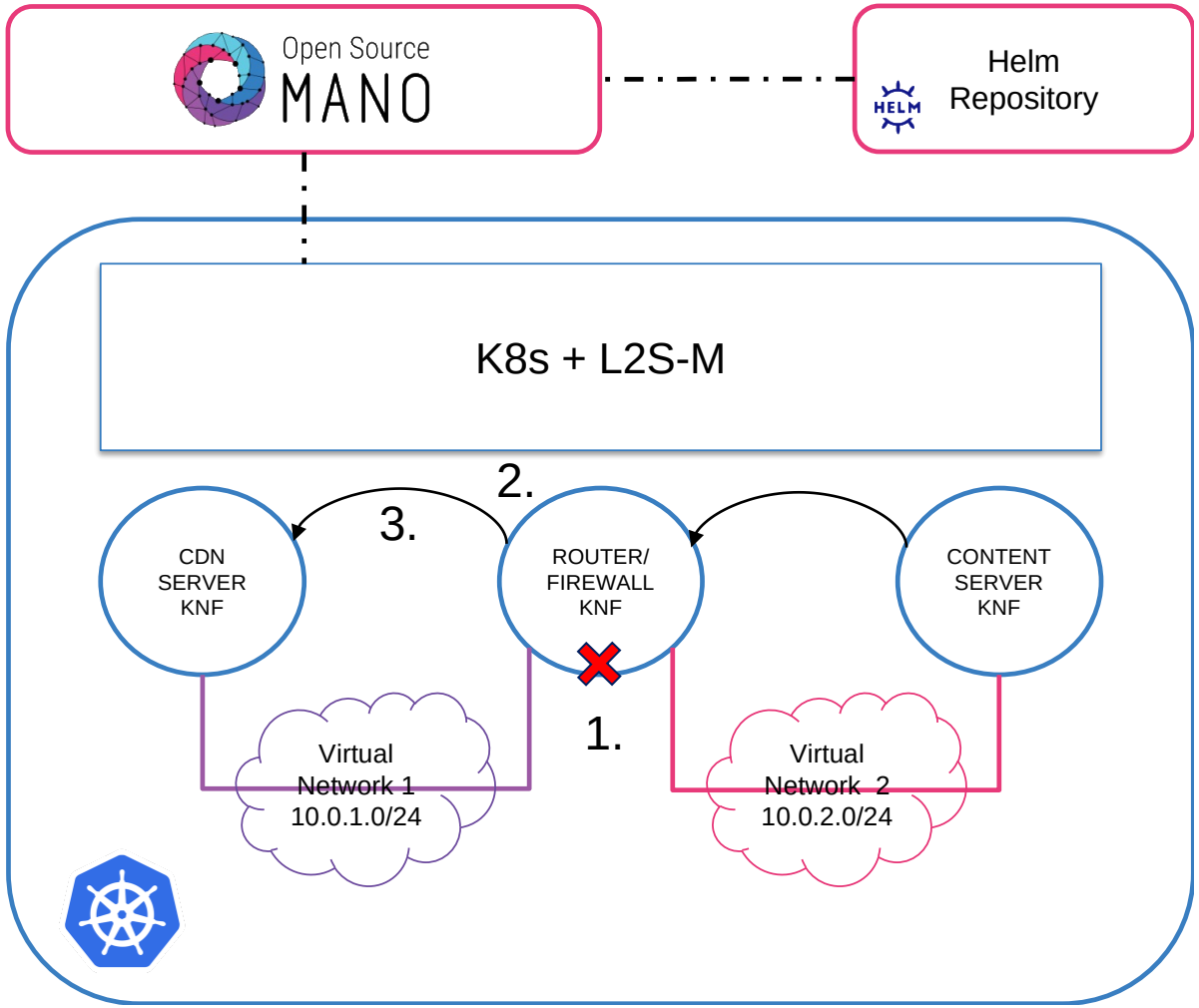
1. Emulate a link disruption in the cluster (Router KNF shuts down) while content is being downloaded:

   ```
   kubectl scale deploy router-server-knf --
                   replicas 0
   ```

2. After some time, re-deploy the router KNF (cluster recovers)

   ```
   kubectl scale deploy router-server-knf --
                   replicas 1
   ```

3. Once the link has been restored, the download resumes.

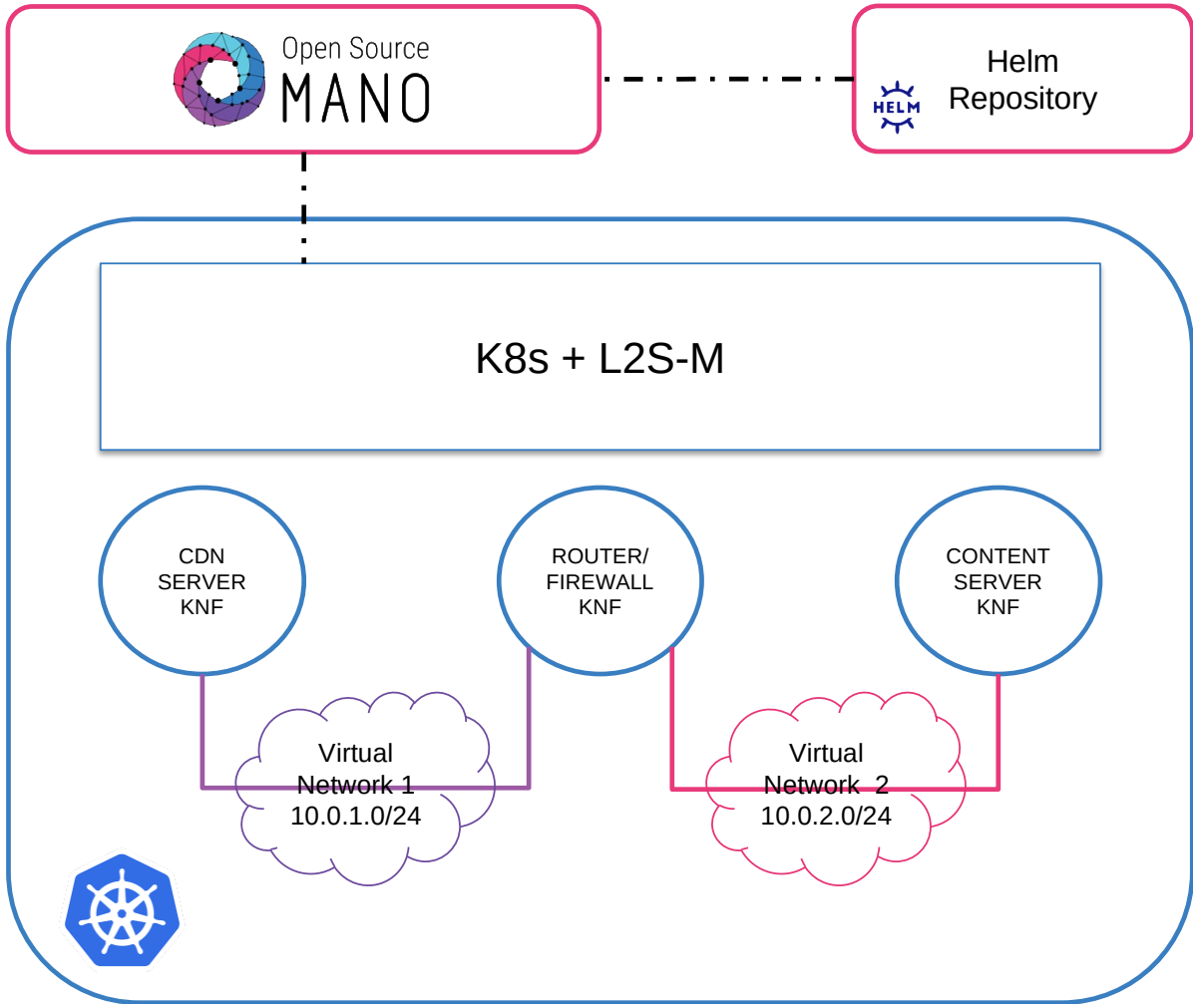


Validation results: KNF ping and traceroute

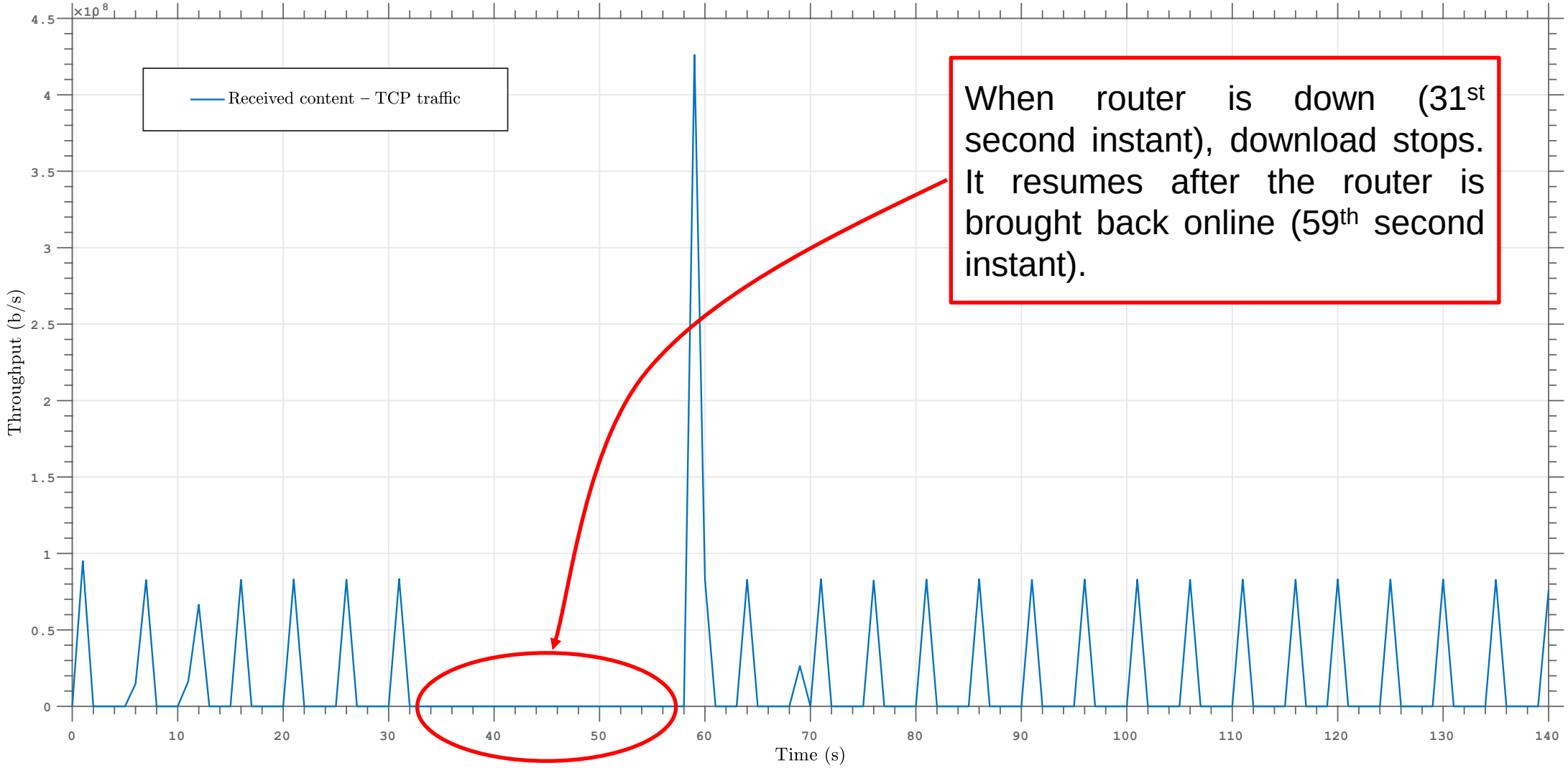
- Performing a ping and traceroute between CDN Server KNF (10.0.1.10) and Content Server KNF (10.0.2.10).
- Ping results show that connectivity between KNFs exists.
- Traceroute results show that the distance between KNFs is 2 hops (i.e., they are located in different broadcast domains).

```
/ # ping 10.0.2.10 -c 3
PING 10.0.2.10 (10.0.2.10): 56 data bytes
64 bytes from 10.0.2.10: seq=0 ttl=63 time=0.995 ms
64 bytes from 10.0.2.10: seq=1 ttl=63 time=0.117 ms
64 bytes from 10.0.2.10: seq=2 ttl=63 time=0.131 ms

--- 10.0.2.10 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 0.117/0.414/0.995 ms
/ # traceroute 10.0.2.10
traceroute to 10.0.2.10 (10.0.2.10), 30 hops max, 46 byte packets
 1  10.0.1.1 (10.0.1.1)  0.054 ms  0.012 ms  0.008 ms
 2  10.0.2.10 (10.0.2.10)  0.014 ms  0.015 ms  0.010 ms
```



Validation results: File download in cache KNF



When router is down (31st second instant), download stops. It resumes after the router is brought back online (59th second instant).

Research projects involved in this PoC

Open Source MANO

H2020 LABYRINTH Project
Grant agreement No. 861696

H2020 FISHY Project
Grant agreement No. 952644

TRUE5G Project
Spanish National Research Agency
PID2019-108713RB681

PoC Demo

All the descriptors and relevant files used in this scenario are available here:

- https://vm-images.netcom.it.uc3m.es/OSM-PoC-2023/

The following QR-Code contains a video showcasing the development of this PoC, including the deployment of the CDN-based service using KNFs. Additionally, the video provides further details about the validation process and the results of this PoC:

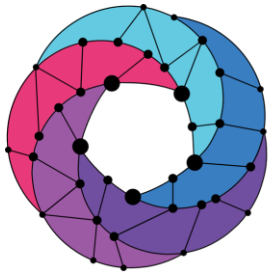
References

[1] The Linux Foundation. *"Helm: The package manager for Kubernetes"*. https://helm.sh

[2] L. F. Gonzalez, I. Vidal, F. Valera and D. R. Lopez, "*Link Layer Connectivity as a Service for Ad-Hoc Microservice Platforms*" in *IEEE Network*, vol. 36, no. 1, pp. 10-17, January/February 2022, doi: 10.1109/MNET.001.2100363

[3] Luis F. Gonzalez, I. Vidal, F. Valera, B. Nogales, Diego R. Lopez. *"Connectivity among CNFs using SDN"*. (2022) https://osm.etsi.org/gitlab/osm/features/-/issues/10921

[4] F5. Inc. *"NGINX: Advanced Load Balancer, Web Server & Reverse Proxy"*. *https://www.nginx.com*



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Thank You!

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