

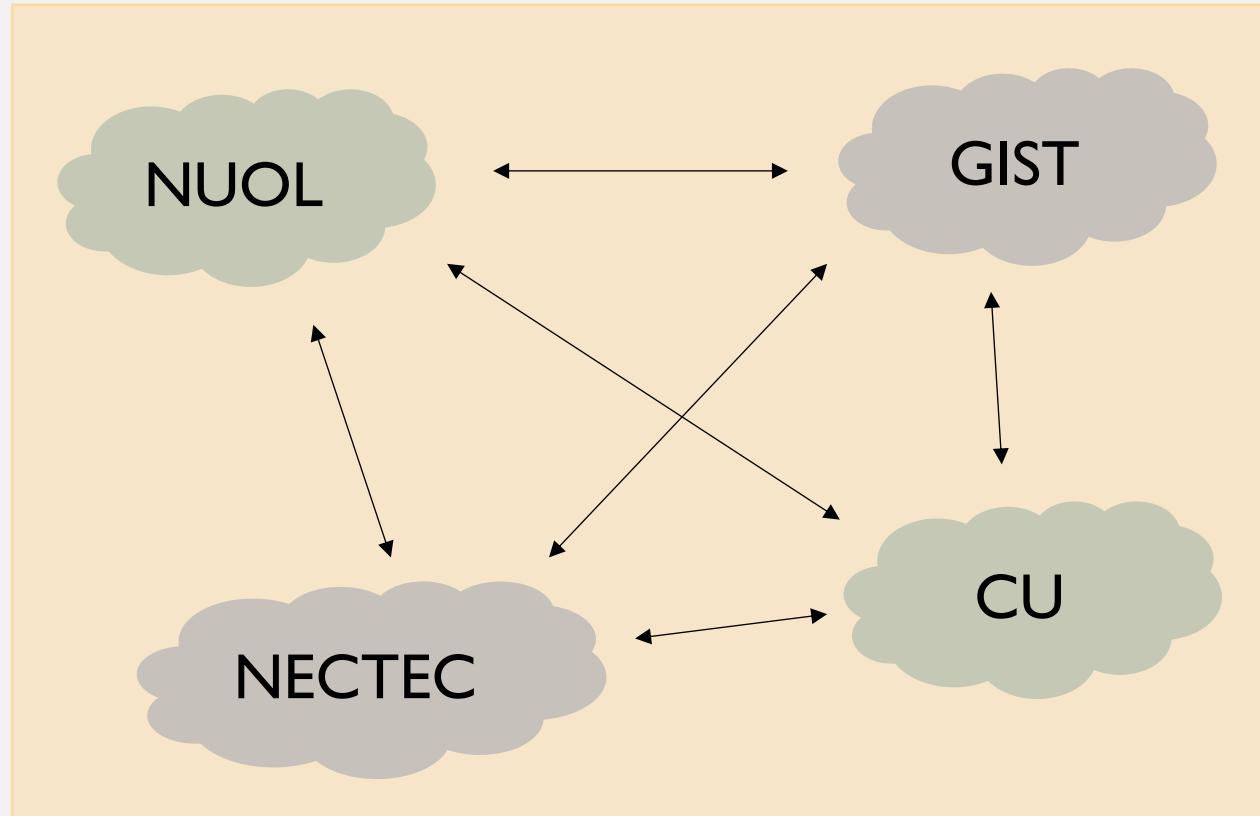
ASIA PACIFIC RESEARCH PLATFORM, APAN-50, HONG KONG,
4TH AUG. 2020 10:10 – 10:20: AN EXPERIMENTAL STUDY OF
KUBERNETES CLUSTER PEER-TO-PEER APPLICATION-LEVEL
FEDERATION VIA ISTIO SERVICE MESH

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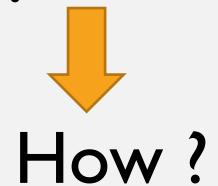
IOTCLOUDSERVE@TEIN



Federated cloud cluster

[3] J. Kim, B. Cha, J. Kim, N. Kim, G. Noh, Y. Jang, H. An, H. Park, J. Hong, D. Jang, T. Ko, W. Song, S. Min, J. Lee, B. Kim, I. Cho, H. Kim, and S. Kang. OF@TEIN: An OpenFlow-Enabled SDN Testbed over International SmartX Rack Sites. Proceedings of the Asia-Pacific Advanced Network 2013; 36: 17–22.

IoTcloudServe@TEIN: a multisite cloud testbed dedicated to researchers and developers for conducting experiments.



How ?

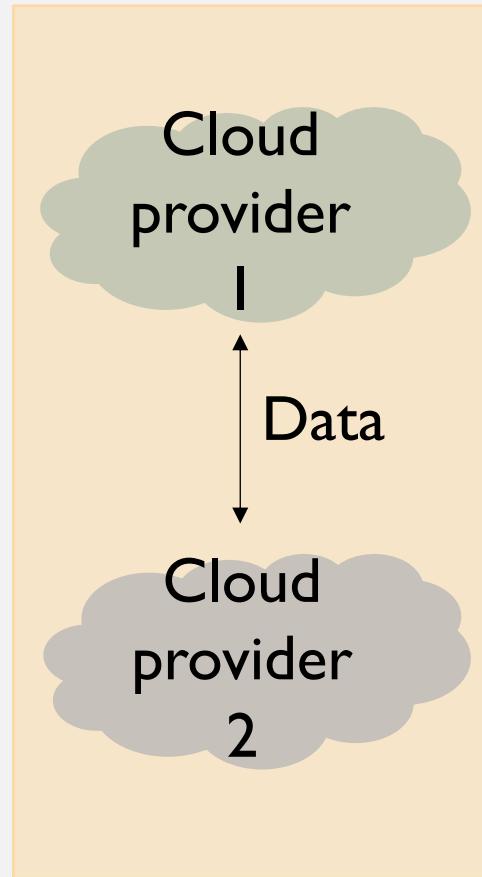
[2] IoTcloudServe@TEIN.[Online]--Available from <https://www.facebook.com/notes/iotcloudservetein/data-centric-iot-cloud-service- platform-for-smart-communities-iotcloudservetein/331080050821742/> (accessed 10 April 2020).

INTRODUCTION

[1] C. Lee, "Cloud Federation Management and Beyond: Requirements, Relevant Standards, and Gaps," *IEEE Cloud Computing*, vol. 3, pp. 42-49, 01/01 2016,

[4] V. Massimo, B. Ivona, and T. Francesco. 2012. Achieving Federated and Self-Manageable Cloud Infrastructures: Theory and Practice. IGI Global, Hershey, PA.

CLOUD FEDERATION

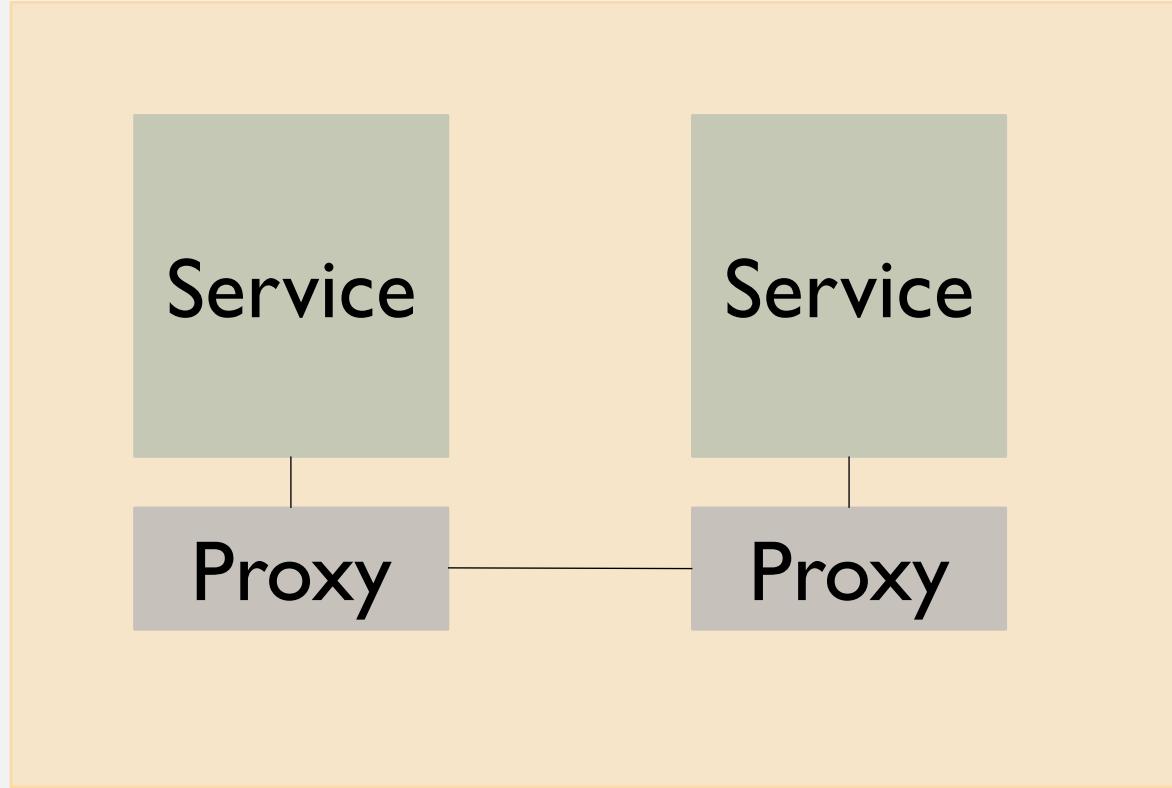


Federated cloud cluster

Advantages of cloud federation:

- High availability
- Increase responsiveness
- Business opportunities

ISTIO



Kubernetes cluster

Service meshes are built using service proxies.



Decoupling application from networking

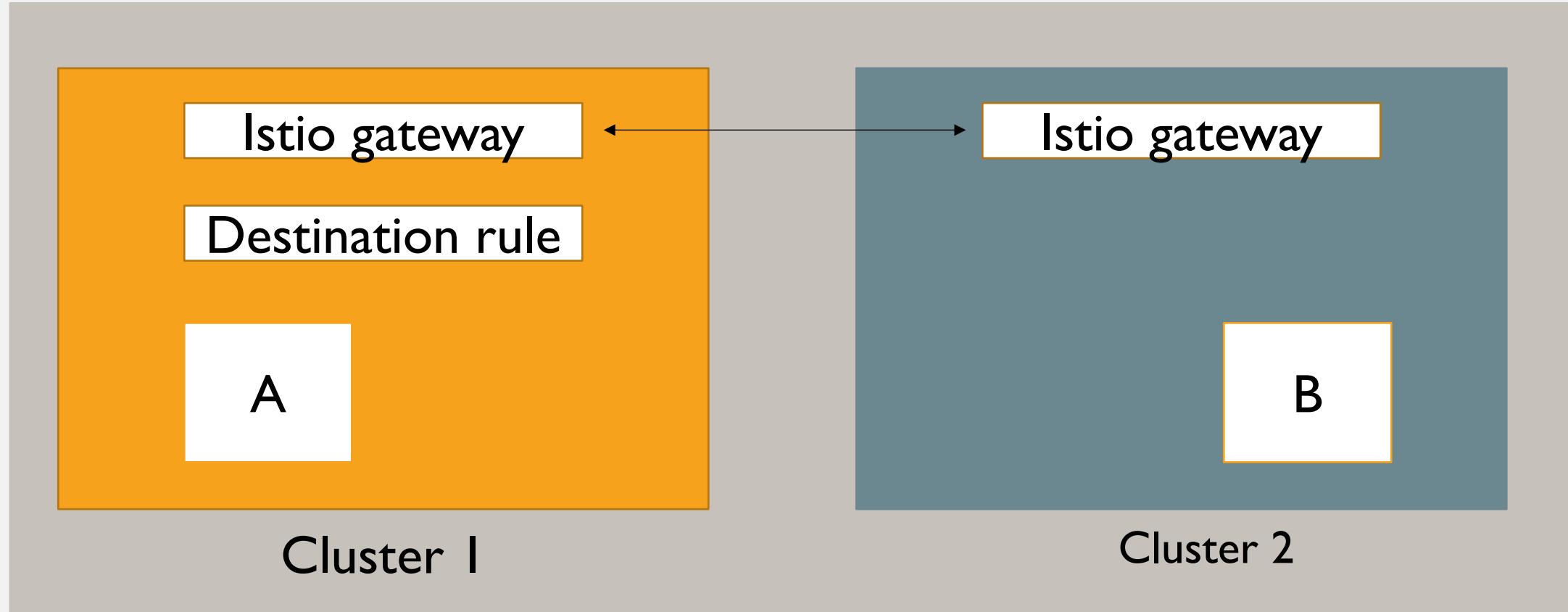


Declaratively define network behavior and traffic flow policy

[7] Kubernetes. [Online] -- Available from <https://kubernetes.io> (accessed 10 April 2019).

[8] Istio:Connect,Secure,Control, and Observe Services. [Online] -- Available from <https://istio.io> (accessed 10 April 2020).

THE PROPOSED IMPLEMENTATION FRAMEWORK



[5] C. Lee , R. Bohn, and M. Michel. The NIST Cloud Federation Reference Architecture 5. NIST Special Publication 500 (2020): 332.

SERVICE ENTRY

```
apiVersion: networking.istio.io/v1alpha3
kind: ServiceEntry
metadata:
name: a
spec:
hosts:
- a.istio.svc.cluster.local
ports:
- name: http
number: 80
protocol: http
resolution: STATIC
location: MESH_INTERNAL
endpoints:
- address: #IP address of Istio gateway in cluster 2
locality: us-west1/us-west1-b
ports:
http: 15443
```

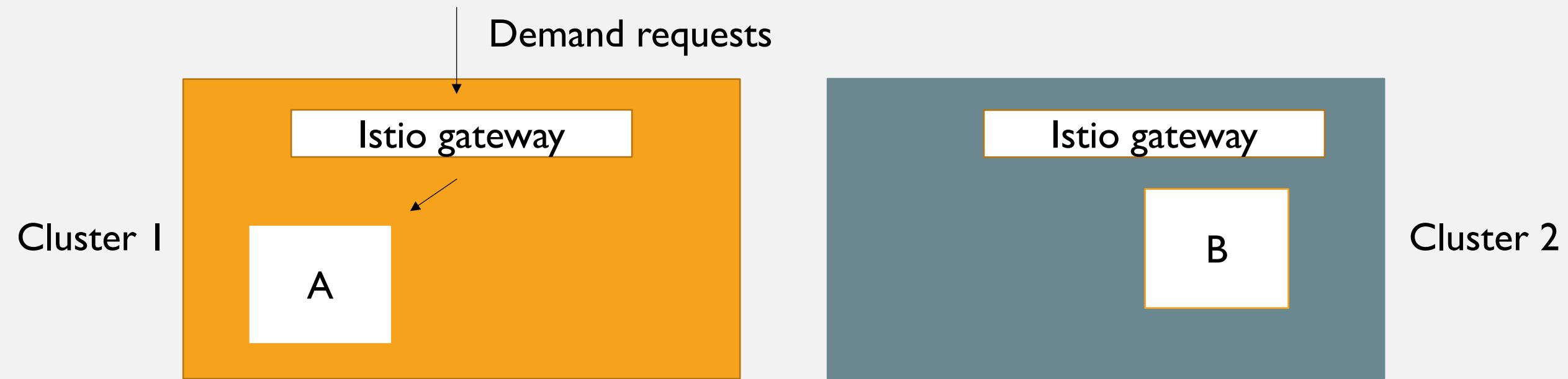
Service entry adds service B as another endpoint of service A

DESTINATION RULE

```
apiVersion: networking.istio.io/v1alpha3
kind: DestinationRule
metadata:
  name: a
spec:
  host: a.istio.svc.cluster.local
  trafficPolicy:
    connectionPool:
      tcp:
        maxConnections: 1
      http:
        http2MaxRequests: 1
        maxRequestsPerConnection: 1
        http1MaxPendingRequests: 1
    outlierDetection:
      consecutiveErrors: 1
      interval: 1s
      baseEjectionTime: 1m
      maxEjectionPercent: 100
    tls:
      mode: "ISTIO_MUTUAL"
```

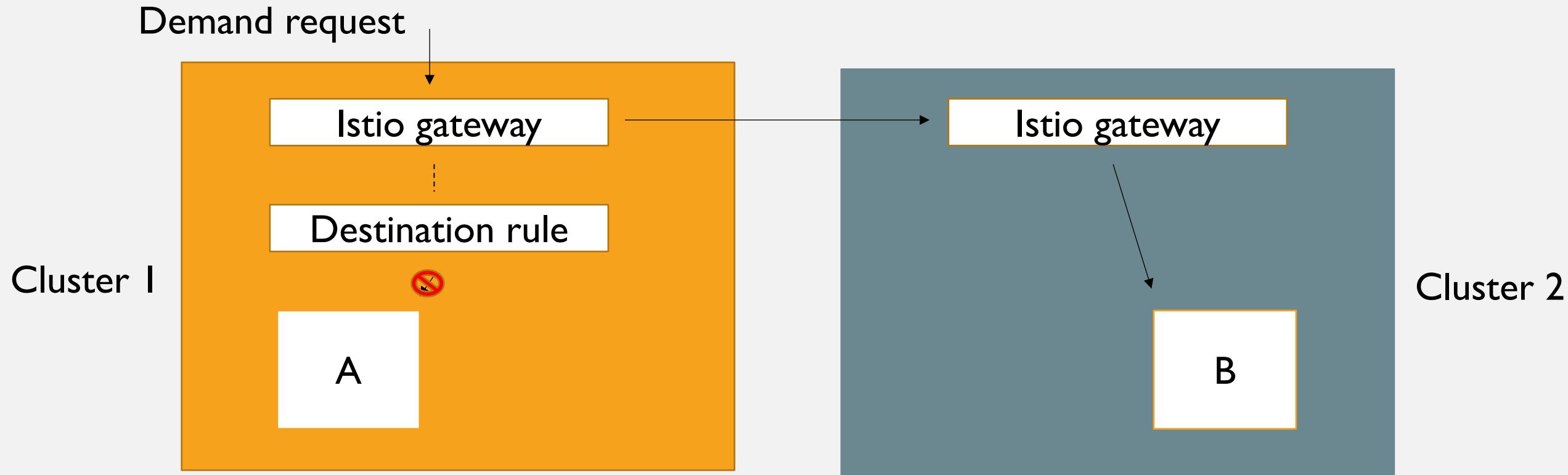
Traffic criteria for triggering the redirecting process are assigned in the ‘connectionPool’ and ‘consecutiveErrors’ field

NETWORK BEHAVIOR



Requests will be routed to service A if service A is healthy

NETWORK BEHAVIOR CONT.



During peak load (service A becomes unhealthy), requests will be redirected to service B

TESTING

Configurations:

- 2 cloud cluster: IoTcloudServe@TEIN and GKE
- Both clusters have been installed with Istio and echo service (echo servers will return the names of the pods in which they are located)
- IoTcloudServe@TEIN has been configured with a destination rule and a service entry

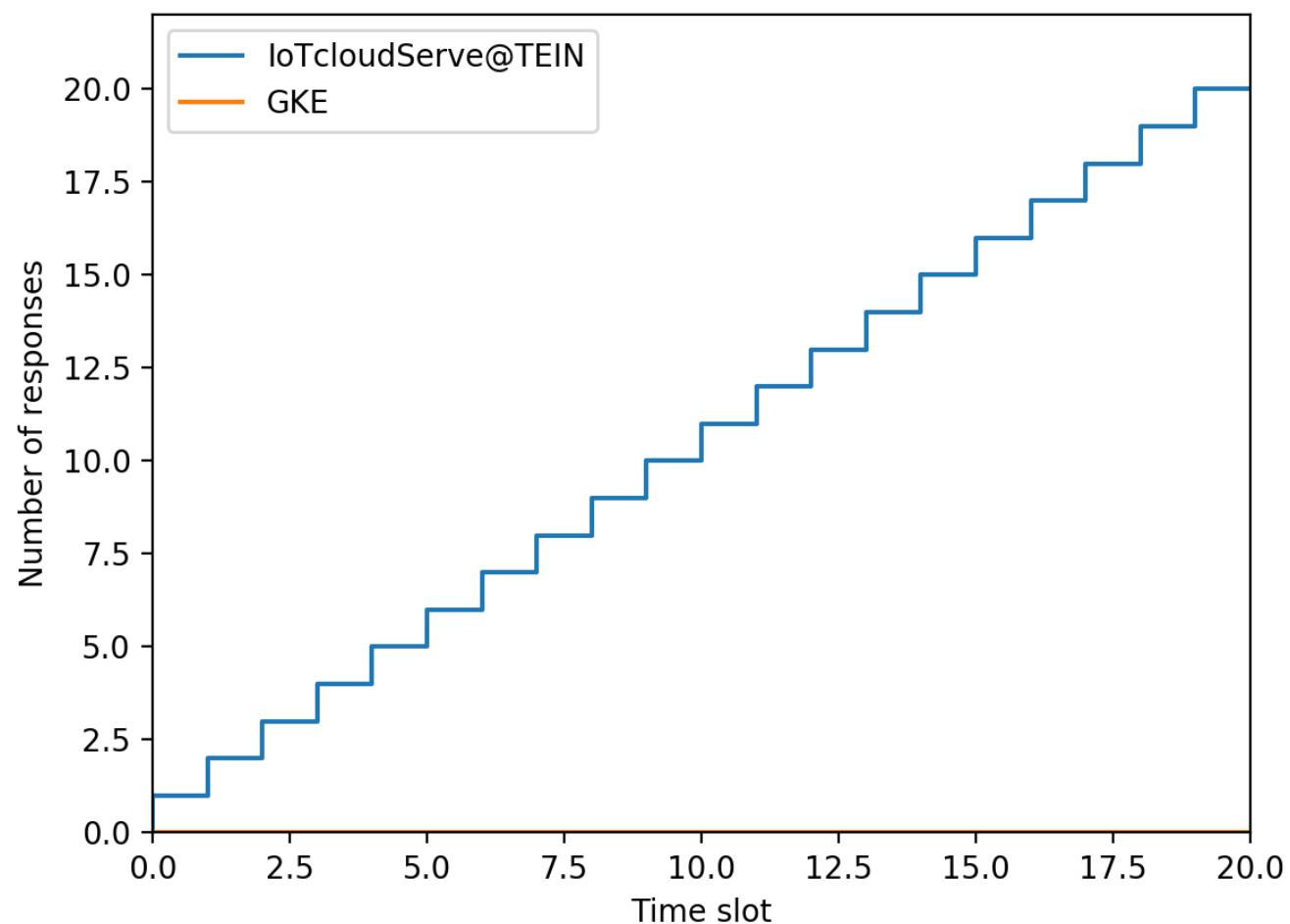
TESTING



Configurations:

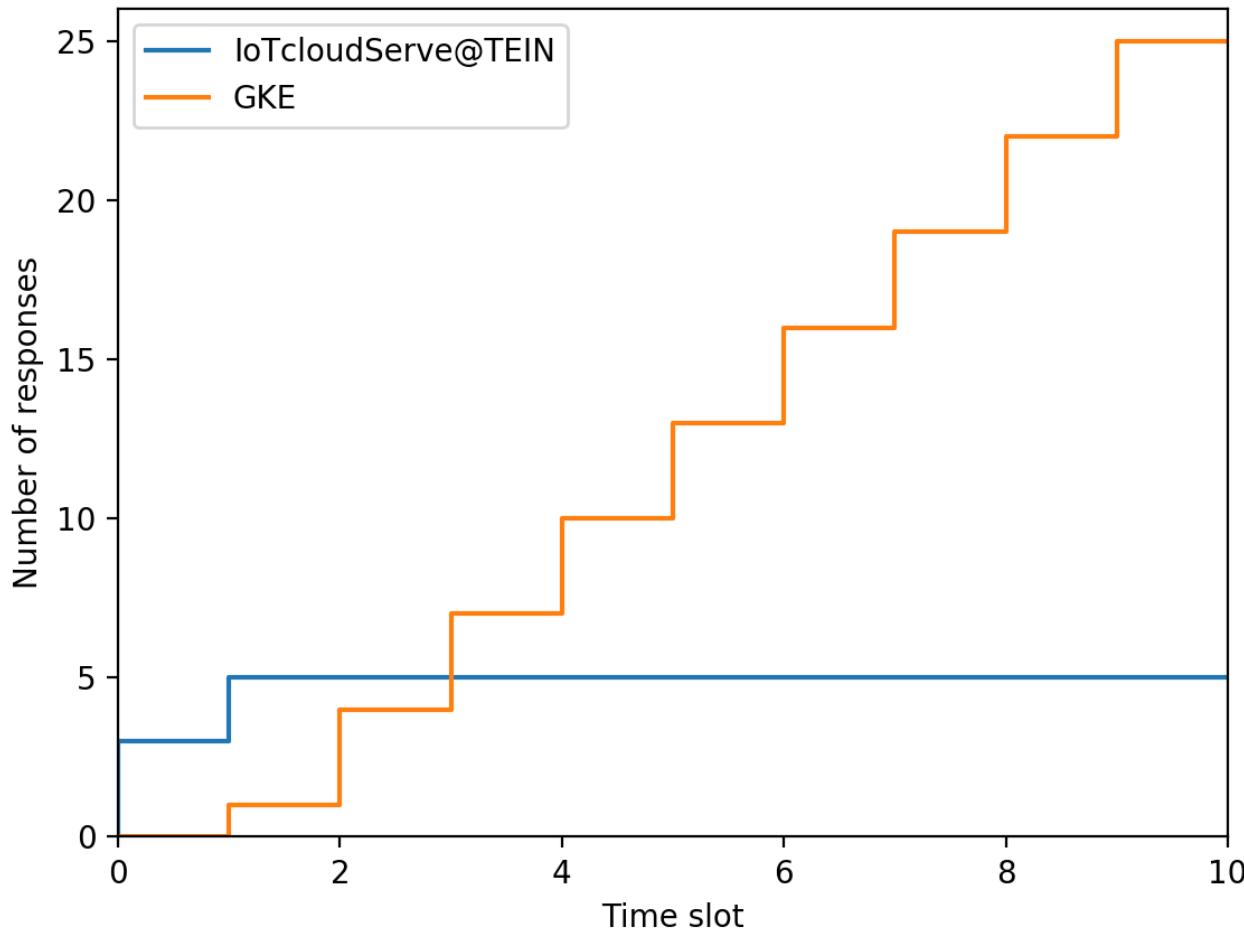
- The destination rule in **IoTcloudServe@TEIN** set the maximum number of simultaneous connection to one connection
- Requests have been generated by a Python script

TESTING



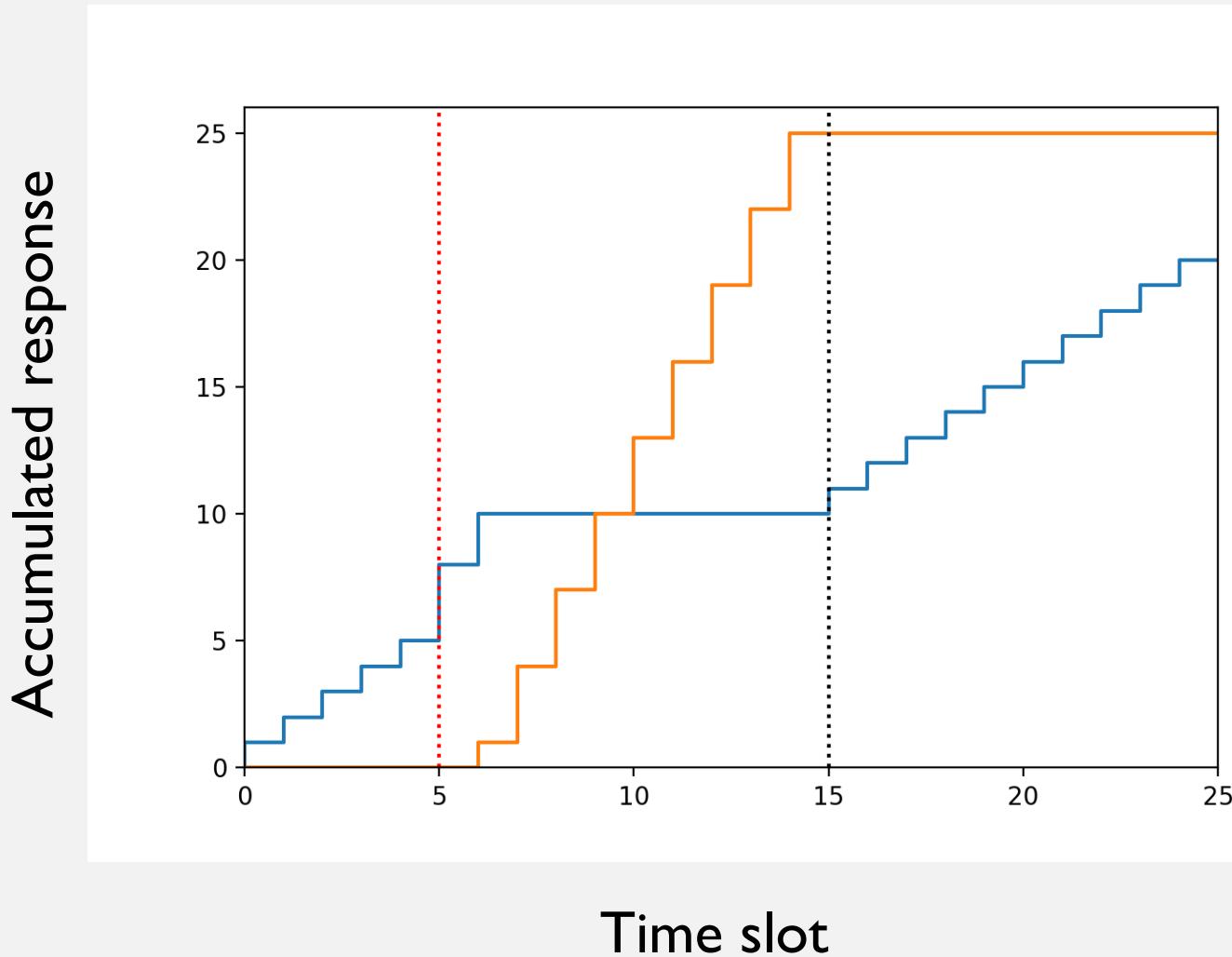
One connection:
IoTcloudServe@TEIN
accepts all the requests

TESTING



Three parallel connections:
IoTcloudServe@TEIN
starts redirecting all the
requests to GKE

RESULT



The result confirms that the proposed federation model behaves as expected.

- IoTcloudServe@TEIN
- GKE
- - - 1st transition line
- · - 2nd transition line

CONCLUSION

A pragmatic peer-to-peer federation model with cross-cluster load balancing and policy management capabilities that can be implemented in any Kubernetes cluster.

ACKNOWLEDGMENT

This work was supported by the Asi@Connect's Data-Centric IoT-Cloud Service Platform for Smart Communities (IoTcloudServe@TEIN) project with grant contract ACA 2016/376-562 under the umbrella of Smart-Mobility@Chula demonstration site.

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<https://www.facebook.com/iotcloudserve/>



Github

<https://github.com/IoTcloudServe>

REFERENCES

- [1] C. Lee. Cloud Federation Management and Beyond: Requirements, Relevant Standards, and Gaps. *IEEE Cloud Computing*, vol. 3, pp. 42-49, 01/01 2016,
- [2] IoTcloudServe@TEIN. [Online] -- Available from <https://www.facebook.com/notes/iotcloudservetein/data-centric-iot-cloud-service-platform-for-smart-communities-iotcloudservetein/331080050821742/> (accessed 10 April 2019).
- [3] J. Kim, B. Cha, J. Kim, N. Kim, G. Noh, Y. Jang, H. An, H. Park, J. Hong, D. Jang, T. Ko, W. Song, S. Min, J. Lee, B. Kim, I. Cho, H. Kim, and S. Kang. OF@TEIN:An OpenFlow-Enabled SDN Testbed over International SmartX Rack Sites. *Proceedings of the Asia-Pacific Advanced Network* 2013; 36: 17–22.
- [4] V. Massimo, B. Ivona, and T. Francesco. 2012. Achieving Federated and Self-Manageable Cloud Infrastructures: Theory and Practice. IGI Global, Hershey, PA.
- [5] C. Lee , R. Bohn, and M. Michel. The NIST Cloud Federation Reference Architecture 5. NIST Special Publication 500 (2020): 332.
- [6] I. Petri, T. Beach, M. Zou, J. D. Montes, O. Rana and M. Parashar, "Exploring Models and Mechanisms for Exchanging Resources in a Federated Cloud," 2014 IEEE International Conference on Cloud Engineering, Boston, MA, 2014, pp. 215-224.
- [7] Kubernetes. [Online] -- Available from <https://kubernetes.io> (accessed 10 April 2019).
- [8] Istio: Connect, Secure, Control, and Observe Services. [Online] -- Available from <https://istio.io> (accessed 10 April 2020).