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Taming Tactical Cluster Federation at the Edge

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Team



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TNO



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Eelco Cramer

DISCLAIMER

Listen to this presentation at your own risk. Presented developments are experimental and are not deployed operationally in current (foreign) missions.

Stefan van Gastel and Anna M. Kosek

do not represent the current policy of the Dutch Ministry of Defense and are concerned with future action and concept development.

They will appear deliberately vague and incomplete at times for obvious reasons.

But they do try their best!

Dutch Ministry Of Defence



Royal Netherlands Air Force



Royal Netherlands Army



Royal Netherlands Navy



Royal Netherlands Marechaussee



MOD Three Core Tasks



1. Defending national territory
and that of our allies



2. Enforcing the national and
international rule of law



3. Providing assistance during
disasters and crises



Threats & Problems - Current state



Vision - Desired state

3 characteristics and 10 design principles

Technologically advanced



Unique personnel and labour-extensive capabilities



Flexibility of action: rapidly deployable, scalable and self-supporting



Strong innovative capability



Escalation dominance, with our partners

Information-driven



Authoritative information position



Multidomain and integrated operations

Reliable partner and protector



Transparent and visible in an engaged society



Focus on a stronger, more self-reliant Europe



Focus on further specialisation within NATO and the EU



Strategic capabilities for a resilient society

Bridge the Gap

Improve Situational Awareness and Decision Support through Information Superiority



Plan



Cloud Native



Experiment

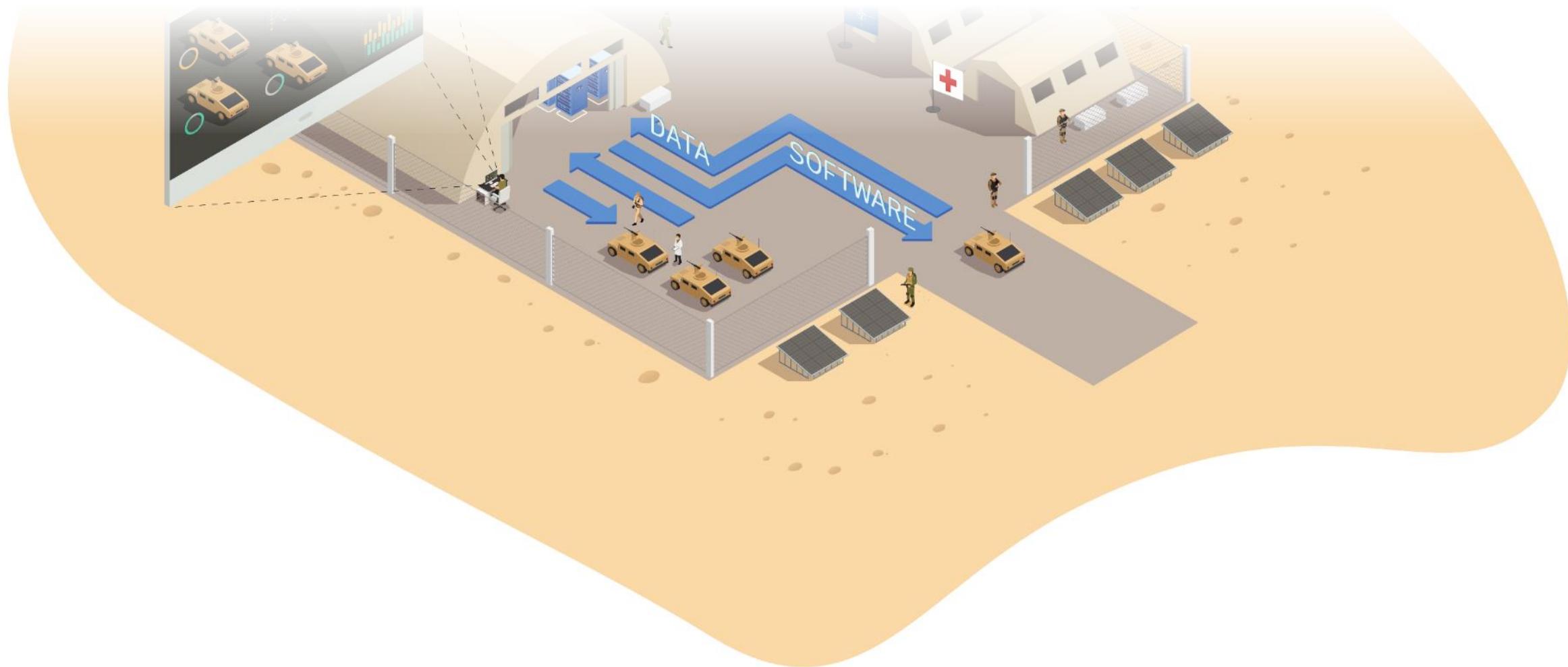
TNO innovation
for life

Improve Situational Awareness and Decision Support through Information Superiority

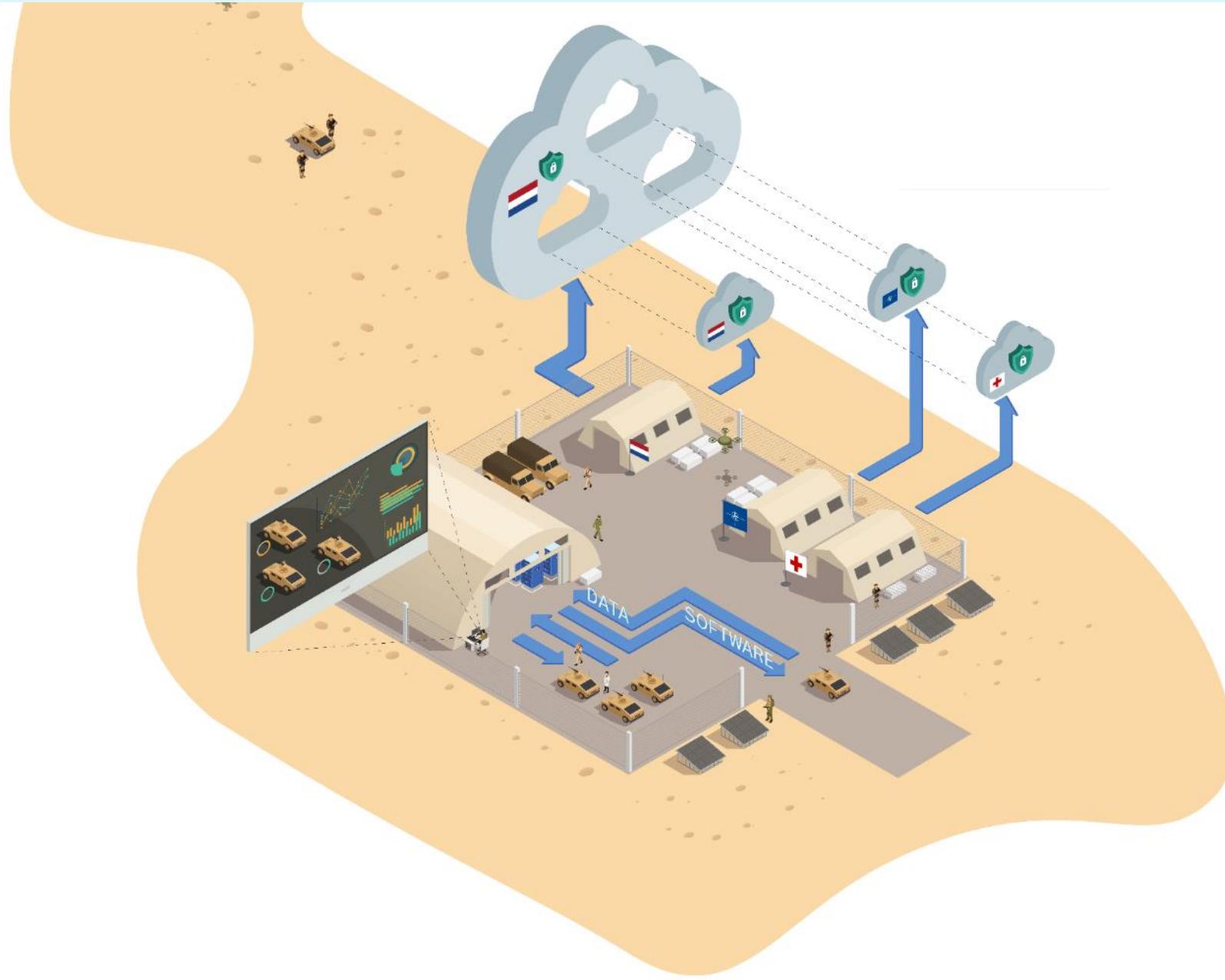




Tactical Federation At The Edge



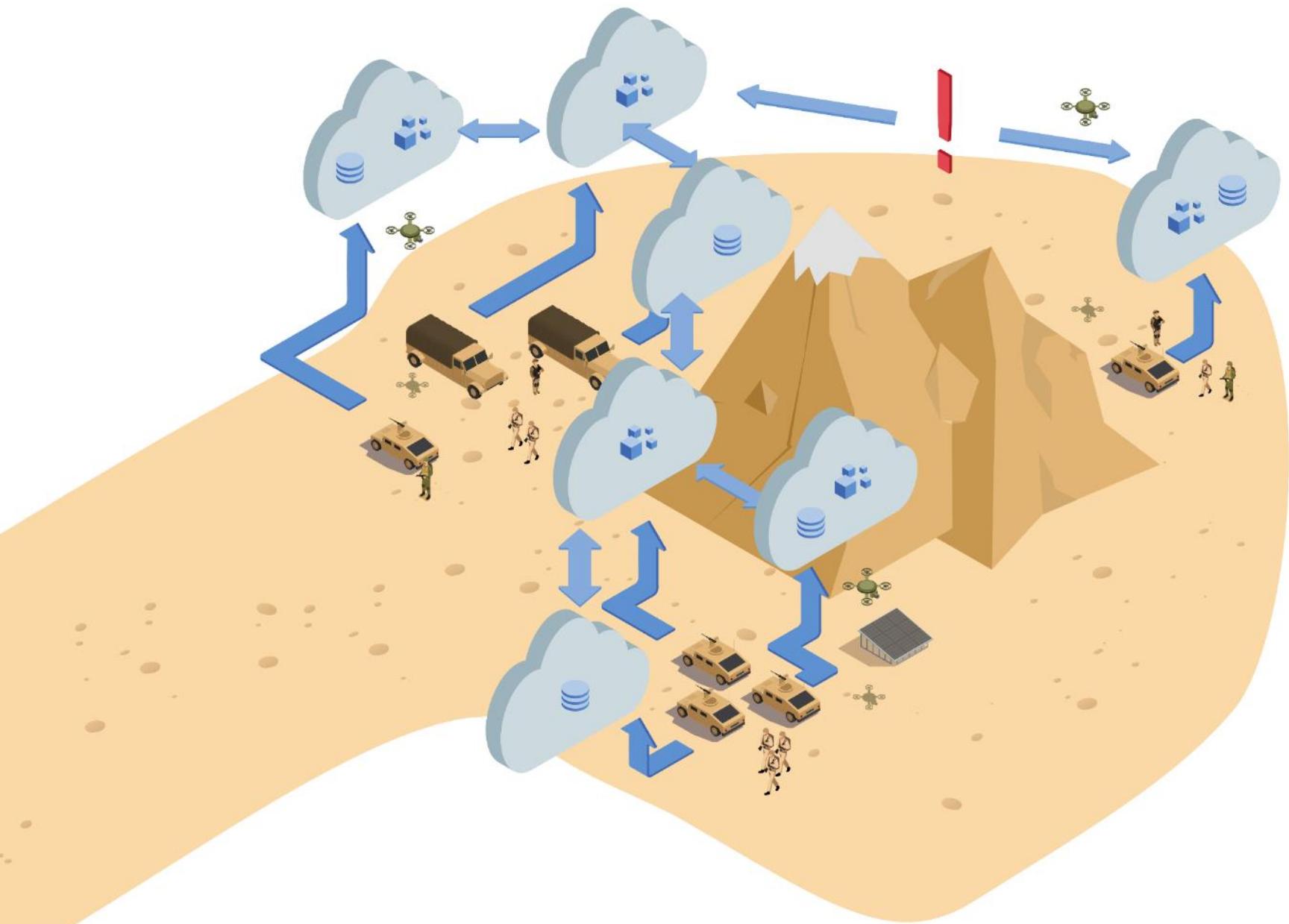
Tactical Federation At The Edge



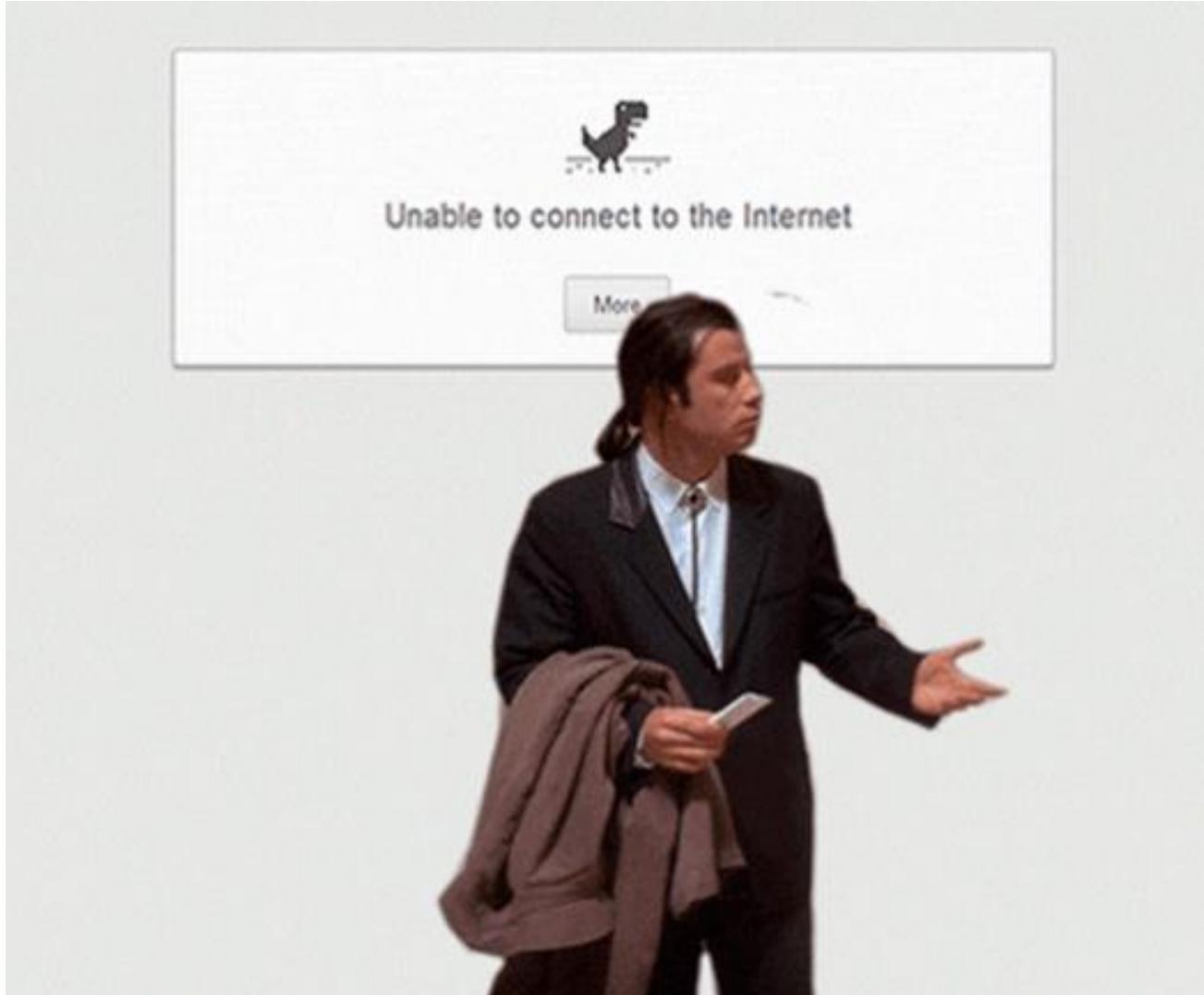
Tactical Federation At The Edge



Tactical Federation At The Edge



Your Edge Is Not Our Edge



Your Edge Is Not Our Edge



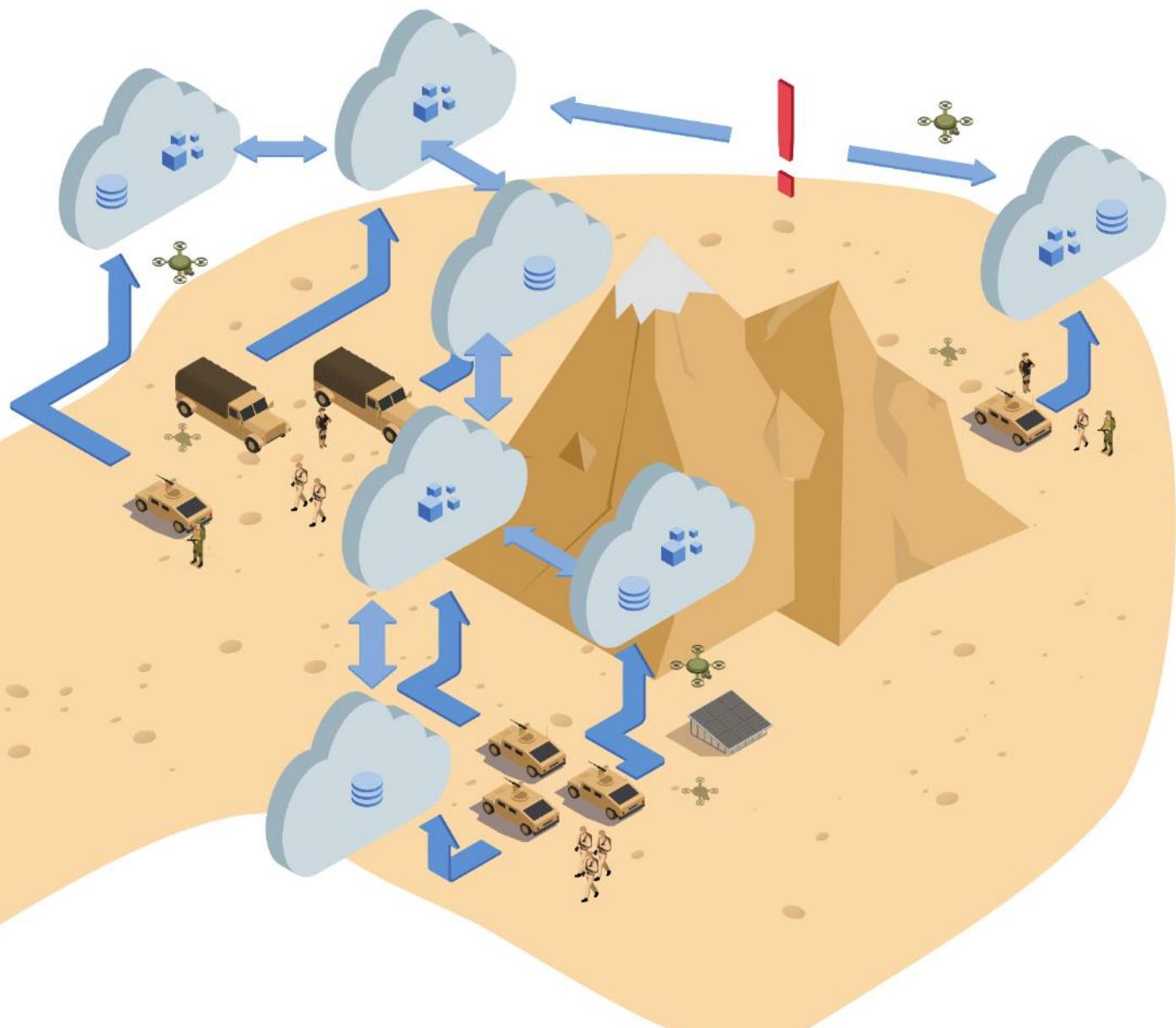
Your Edge Is Not Our Edge



Your Edge Is Not Our Edge



--ff to Cluster Federation



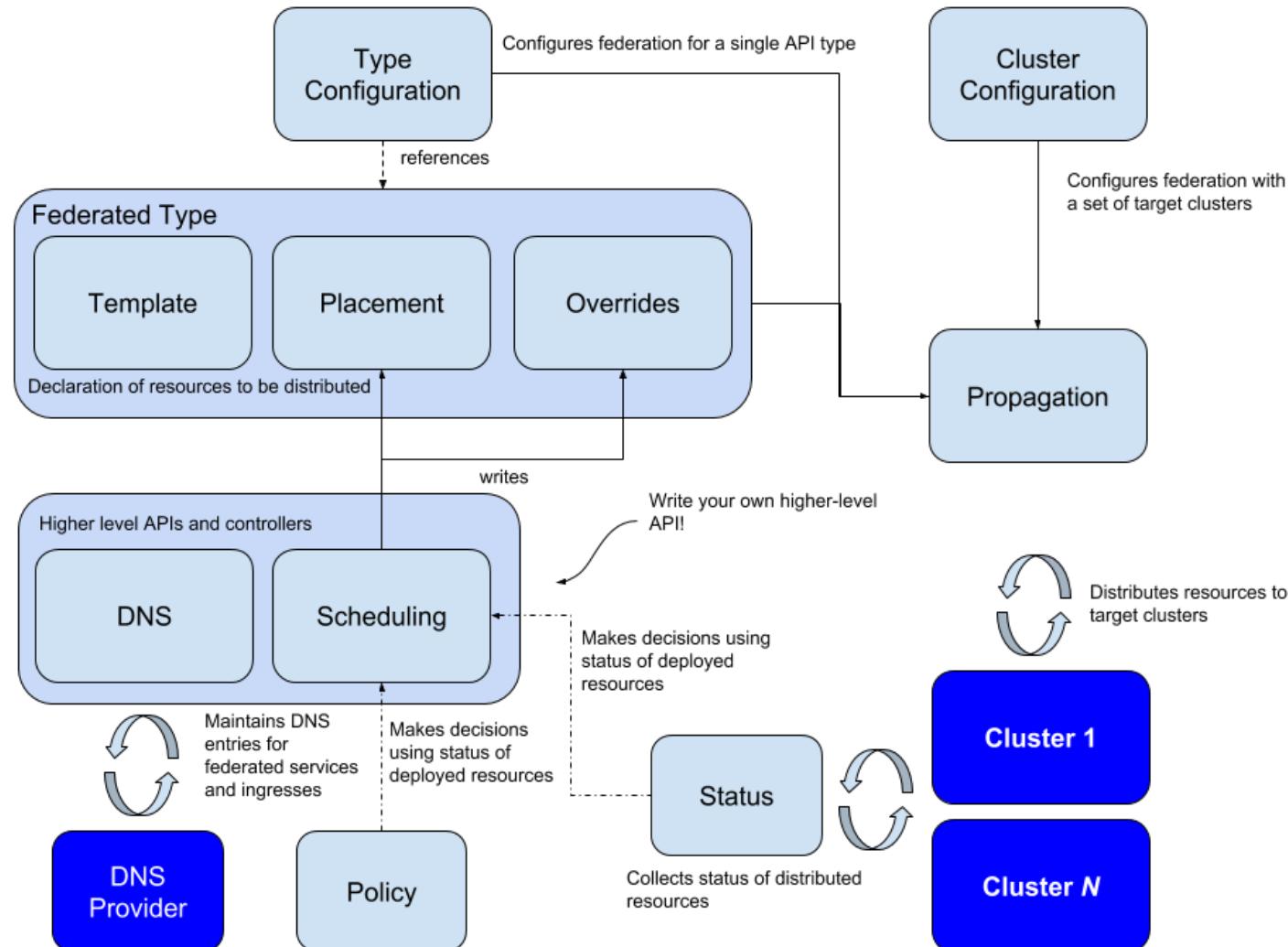
Definition of (Cluster) Federation



Definition of (Cluster) Federation

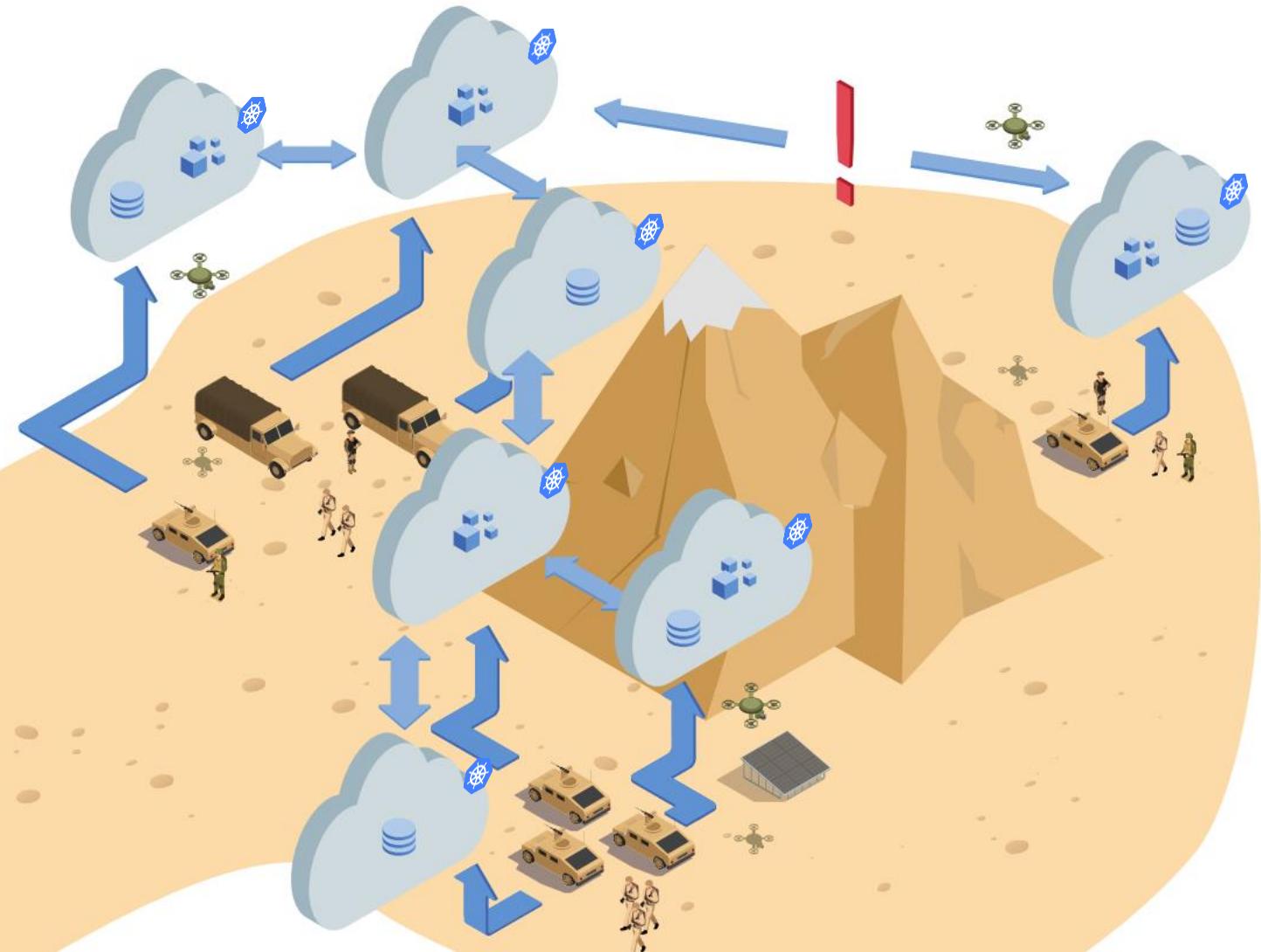


Kubernetes Cluster Federation, a multi-cloud or multi-region implementation for centralized deployment and management of applications and services across multiple Kubernetes clusters.

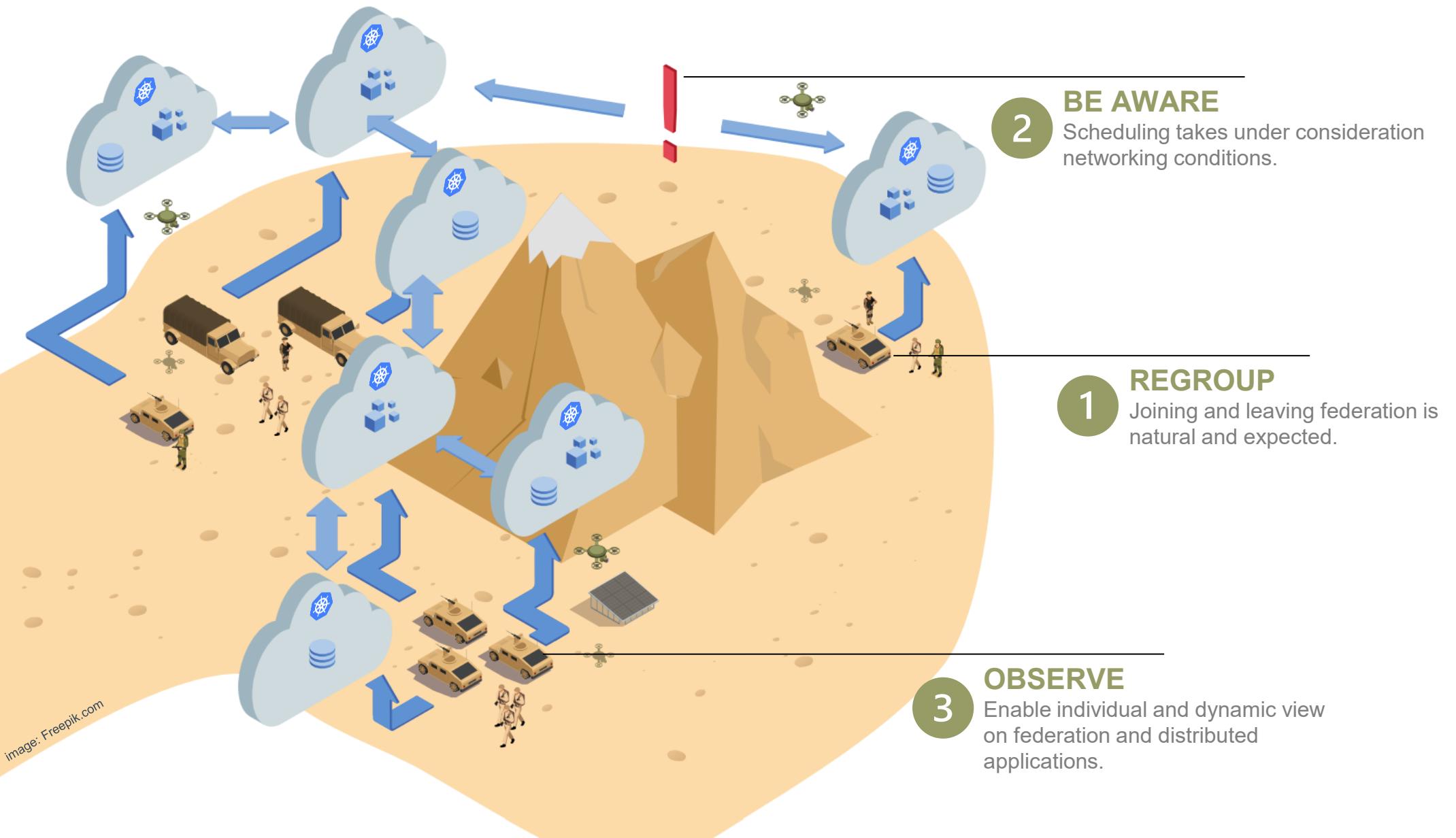


Tactical Federation

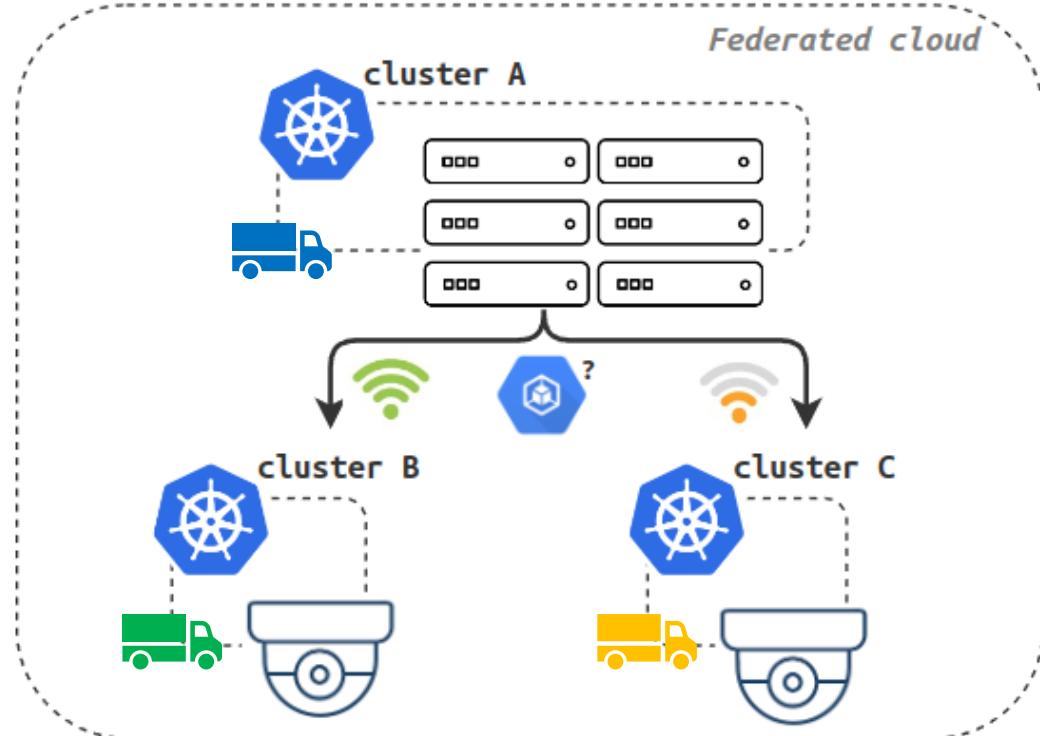
In tactical federation manned or unmanned vehicles join spontaneously in ad-hoc cloud constellations to deliver a resilient, distributed, and collaborative computation.



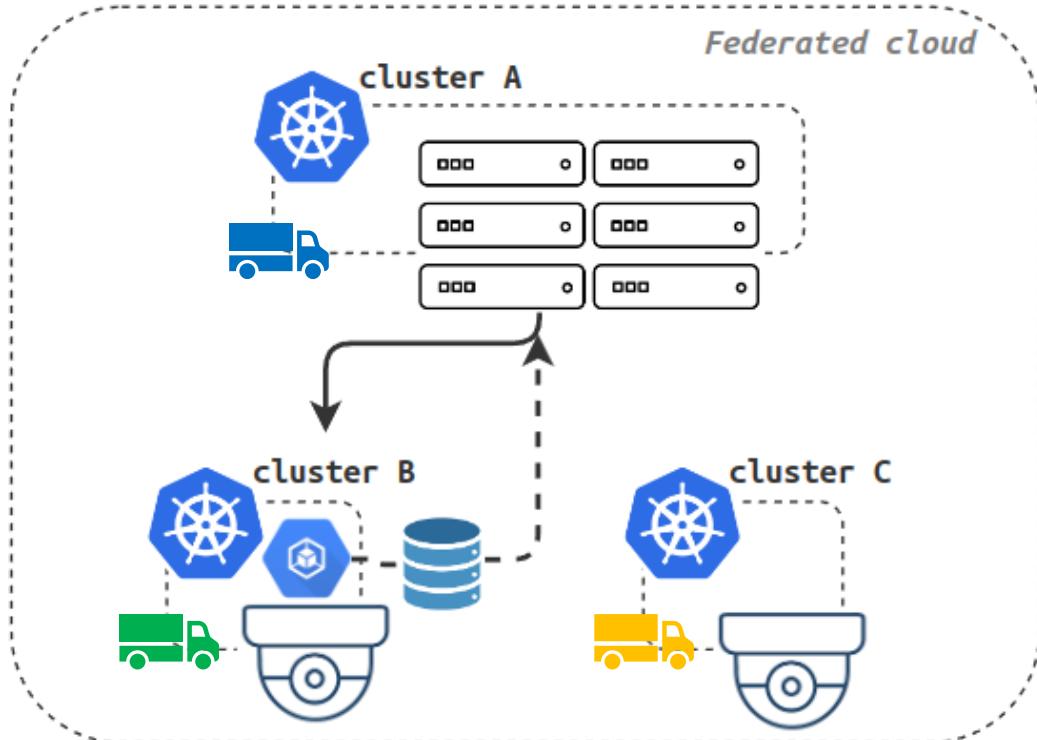
Tactical Federation Wish List



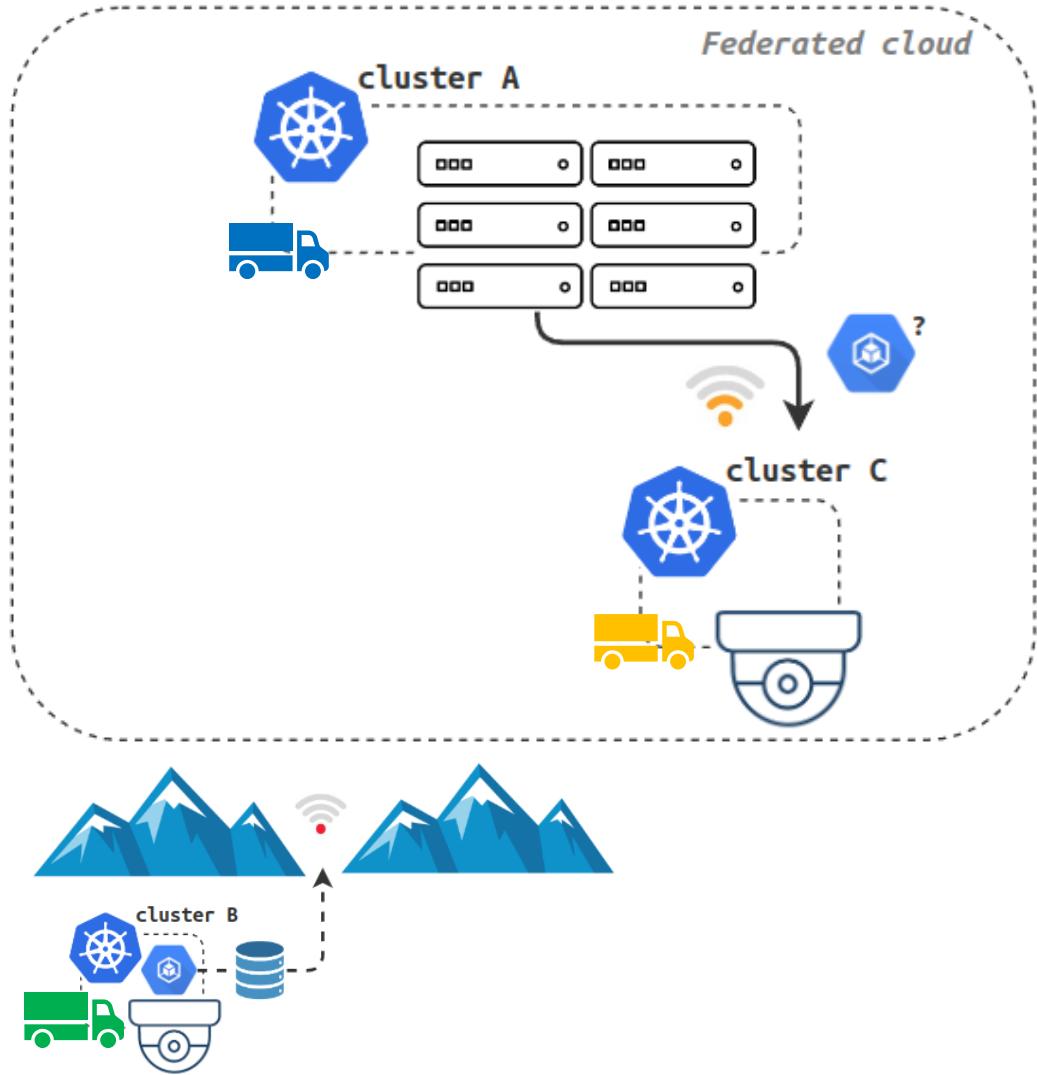
TacFed scenario



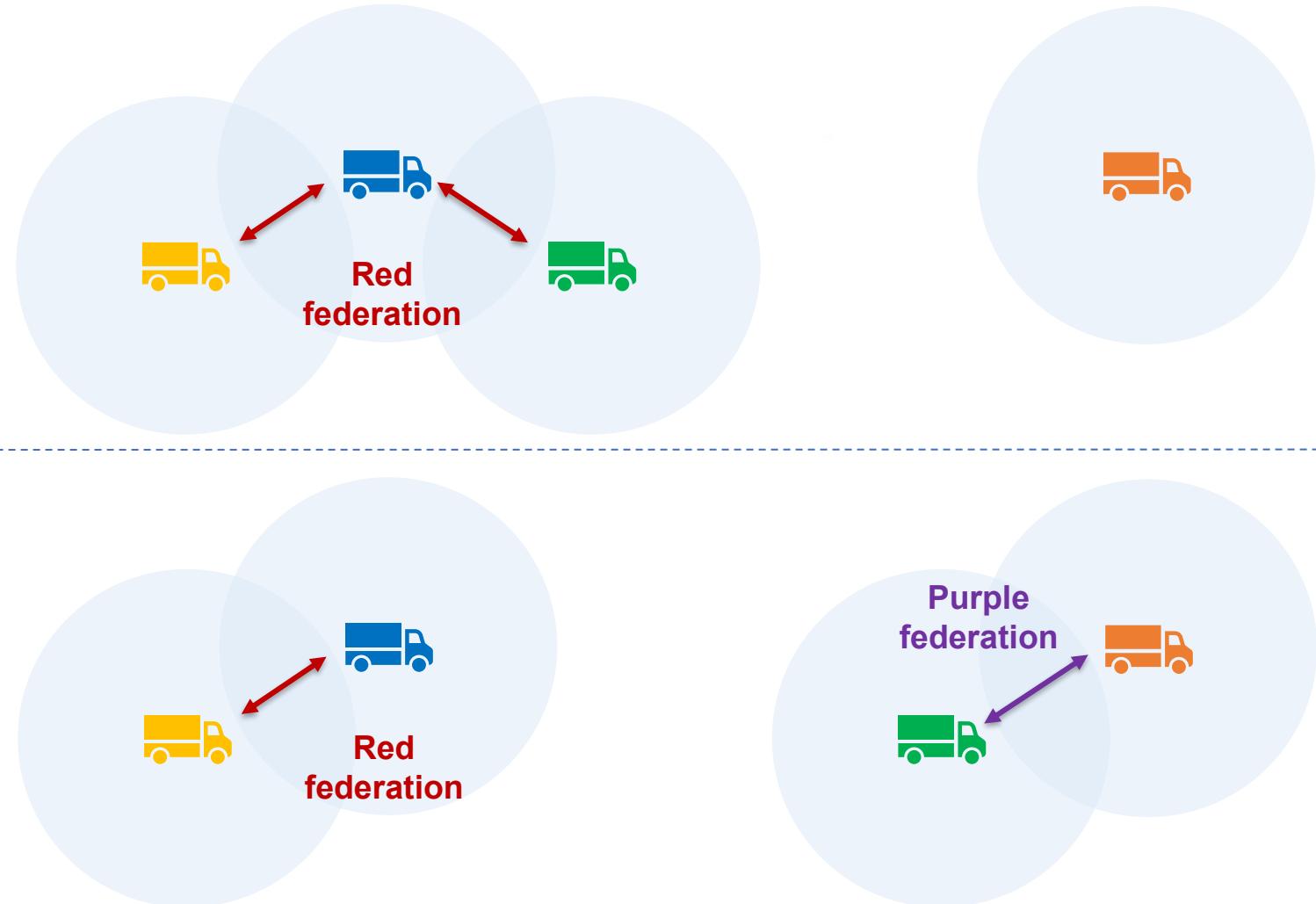
TacFed scenario



TacFed scenario



Wish 1: Joining and leaving federation is natural and expected.



🚚 joins **red** federation temporarily and shares computation with 🚚 and 🚚, after a while it moves its location and joins the **purple** federation to collaborate with 🚚.

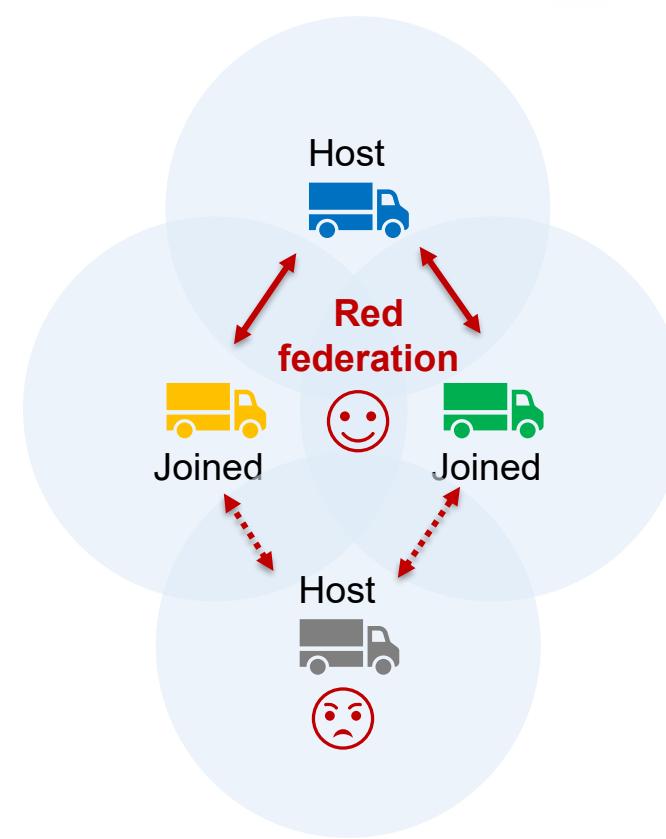
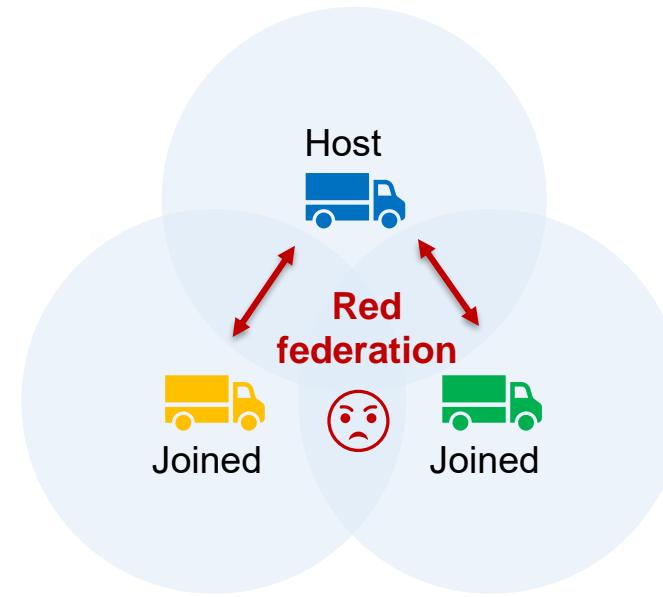
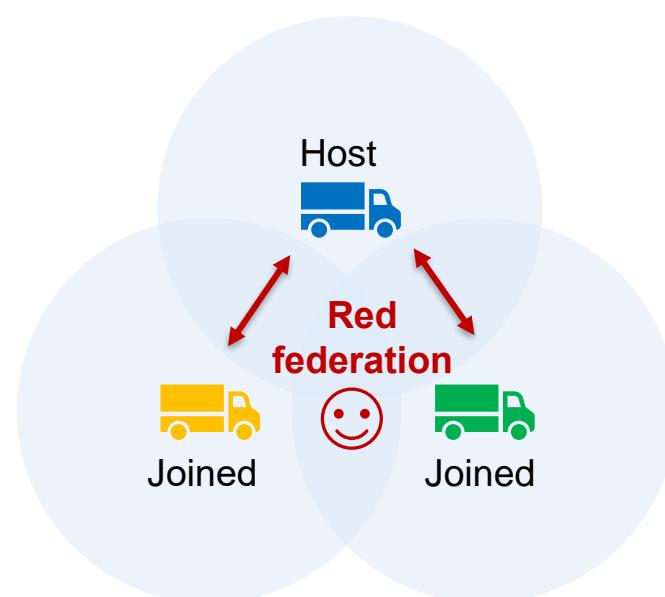
Hierarchical federation with



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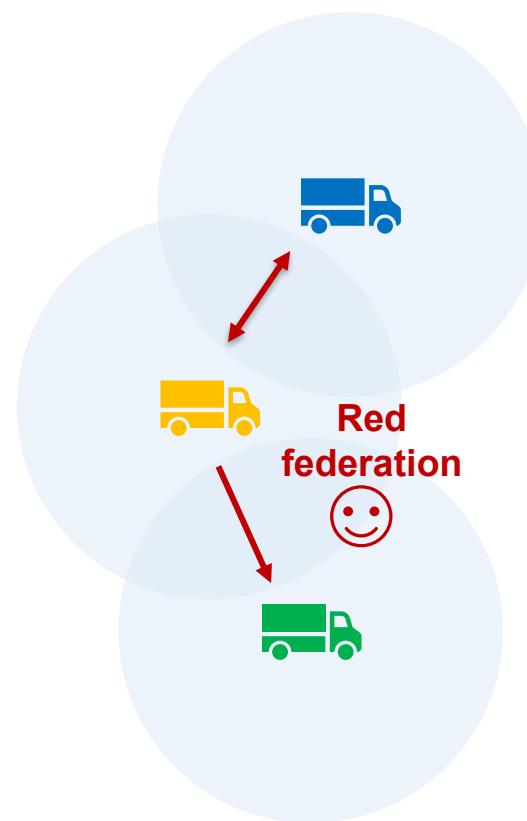


Disappearance of the joined cluster does not influence the federation.

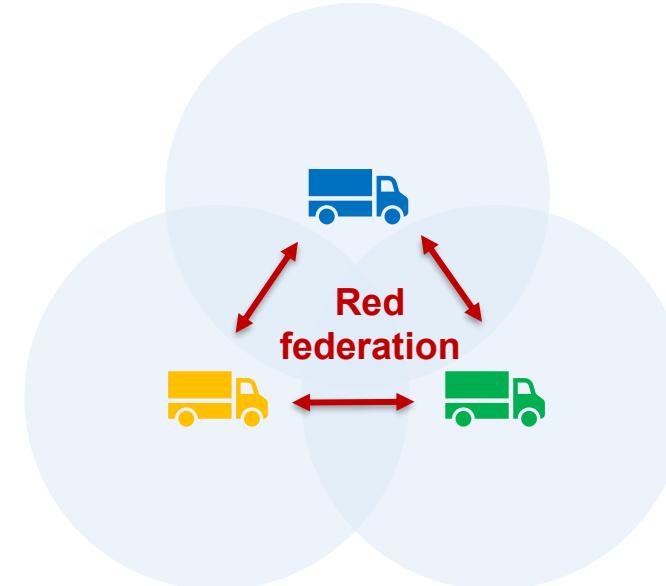
Disappearance of the host cluster makes the federation go brrrr...

Appearance of another that wants to schedule applications to other clusters not possible.

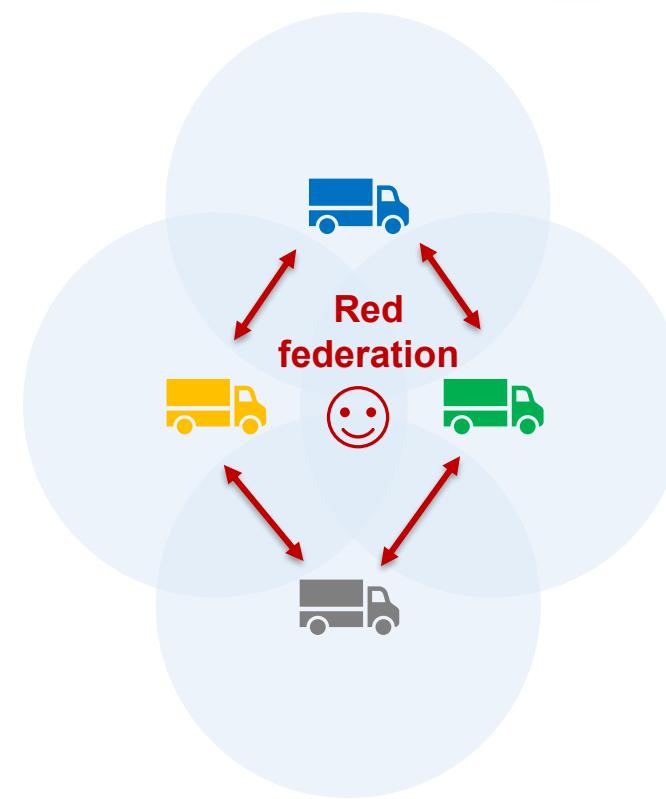
Distributed federation with



Any cluster can agree with any cluster to form a federation. The agreement is directional.

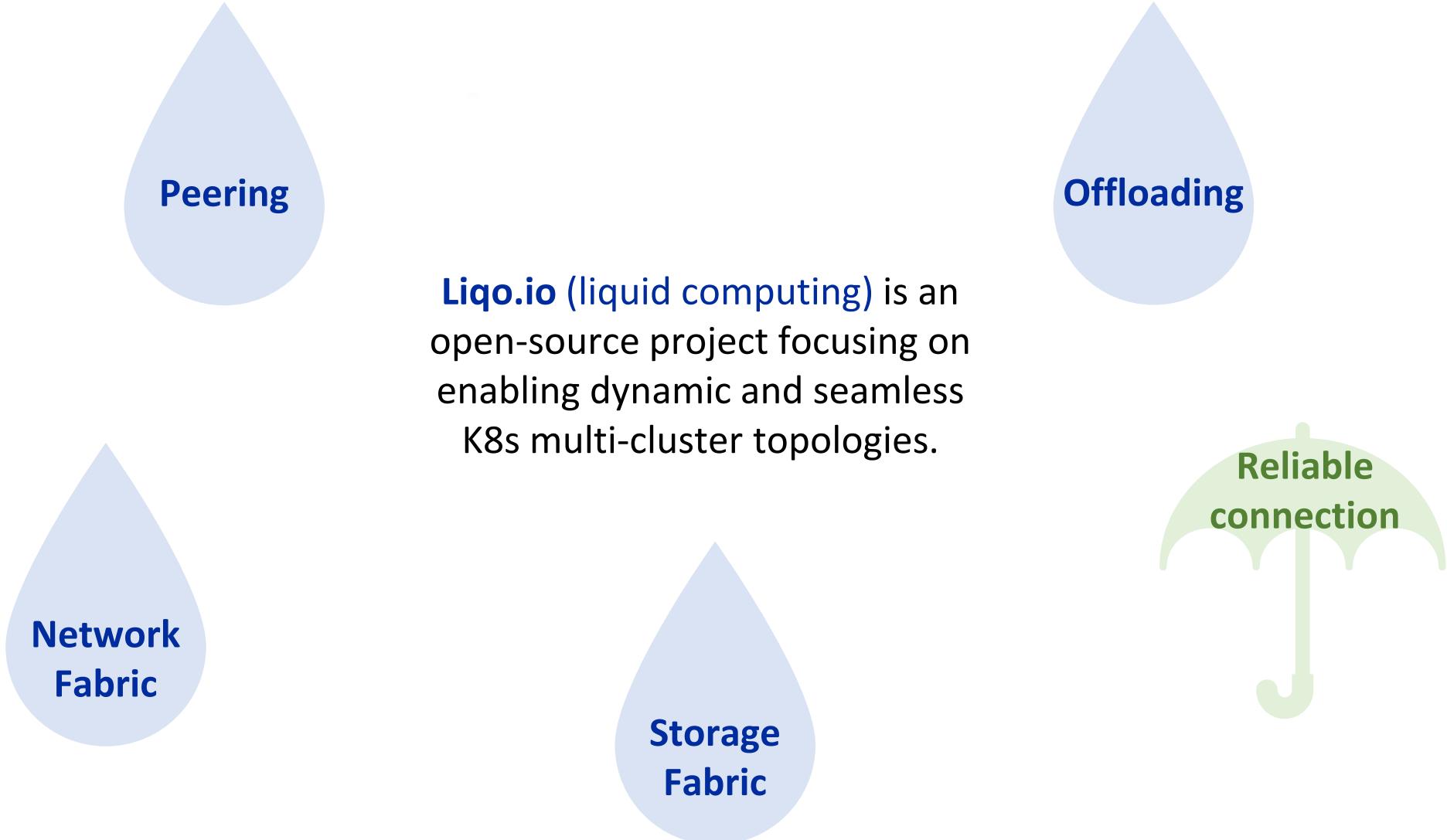


Disappearance of the cluster  is graceful and connected clusters are informed. Unjoining period can be delayed.

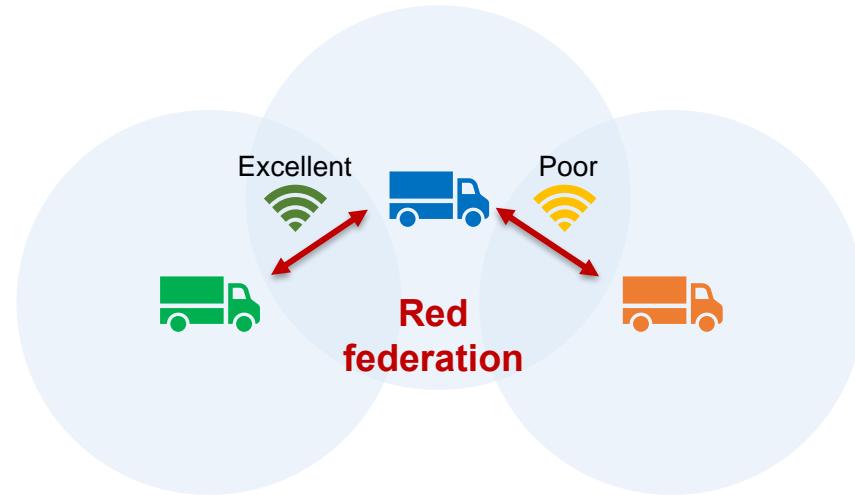


Appearance of another  that wants to schedule applications to other clusters is possible.

Distributed federation with Liqo

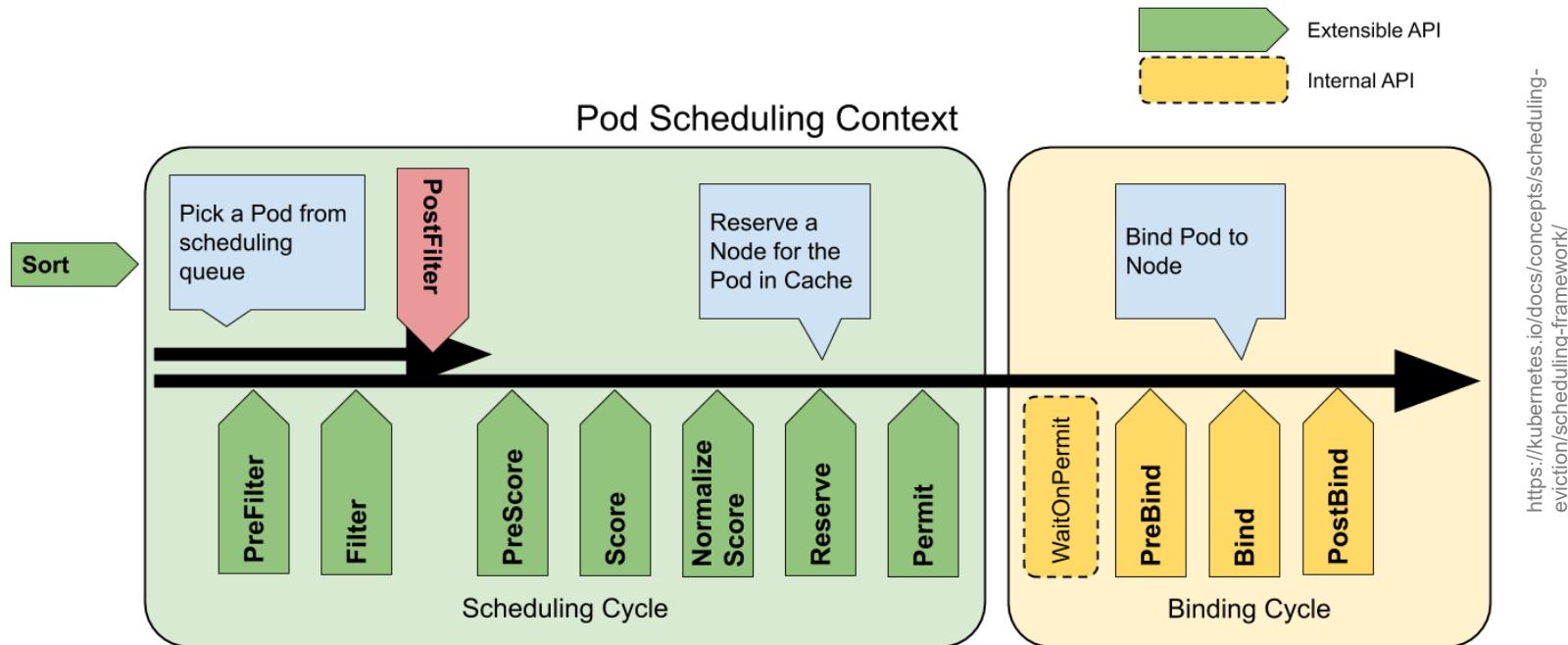


Wish 2: Scheduling takes under consideration networking condition.



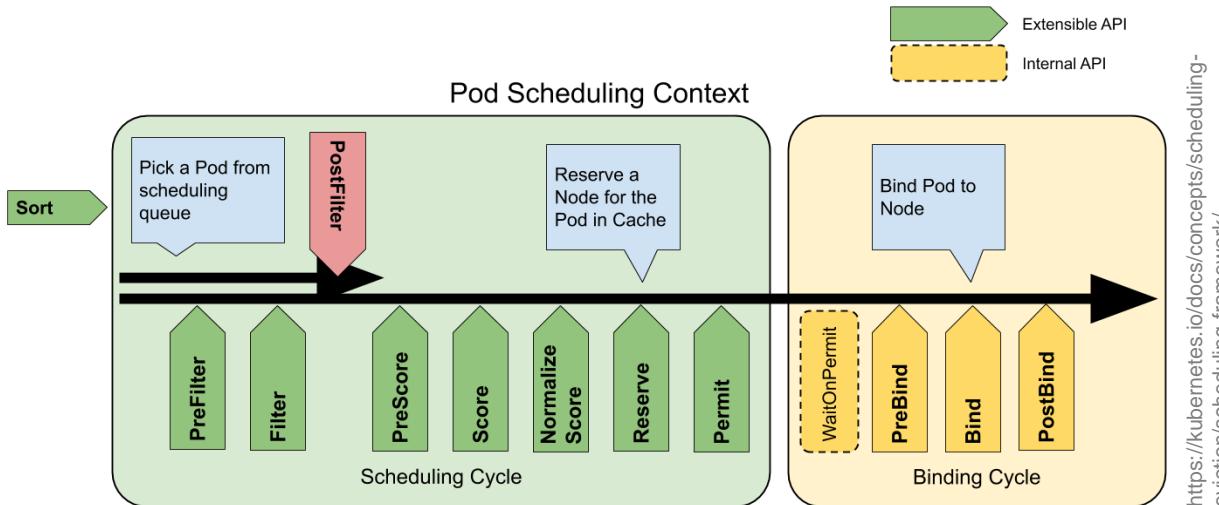
🚚 can schedule an application both to 🚚 and 🚚, however the current networking conditions are better with 🚚 .

Scheduling with kube-scheduler



- **TaintToleration**
- **NodeName**
- **NodePorts**
- **NodeAffinity**
- **PodTopologySpread**
- **NodeUnschedulable**
- **NodeResourcesFit**
- **VolumeBinding**
- ...
- **ImageLocality**
- **TaintToleration**
- **NodeAffinity**
- **PodTopologySpread**
- **NodeResourcesFit**
- **NodeResourcesBalancedAllocation**
- **VolumeBinding**
- ...

Wish 2: Scheduling takes under consideration networking condition with OLSR and TAS

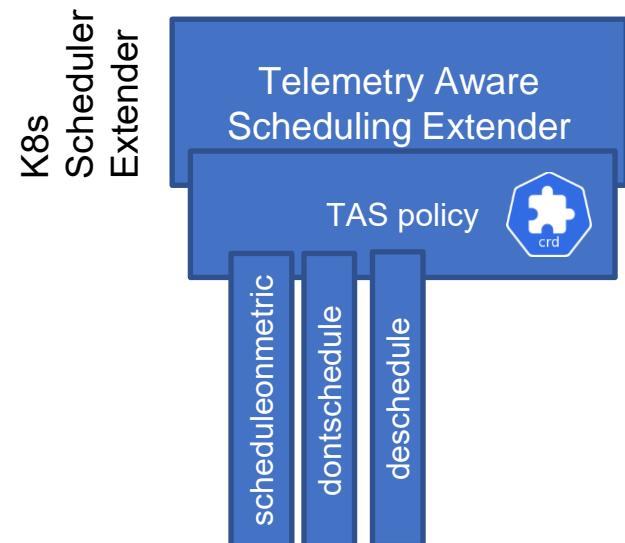


<https://kubernetes.io/docs/concepts/scheduling-eviction/scheduling-framework/>

TAS & OLSR taming performed with skill by Eelco and Johan



Telemetry Aware Scheduling (TAS)



Optimized Link State Routing Protocol (OLSR)

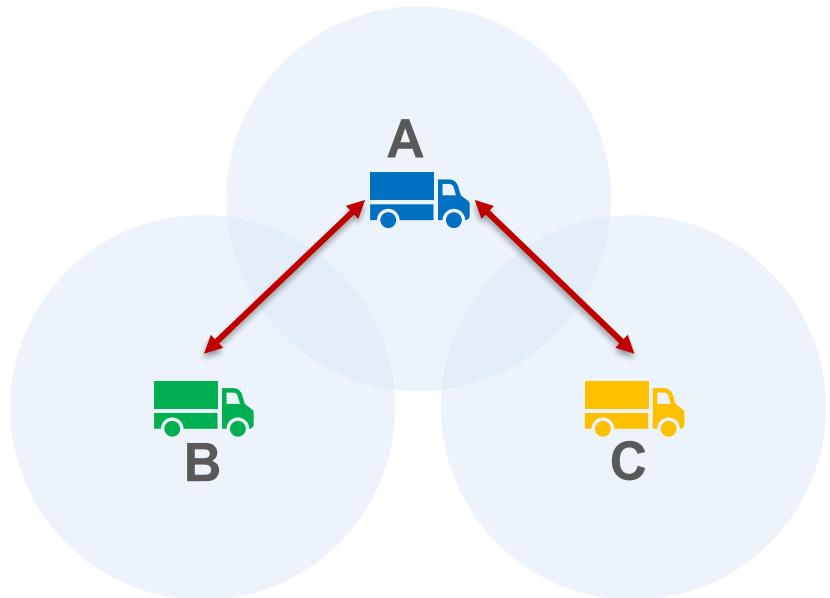


<https://github.com/intel/platform-aware-scheduling/tree/master/telemetry-aware-scheduling> <https://github.com/OLSR/OONF>

```
apiVersion: telemetry.intel.com/v1alpha1
kind: TASPolicy
metadata:
  name: olsr-scheduling-policy
  namespace: demo-federated
spec:
  strategies:
    deschedule:
      rules:
        - metricname: olsr-network-cost
          operator: Equals
          target: -1
    dontschedule:
      rules:
        - metricname: olsr-network-cost
          operator: GreaterThan
          target: 600
    scheduleonmetric:
      rules:
        - metricname: olsr-network-cost
          operator: LessThan
```

How do we test these ideas together?

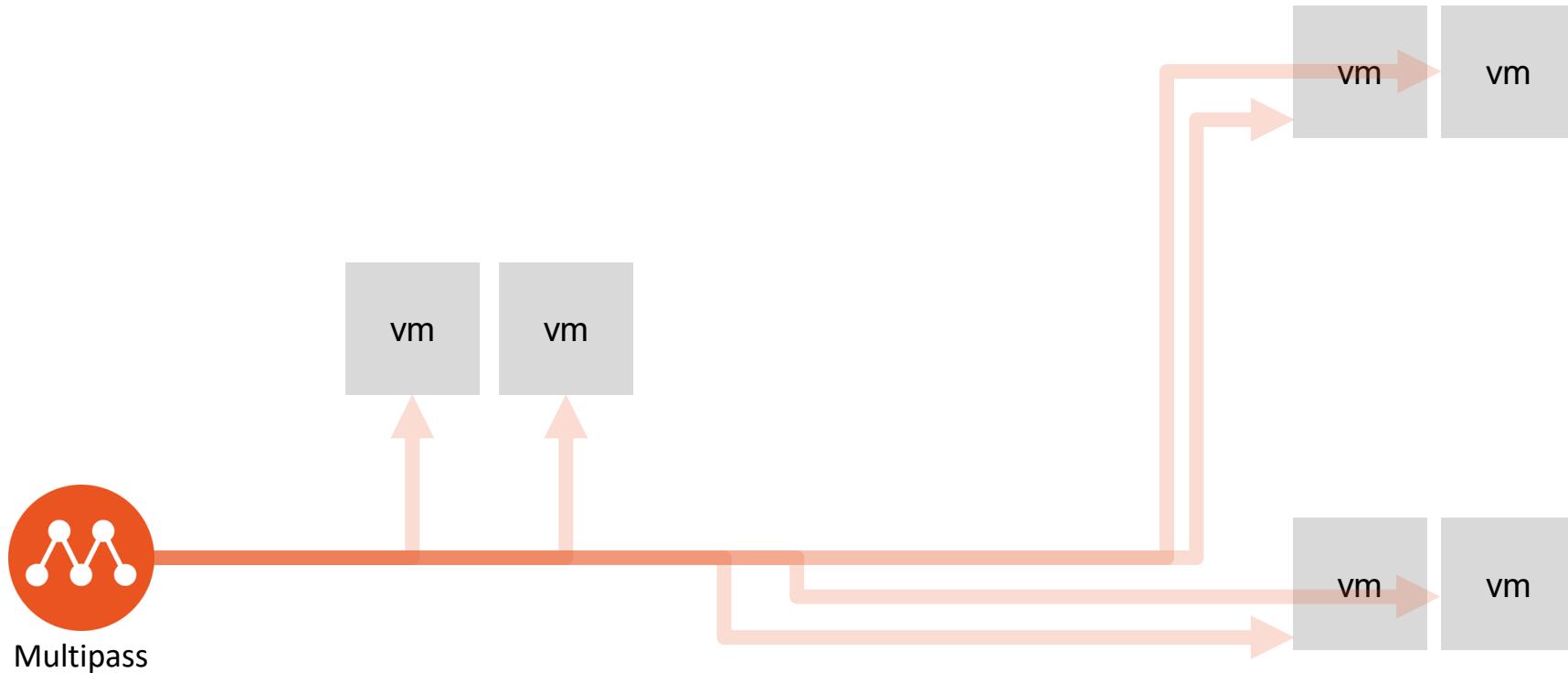
Let's make a tactical cluster federation testbed!



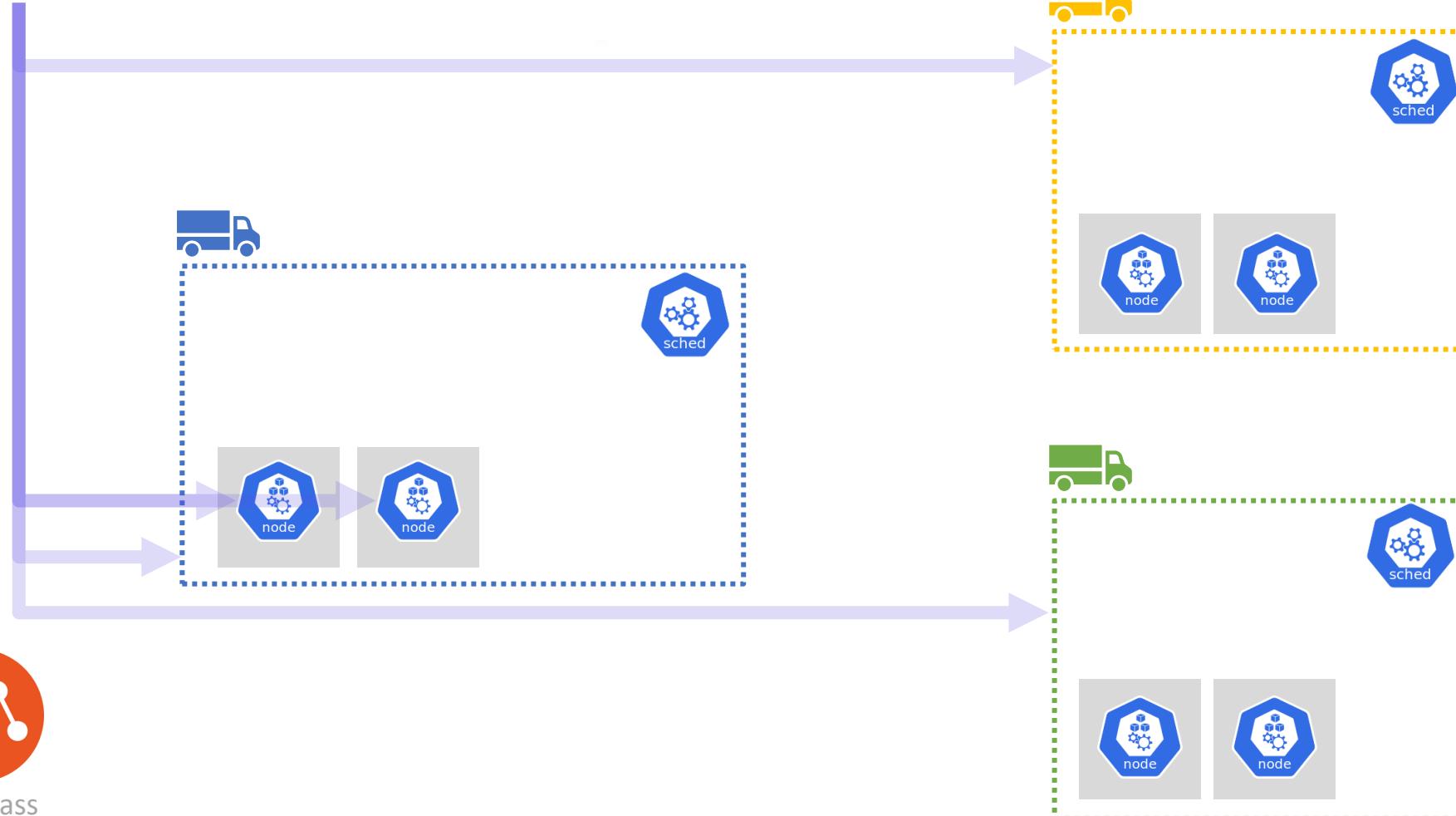
Experiment setup

- Create 3 K8s clusters 2 node each: A,B,C
- Pair bidirectionally A and B, A and C
- Deploy data streaming application across clusters
- Simulate network degradation between clusters

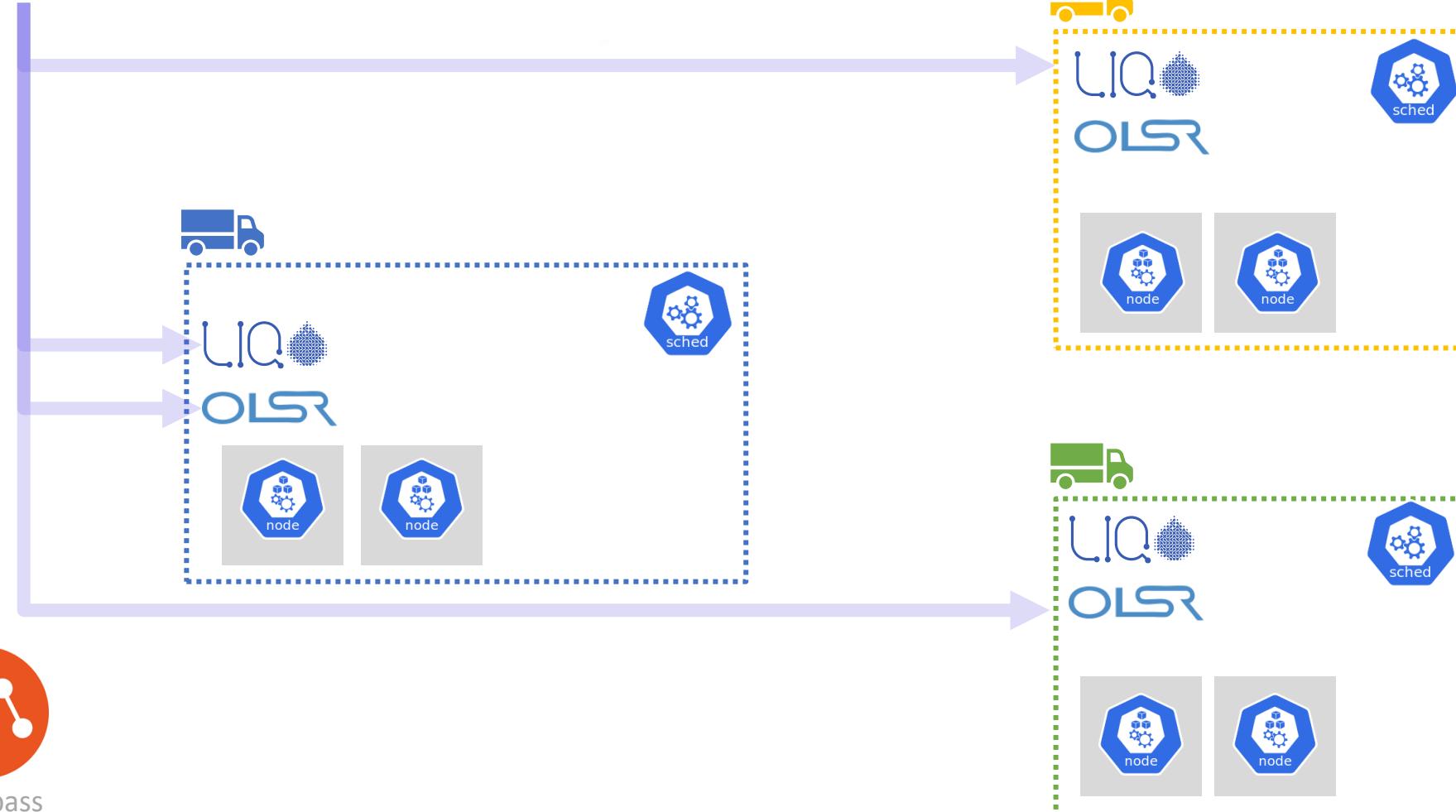
How do we test these ideas together?



How do we test these ideas together?



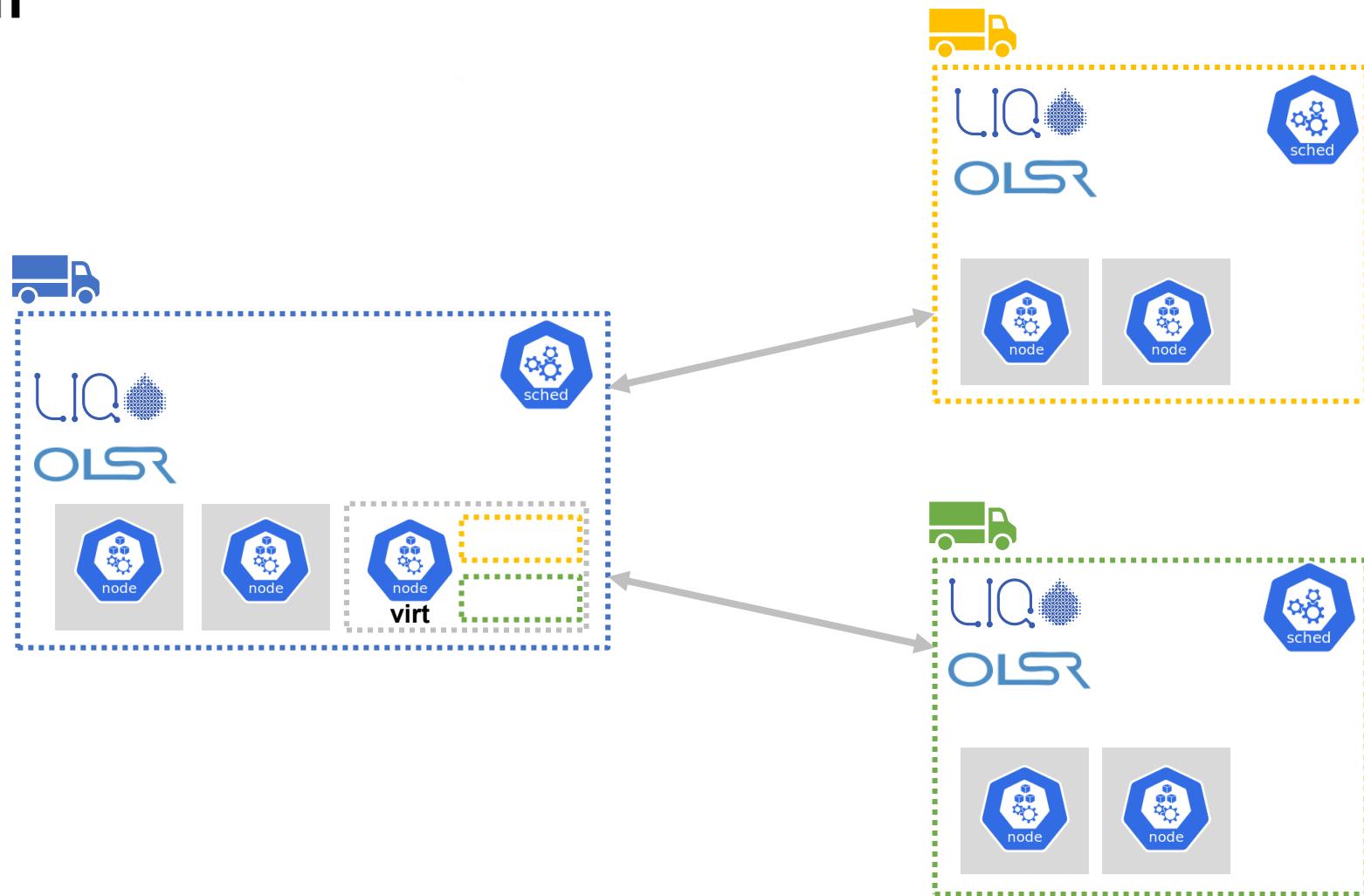
How do we test these ideas together?



How do we test these ideas together?



HashiCorp

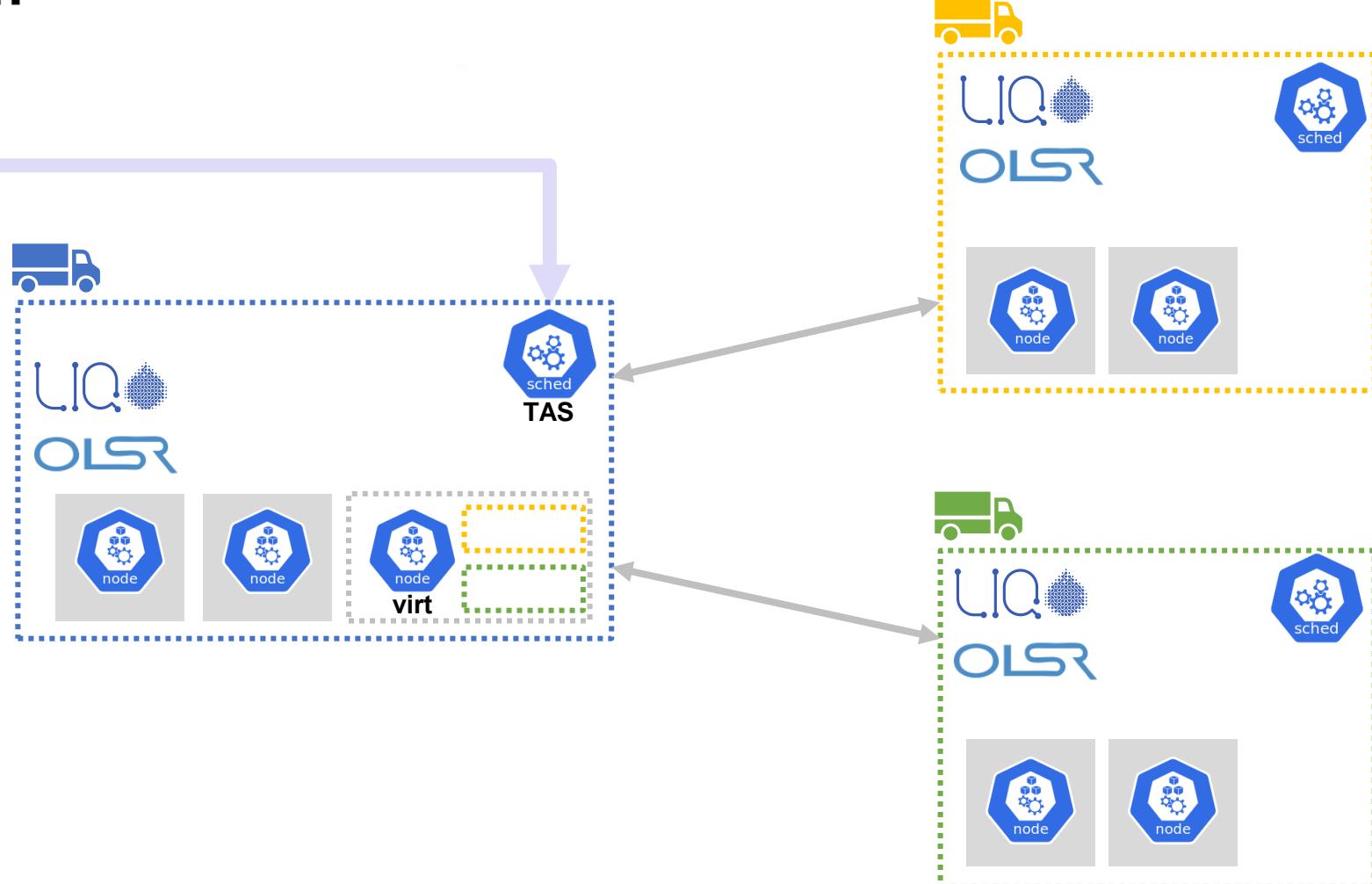


Multipass

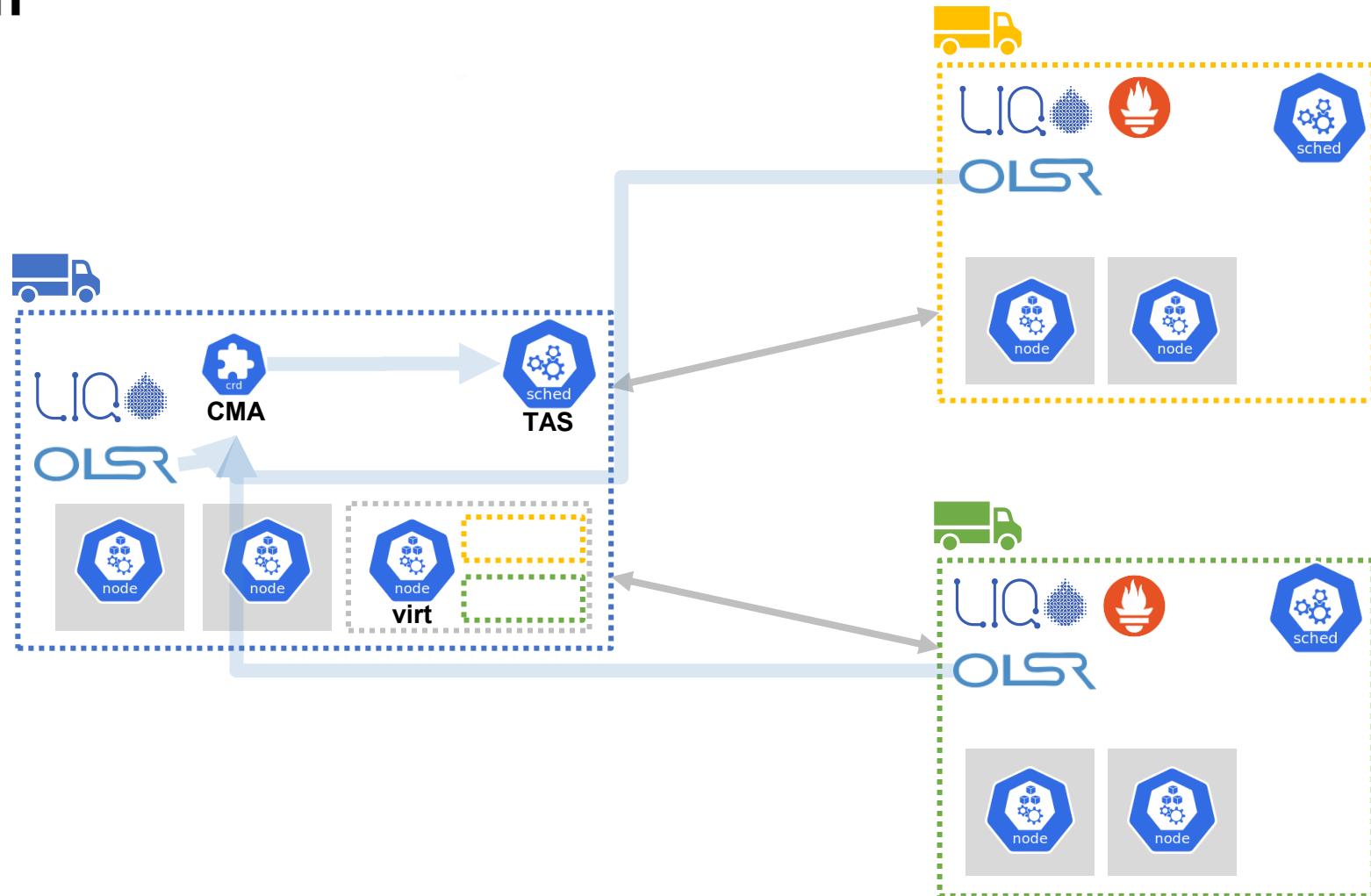
How do we test these ideas together?

HashiCorp
Terraform

Multipass



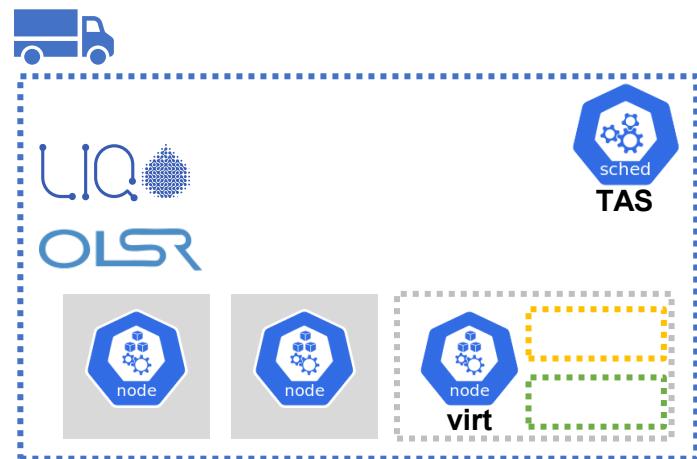
How do we test these ideas together?



Experiment step 1: apply network effects

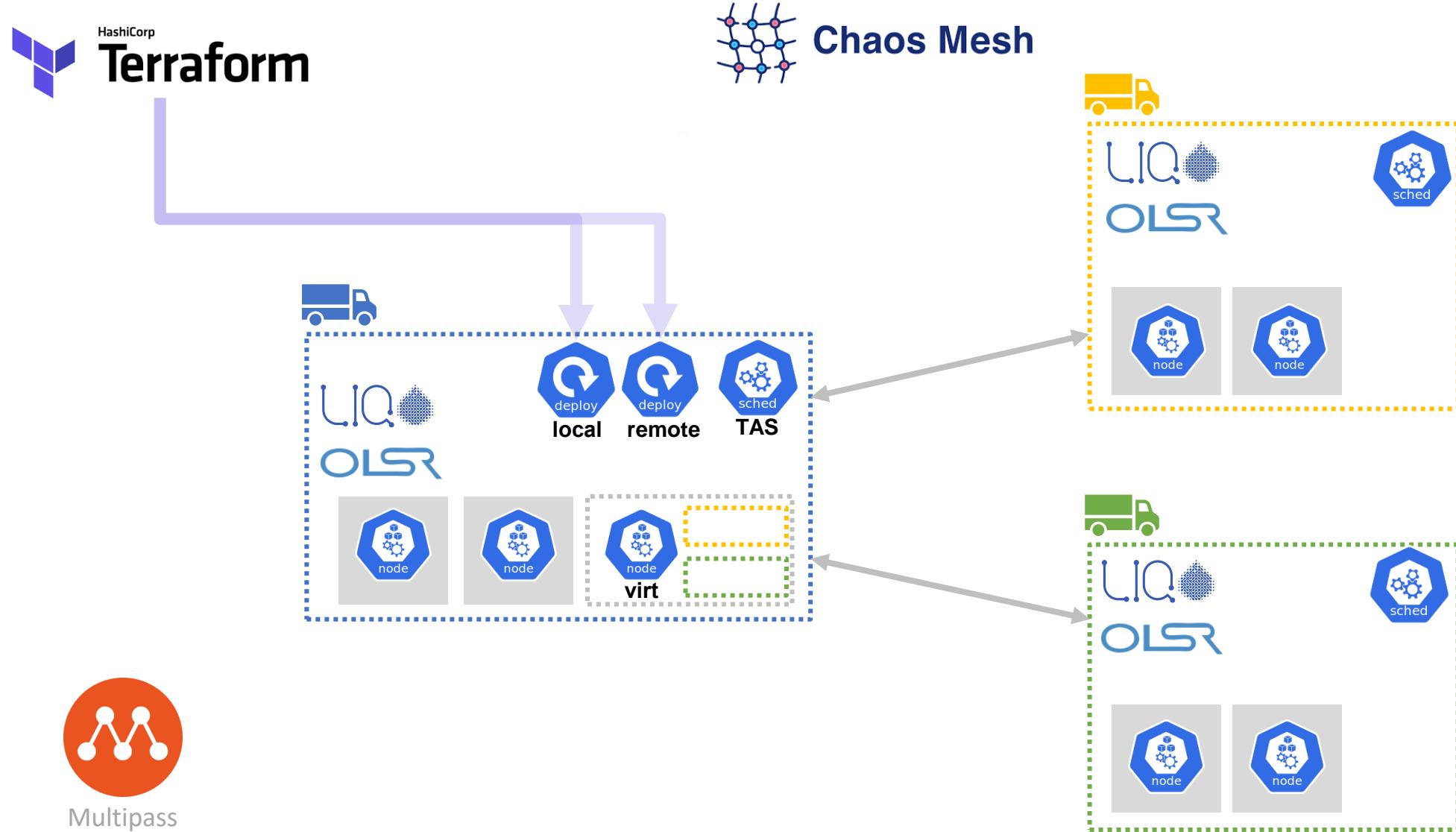


Chaos Mesh

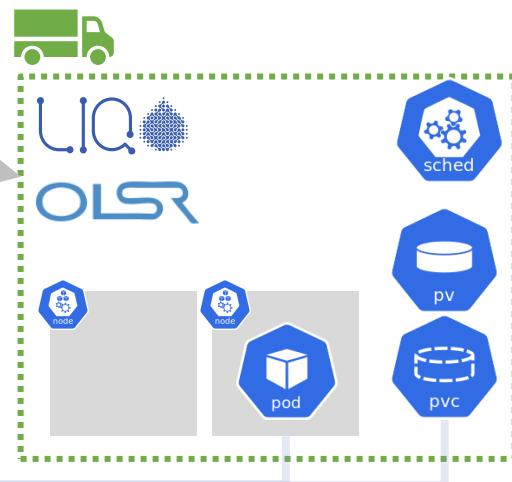
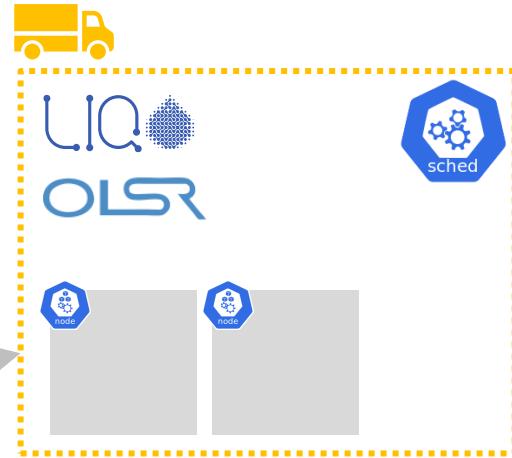
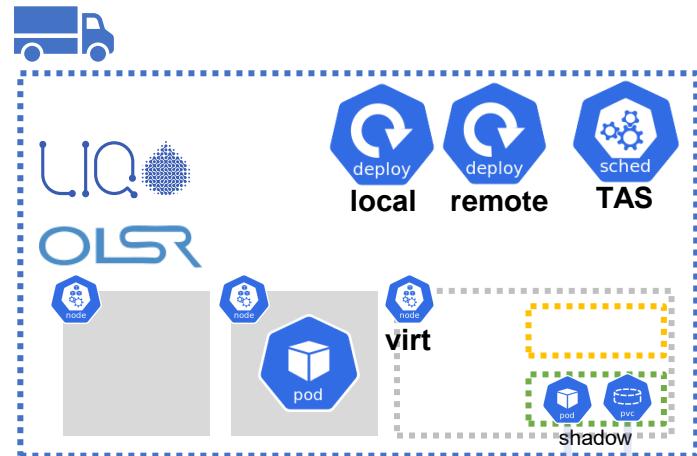


Multipass

Experiment step 2: deploy an application to cluster A



Experiment step 4: application offloading

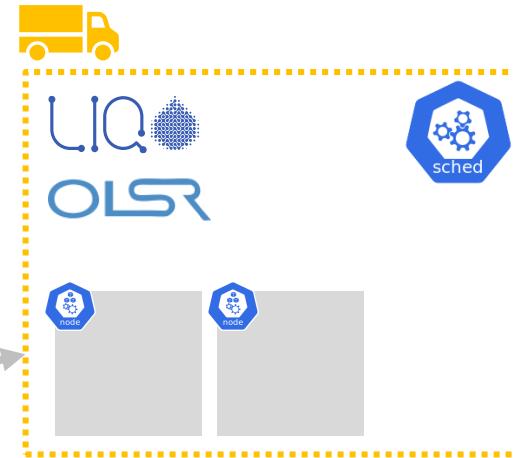
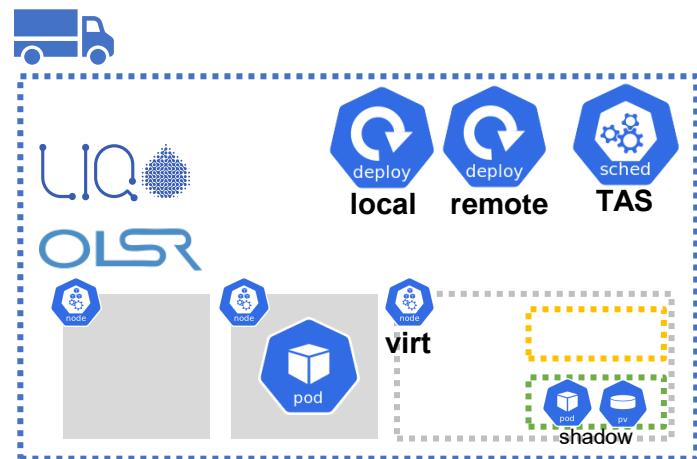


Liqo resource reflection

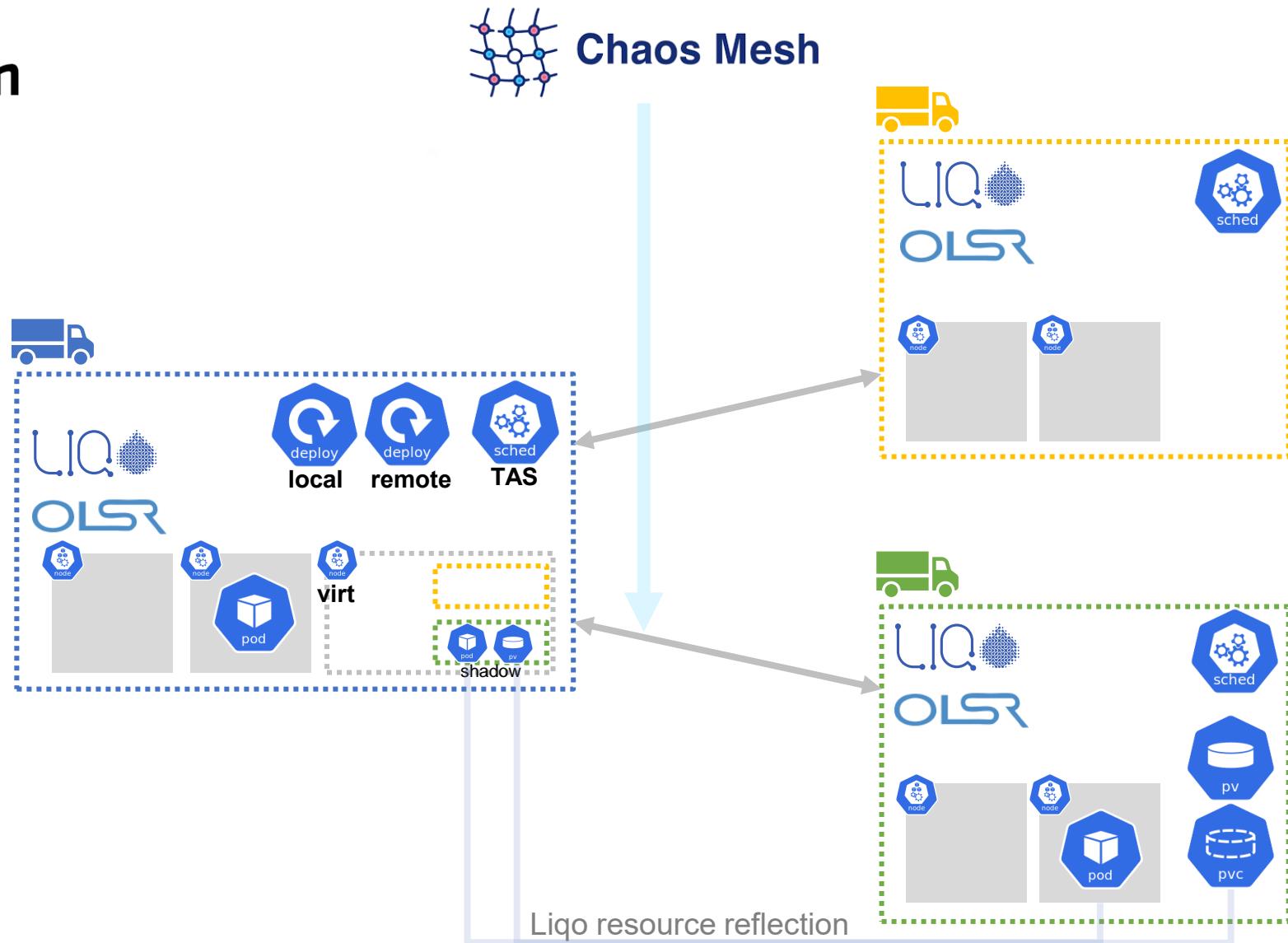
Experiment step 5: limit connection to cluster B



Chaos Mesh

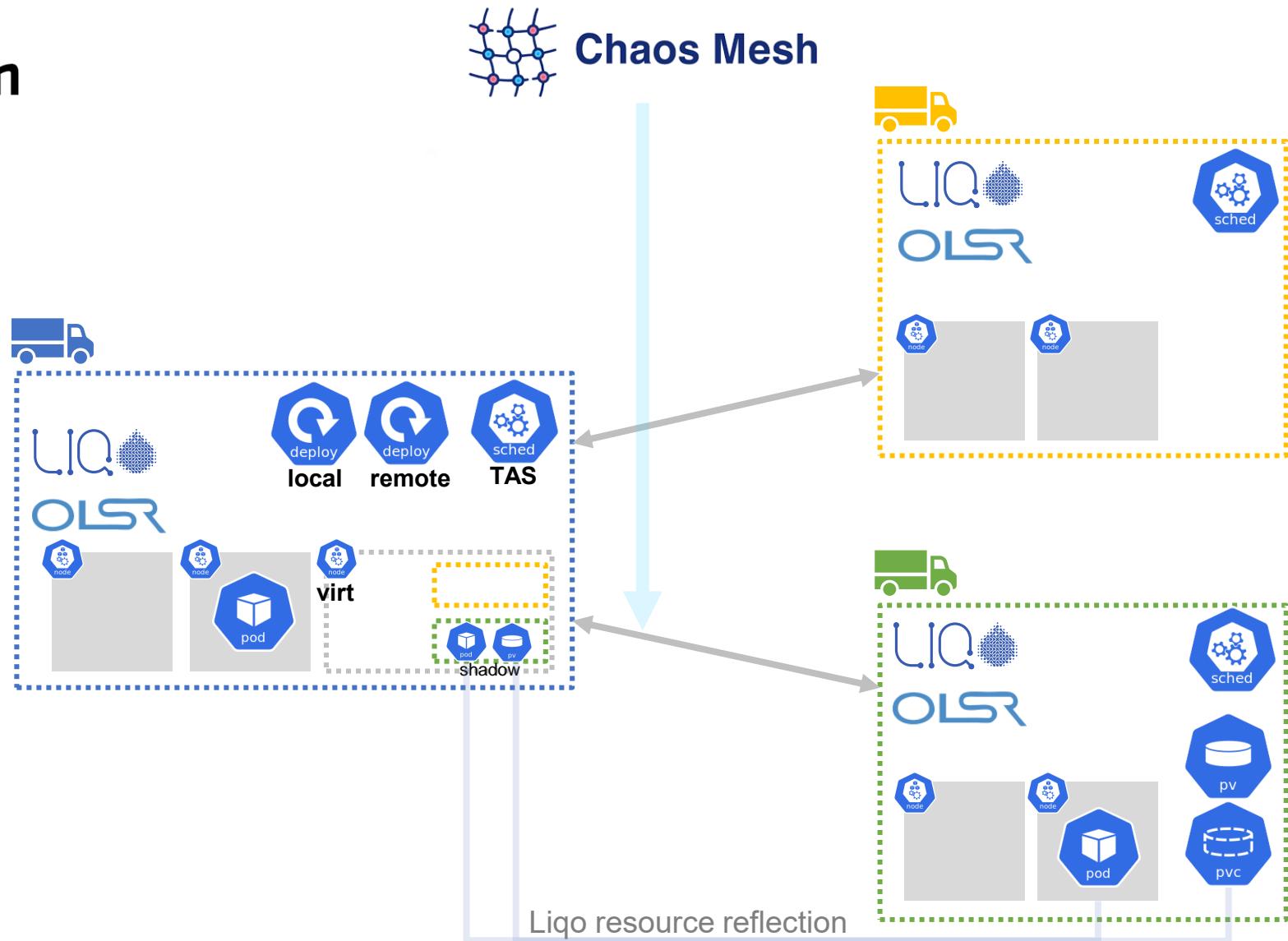


Experiment step 5: restore connection to cluster B



Multipass

Experiment step 5: restore connection to cluster B

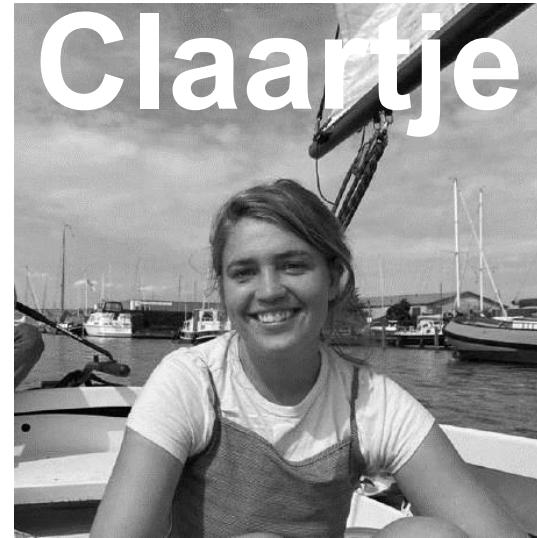


Multipass

TacFed
test-bed
developed
by Geert



Demo of Fleet Federation Dashboard created by Claartje



```
block within the module.  
(and 2 more similar warnings elsewhere)  
  
Warning: Quoted references are deprecated  
  
  on modules/kubernetes_deployments/main.tf line 108, in resource "null_resi  
108:   "helm_release.chaos_mesh"  
  
In this context, references are expected literally rather than in quotes. Tr  
quotes, but quoted references are now deprecated and will be removed in a fi  
the quotes surrounding this reference to silence this warning.  
(and 5 more similar warnings elsewhere) [
```

```
Apply complete! Resources: 138 added, 0 changed, 0 destroyed.
```

```
~/git/v1905/tacfed/experiment-infrastructure demo #4 13  
$ ./demo-run.sh
```

```
experiment-infrastructure:zsh  
Image is up to date for docker.io/liqu/virtual-kubelet@sha256:2e4e23bf639af02t  
cb72f7c2e98f  
Image is up to date for docker.io/liqu/uninstaller@sha256:84063582962ed880f71  
0884e3be  
Image is up to date for docker.io/envoyproxy/envoy@sha256:4b99b1c1@ch85fb1a2:  
074bf7c4  
Image is up to date for docker.io/liqu/telemetry@sha256:1fc224dc45fec3ba30fa6c  
daec2c
```

```
~/git/v1905/tacfed/experiment-infrastructure demo #4 13  
$
```

```
fmx:zsh  
cd ~/git/v1905/tacfed/experiment-infrastructure
```

```
~/git/v1905/tacfed/experiment-infrastructure demo #4 13  
$ cd ../fmx
```

```
~/git/v1905/tacfed/fmx main [4]  
$ code .
```

```
~/git/v1905/tacfed/fmx main [4]  
$
```

TacFed

Fleet Federation Dashboard

Backend
connected

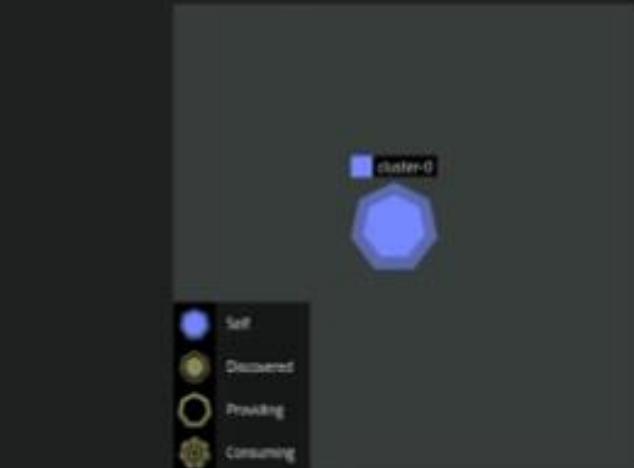
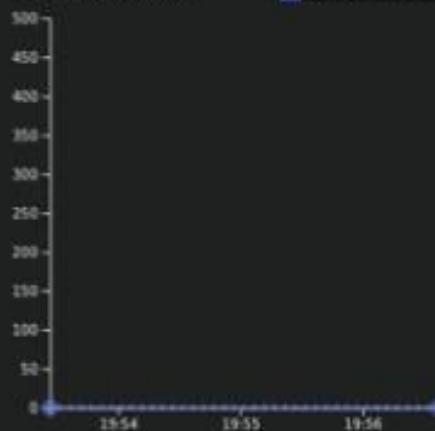
Last events update
18:53:49

Last Federation update
18:53:52

Last OLSR update
18:56:37

OLSR network cost

cluster-0-master-4



Lessons learned



"No plan survives contact with the enemy". Cloud Native technology meets a much-desired need: To adapt and be resilient.

Liqo Data Gravity in combination with deferred unjoining makes a neat offline data gathering solution.



It is not easy, but totally possible to make a complex process into a beautiful picture.



With the current results we can also translate these results back to our regular IT environments.
Also; Who haz them nice sockz?



If you have a dynamic and intuitive visualization and a good story you can explain cluster federation to anybody, even a helicopter pilot.

Decreasing the quality of the connection eventually affects the underlying core federation mechanisms.

	LAN	Best	Average	Worst
Discovery	✓	✓	✓	✓
Peering	✓	✓	✗	✗
Offloading	✓	✓	✗	✗
Unjoining	✓	✓	✗	✗

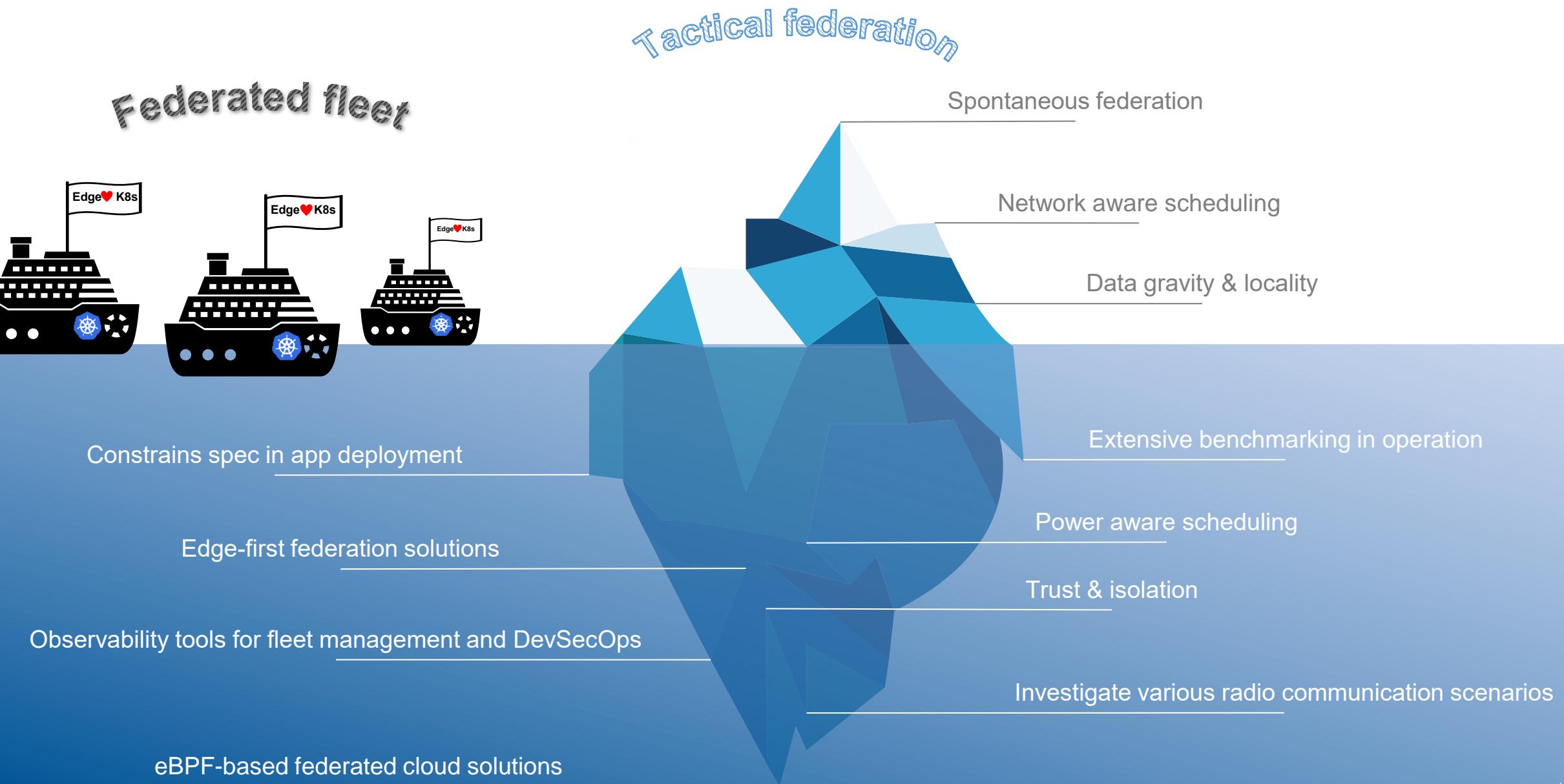


	Bandwidth	Loss	Latency
LAN	1 Gbit/s - no restrictions	No added loss	No added latency
Best	4 Mbit/s	5%	200ms
Average	2 Mbit/s	10%	400ms
Worst	650 kbit/s	15%	3000ms

Federated cloud, especially at the edge, has big (but interesting) challenges. When done right however, it unlocks great new opportunities - for example in sustainable computing or orbital edge computing



Where Do We Go From Here?





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Joint IT Command, Dutch Ministry Of Defence*
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Excited about Tactical Federation with K8s? Let us know!



Johan van der Geest

*Senior Scientist Cloud Computing
TNO*
<https://www.linkedin.com/in/johanvdgeest/>