Bridging Clusters: A comparative Look at Multicluster Networking Performance in Kubernetes

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Agenda

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2. Single-Cluster vs Multi-Cluster
3. Multicluster networking solutions feature comparison
   a. Submariner
   b. Skupper
   c. Istio
4. Testbed description
5. Tooling
6. Results
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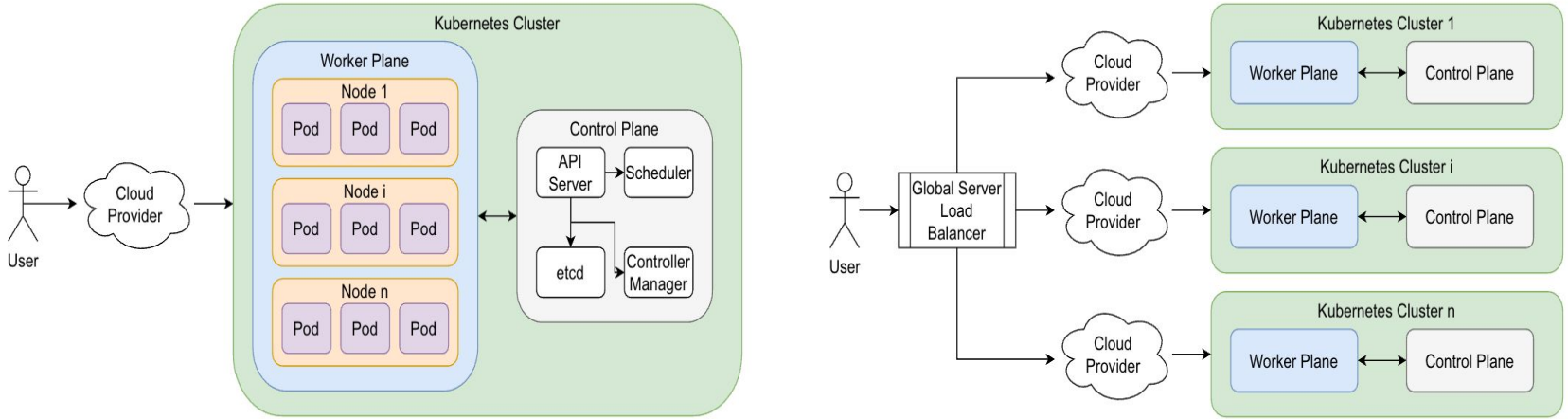
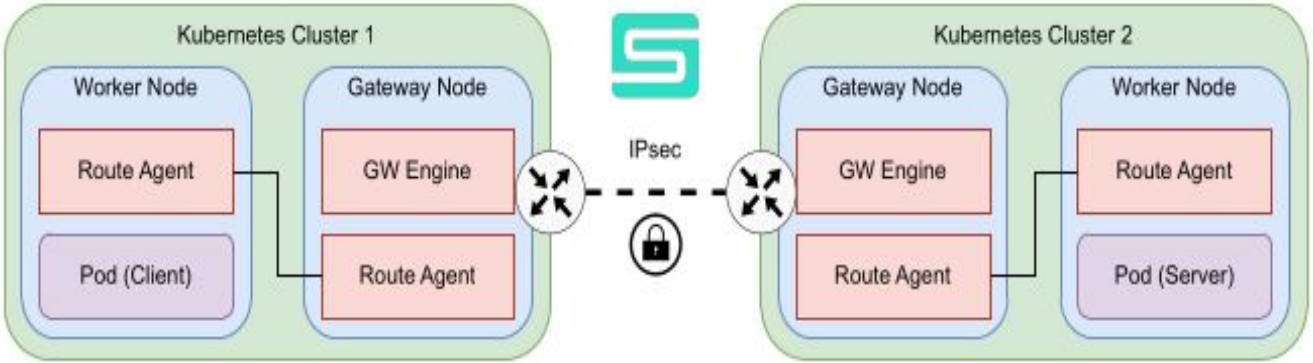
CODECO
Cognitive Decentralised Edge Cloud Orchestration
Funded by the European Union

Single vs Multi-Cluster



Why Multi-Cluster? Geo-redundancy, scale, fault-isolation

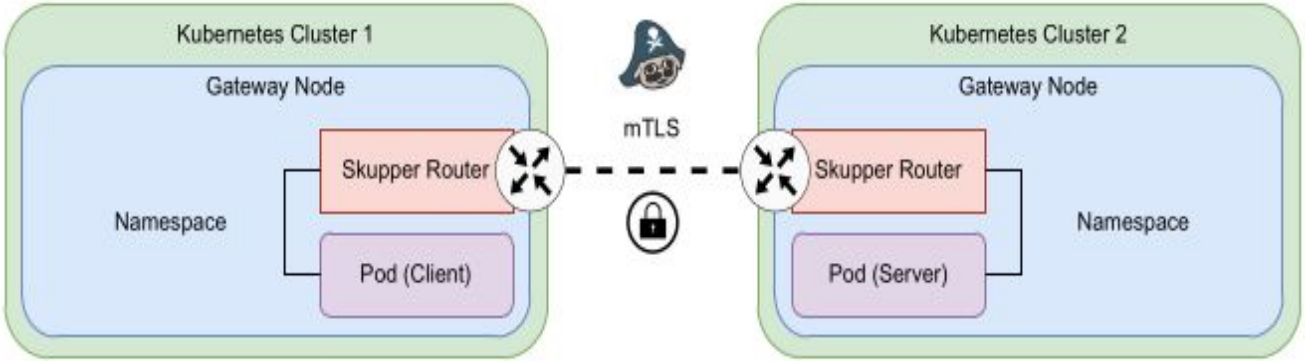
Submariner



Cross-cluster L3 connectivity using encrypted or unencrypted connections

Version: 0.18.9

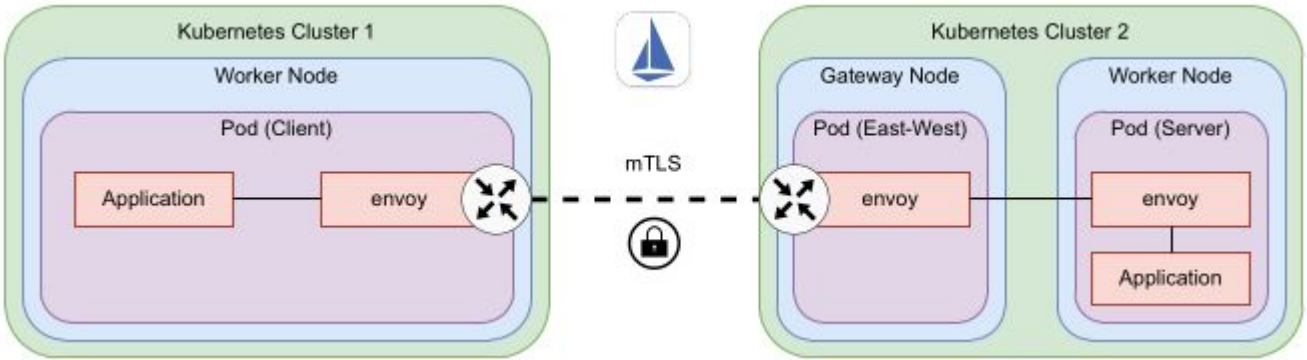
Skupper



Skupper is a layer 7 service interconnect that enables secure communication across Kubernetes clusters with no VPNs or special firewall rules.

Version: 1.8.1

Istio (Service Mesh)



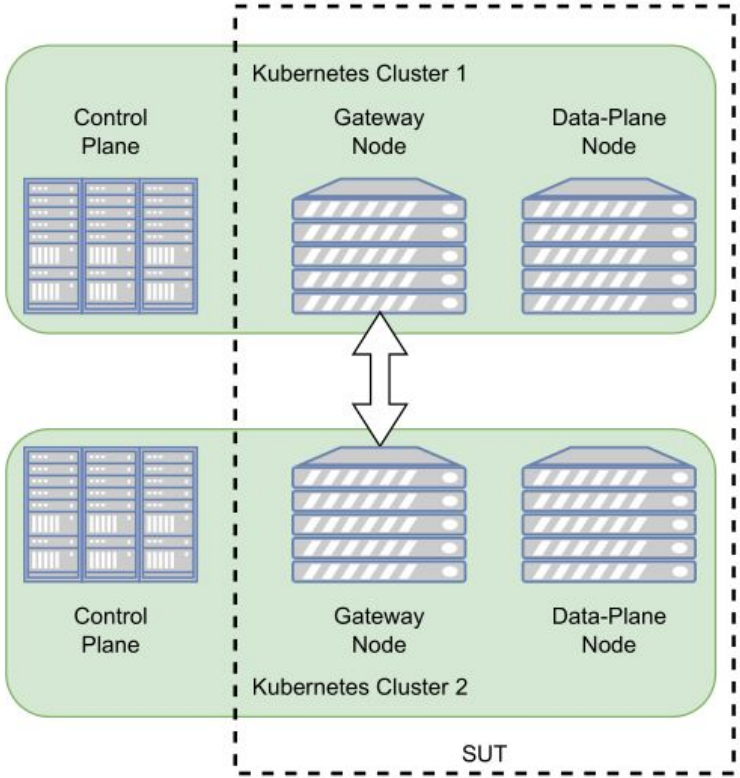
Service Mesh is an infrastructure layer that enables managed, secure and observable communication - there are existing deployment options to extend this layer across cluster boundaries.

Version: 1.23.2

Feature Comparison

	Skupper	Submariner	Istio
Operation layer	L4	L3	L4/L7
Network topology	Point to point	Hub/spoke	Network mesh
Inter-connect level	Namespace	Cluster	Service
Service discovery	✓	✓	✓
Security features	mTLS	IPsec	mTLS
Authentication policies	Limited	✗	✓
Integrated observability	Limited	Limited	✓
Configuration Complexity	Low	Low	High
CNI independence	✓	✗	✓
Traffic management	✗	✗	✓
Multicloud support	✓	✓	✓
End user persona	Developer	Cluster admin	Cluster admin, Developer
License	Apache 2.0	Apache 2.0	Apache 2.0
CNCF hosted	✗	✓	✓

Testbed



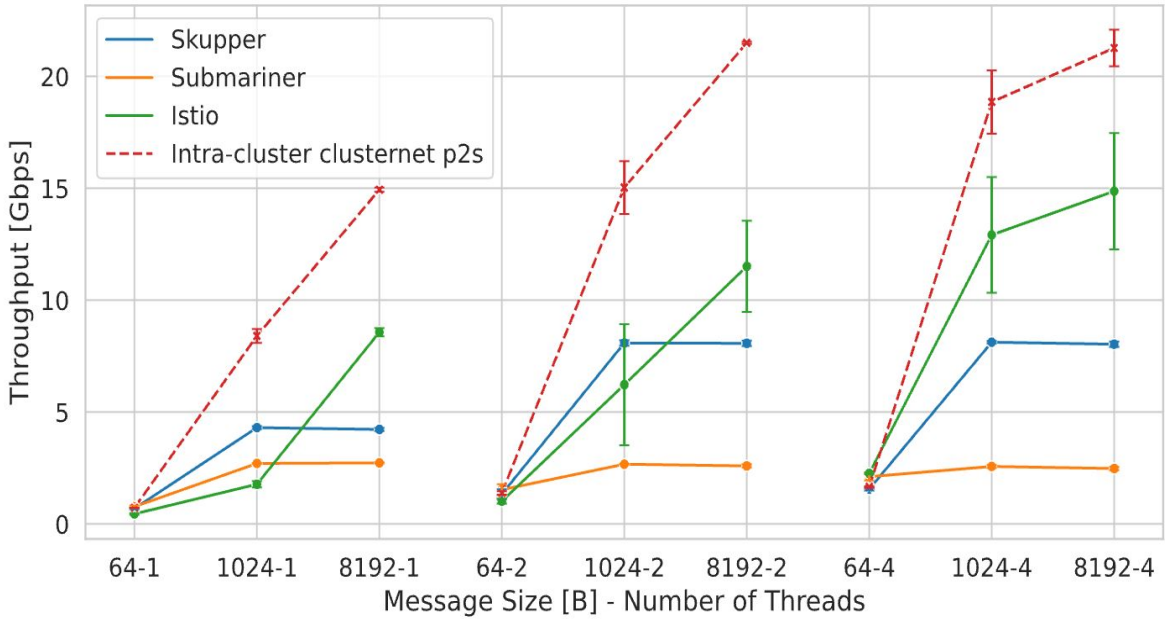
OpenShift 4.16

Tooling

- Layer 4: uperf (stream and request-response)
- Layer 7: wrk2
- Energy monitoring: Kubernetes Efficient Power Level Exporter (Kepler)

Templates can be found at:
https://github.com/RedHatResearch/icpe25-multi-cluster-networking

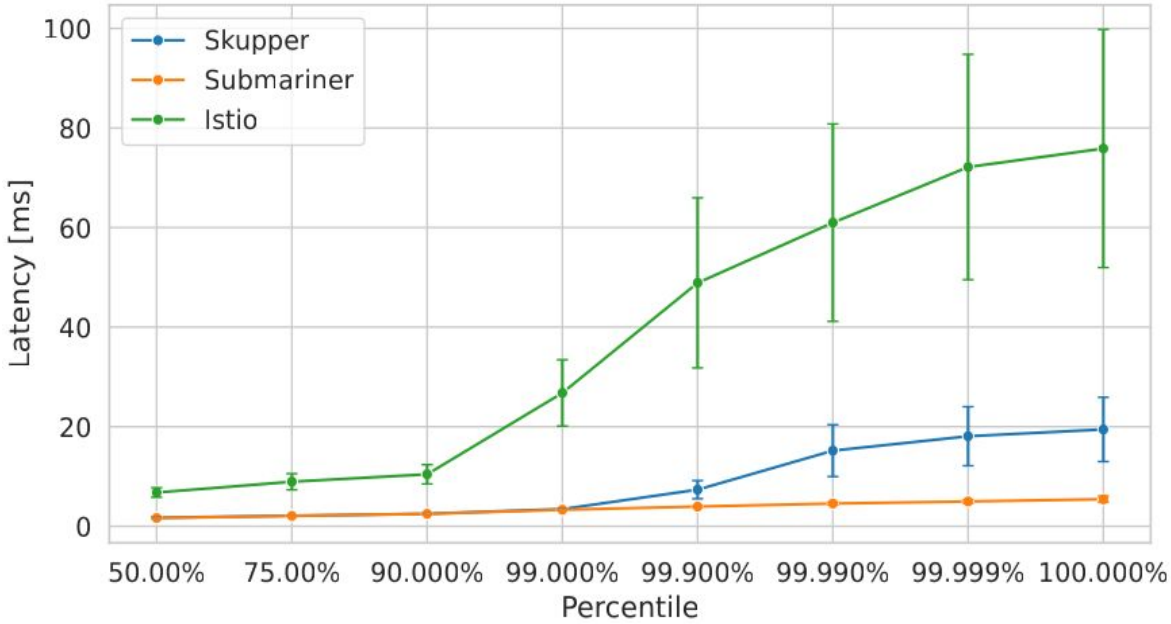
Stream



- Istio has the highest throughput, Skupper is pegged at ~8Gbps and Submariner comes in as the lowest at ~3Gbps due to a IPSec/Kernel implementation limitation
- RFC 9611 introduces support for encrypted traffic to be handled across multiple CPUs without splitting logical tunnels

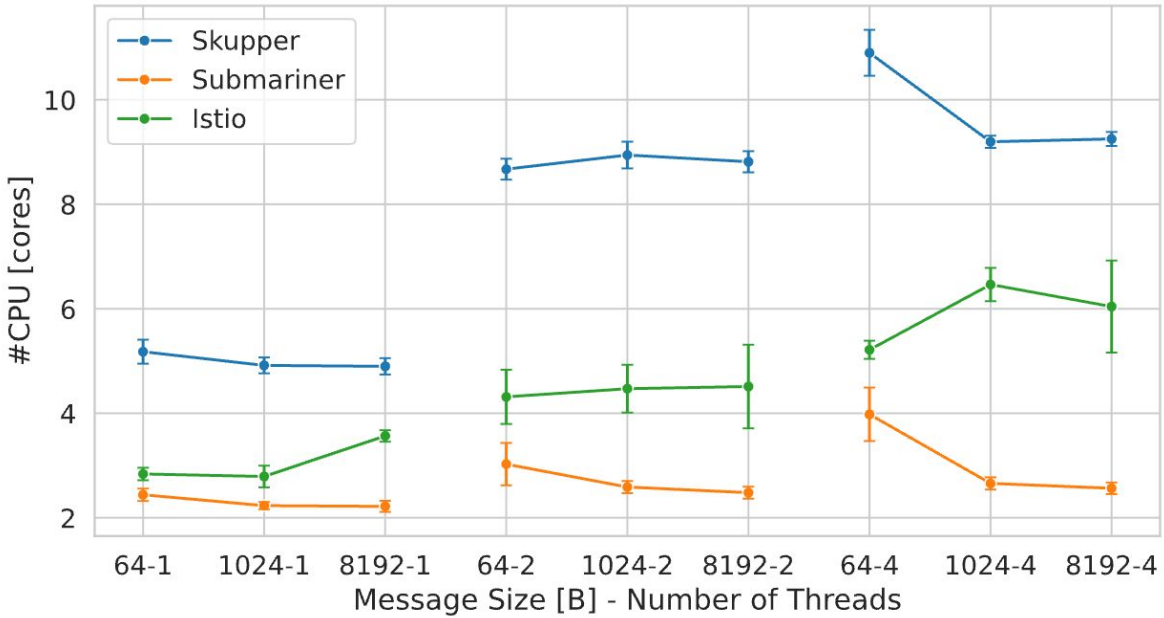
HTTP

10000 RPS, 100 connections, 2 threads, 1KB packet



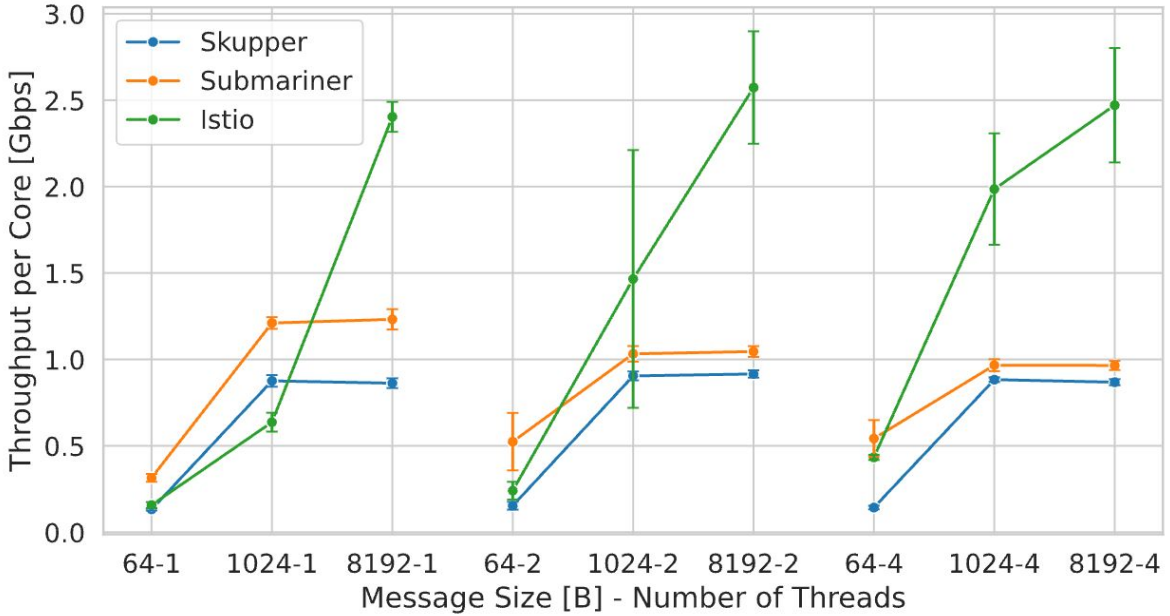
Submariner > Skupper > Istio

Resource consumption Overhead



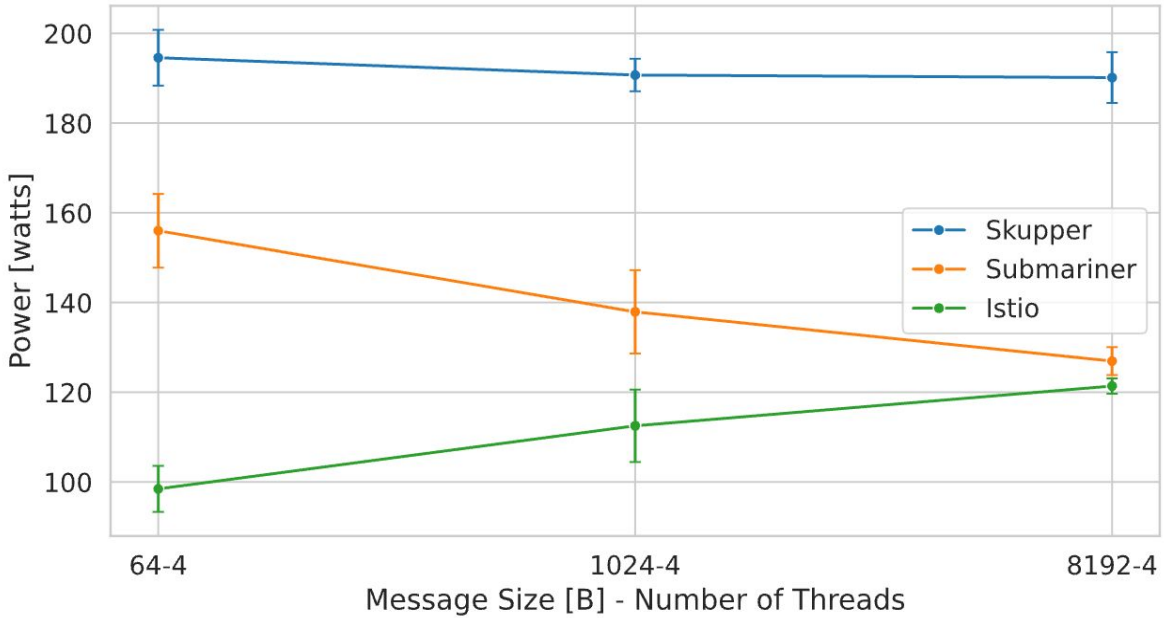
- Submariner is the most resource efficient, followed by Istio.
- Skupper consumes the most number of CPUs at all packet size/thread combinations

Normalized Resource Consumption



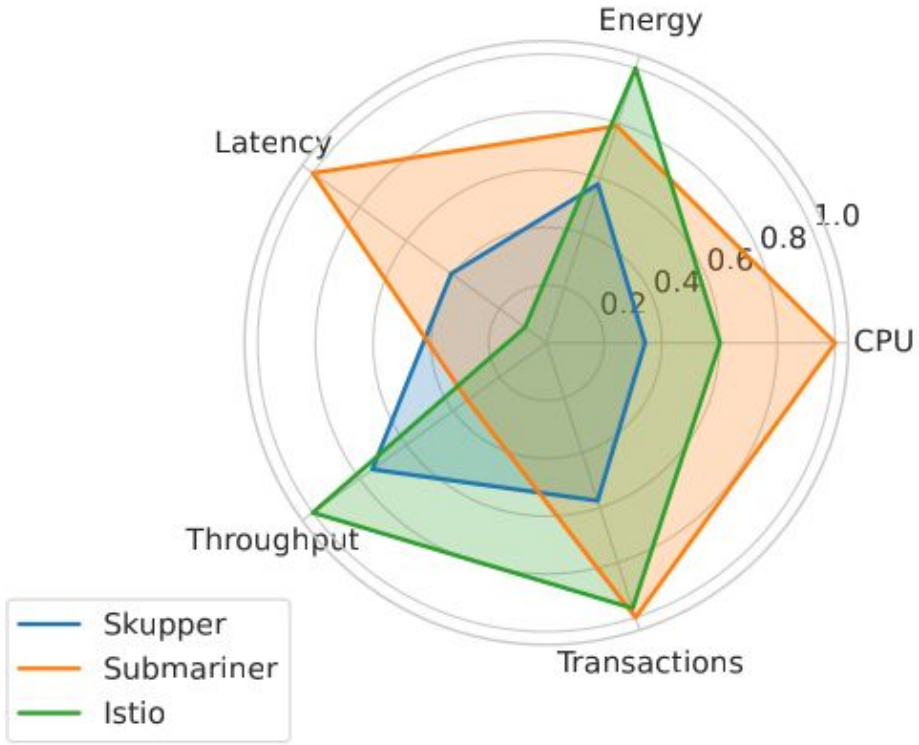
Istio and Submariner do better than Skupper on throughput per core

Power consumption



Higher CPU usage is correlated with higher power consumption

Bringing it all together



Future work

- Leverage real-world benchmarks involving messaging, databases, and applications based on microservices architecture
- Explore are key capabilities of the control plane
  - Service discovery time
  - Service failure time
- Scale the number of clusters under test

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