



# Highly Reliable Cloud Native DNS Service

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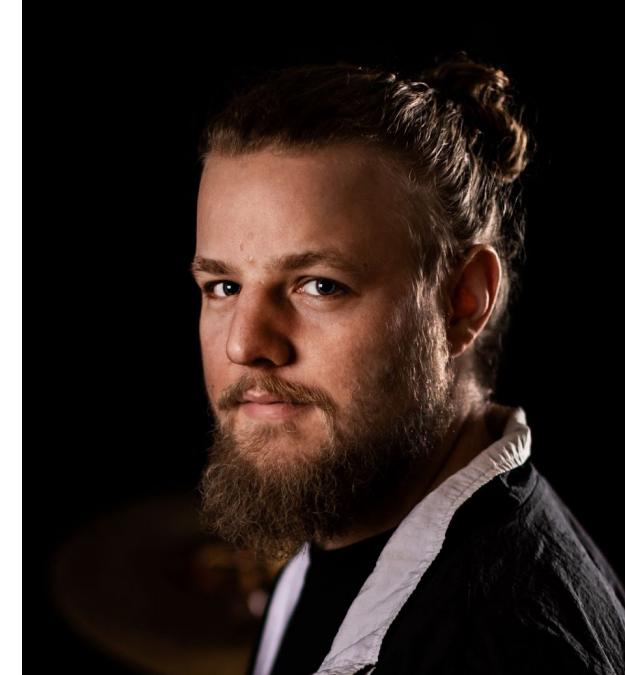
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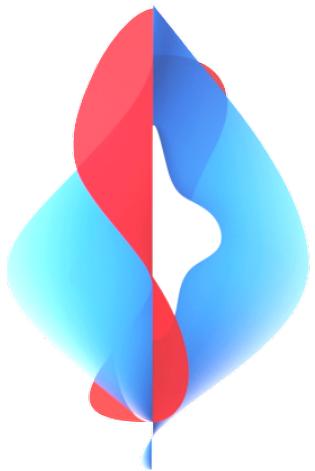
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**swisscom**



## Context & Related Talks

### 5G - driving our journey from Telco to TechCo

by Swisscom CTIO Mark Düsener at Connect Conference 2022

<https://www.youtube.com/watch?v=hND7TiXJED8>



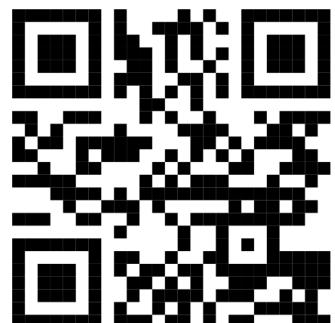
### Evolving GitOps: Harnessing Kubernetes Resource Model for 5G

by Alexander North, Ashan Senevirathne and Joel Studler at ContainerDays 2024

### How We Are Moving from GitOps to Kubernetes Resource Model in 5G Core

by Ashan Senevirathne and Joel Studler at KubeCon Europe 2024

<https://www.youtube.com/watch?v=crmTnB6Zwt8>





# DNS in 5G Core

**5G**

## Specific Private Zones

Domains used in Mobile Network only such as 3gppnetwork.org



## Moderate Throughput

10s to 100s of Requests/second



## Low Latency

DNS is an important factor in the overall performance of the Mobile Network



# Requirements for the 5G Core DNS Service



## Proximity to Consumer

Minimal amount of hops between 5G Core and DNS

X No SaaS allowed



## Fully Automated

GitOps driven and automated provisioning of DNS records

X No manual interaction allowed



## Geo Redundant & HA

Spread across multiple K8s clusters and geo regions to increase reliability

X No singletons



## Support of Advanced DNS features

Resource Records such as NAPTR and SRV supported for e.g. SIP Phone Calls

X Need to go beyond A and CNAME



## K8s integration with ExternalDNS

The System leverages Kubernetes Patterns such as CRs and Operators

X No CRUD outside kube-api



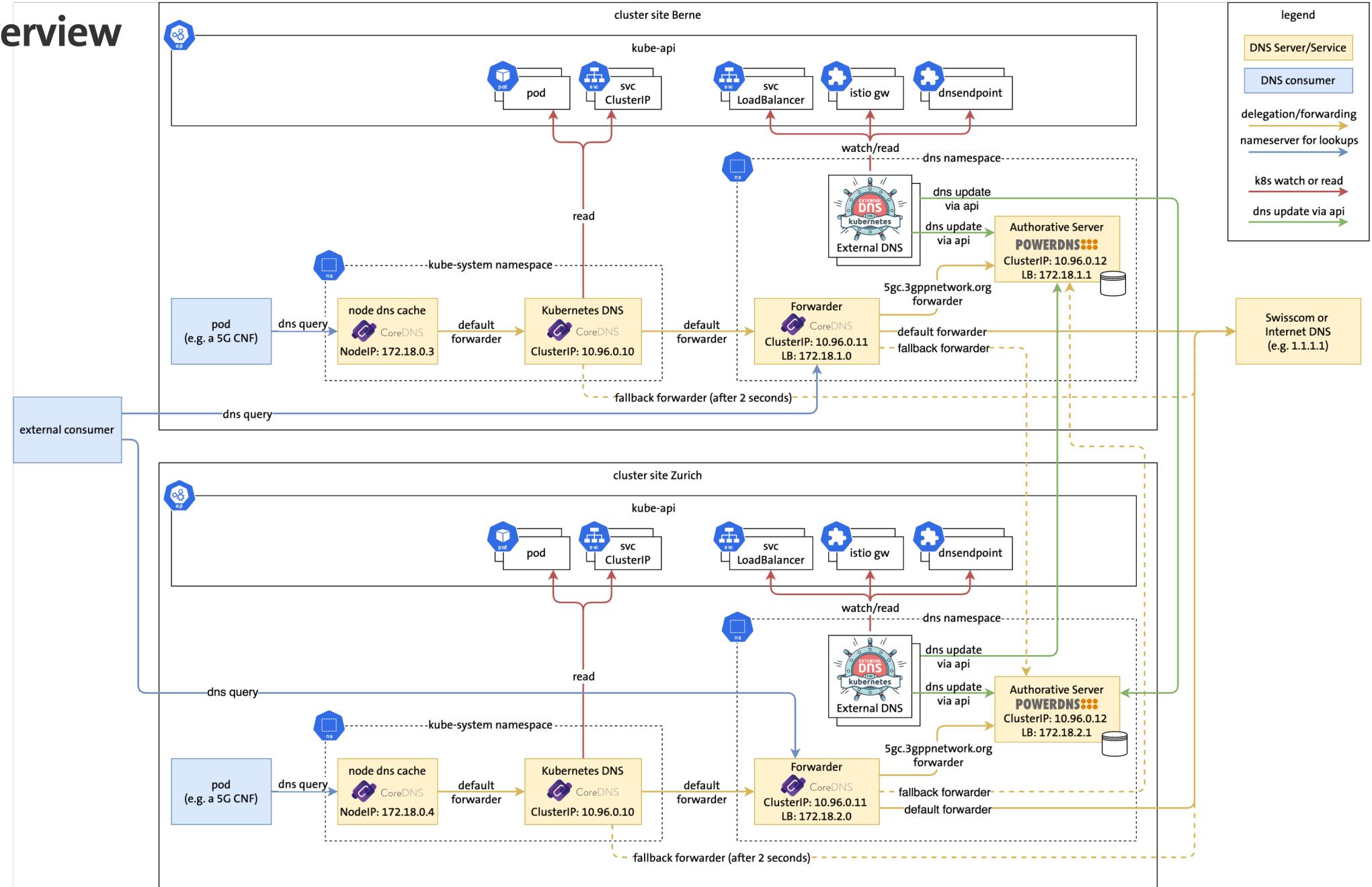
## Minimal Amount of SPOFs

Share nothing by removing single points of failure from the System

X No shared mgmt system

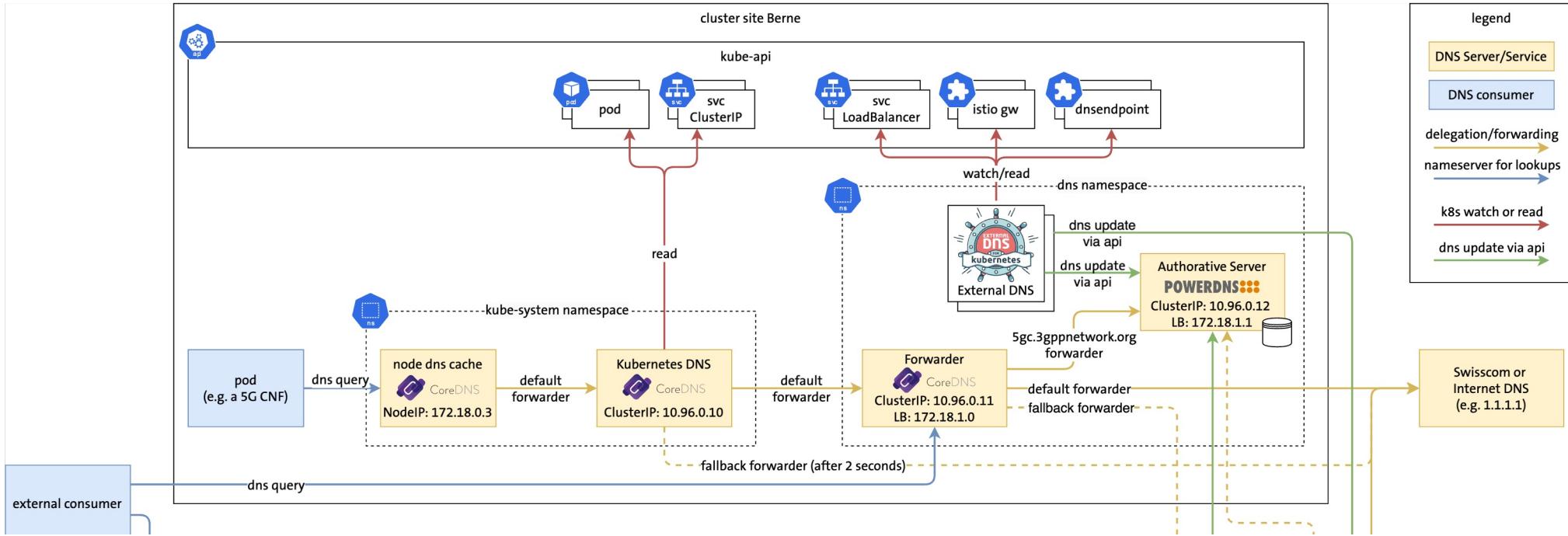


# Overview





# Overview





# In-Cluster Service Discovery in Kubernetes

CoreDNS (<https://coredns.io>)

kube-api as Backend

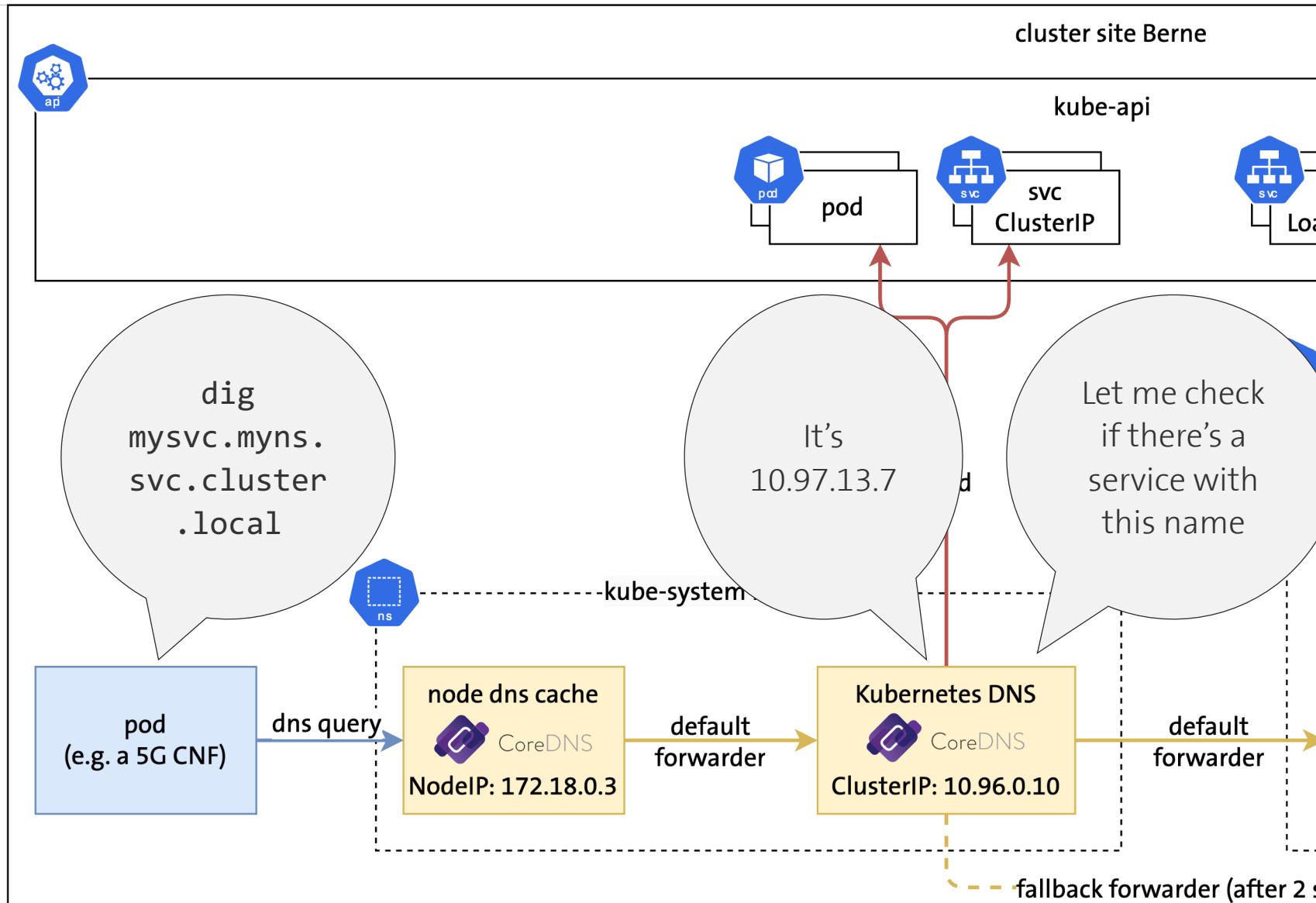
Features:

✓ In-Cluster Service Discovery

Missing:

X Not exposed outside of K8s

X No custom Resource Records





# In-Cluster Service Discovery in Kubernetes: Resources

Kubernetes DNS: <https://kubernetes.io/docs/concepts/services-networking/dns-pod-service>

Reserved ClusterIP Address assignment: <https://kubernetes.io/docs/concepts/services-networking/cluster-ip-allocation/#why-do-you-need-to-reserve-service-cluster-ips>

Node Cache: <https://kubernetes.io/docs/tasks/administer-cluster/nodelocaldns>

Debugging Kubernetes DNS: <https://kubernetes.io/docs/tasks/administer-cluster/dns-debugging-resolution>

Customize DNS Service: <https://kubernetes.io/docs/tasks/administer-cluster/dns-custom-nameservers>



# Requirements for Authoritative Server

## Requirement

ExternalDNS\* Support for K8s integration

A & CNAME Resource Records

NAPTR Resource Records (e.g. for SIP phone calls)

Proximity to Consumer



CoreDNS

CoreDNS **3**

POWERDNS 

PowerDNS **1**  
Authoritative

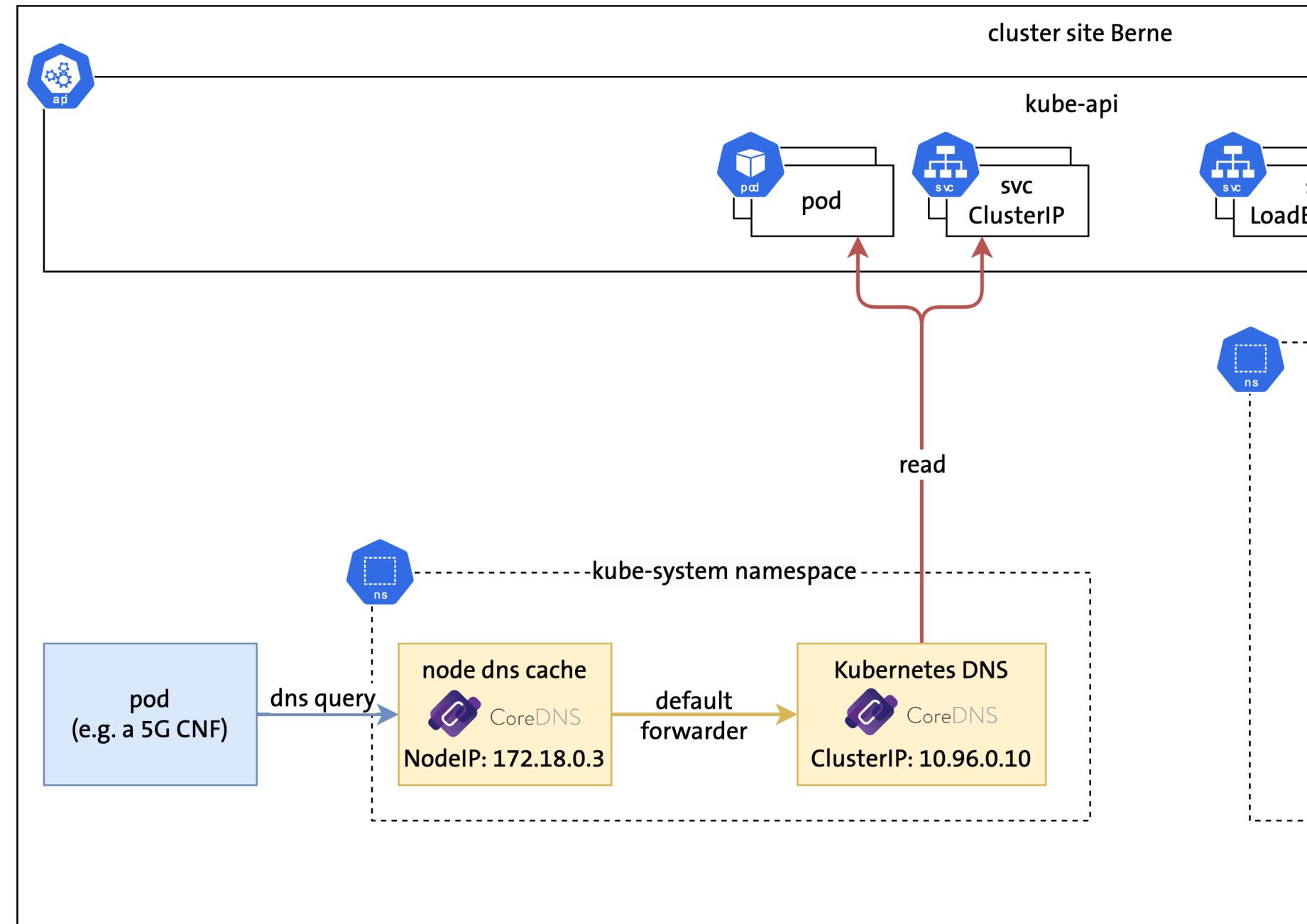


SaaS **2**

✓	✓	✓
✓	✓	✓
✗	✓**	✓**
✓	✓	✗

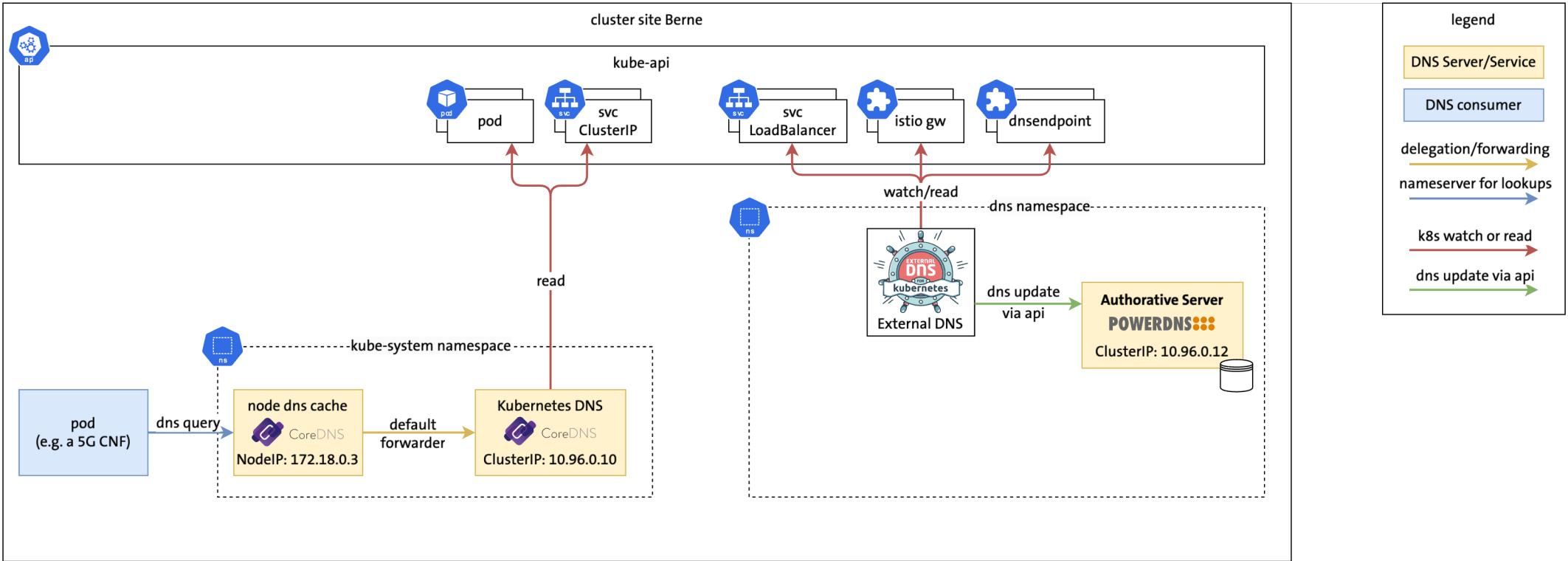
\* <https://github.com/kubernetes-sigs/external-dns>

\*\* After a fix in external-dns <https://github.com/kubernetes-sigs/external-dns/pull/4212>





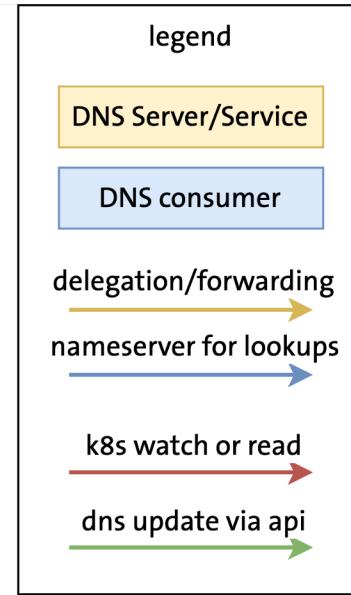
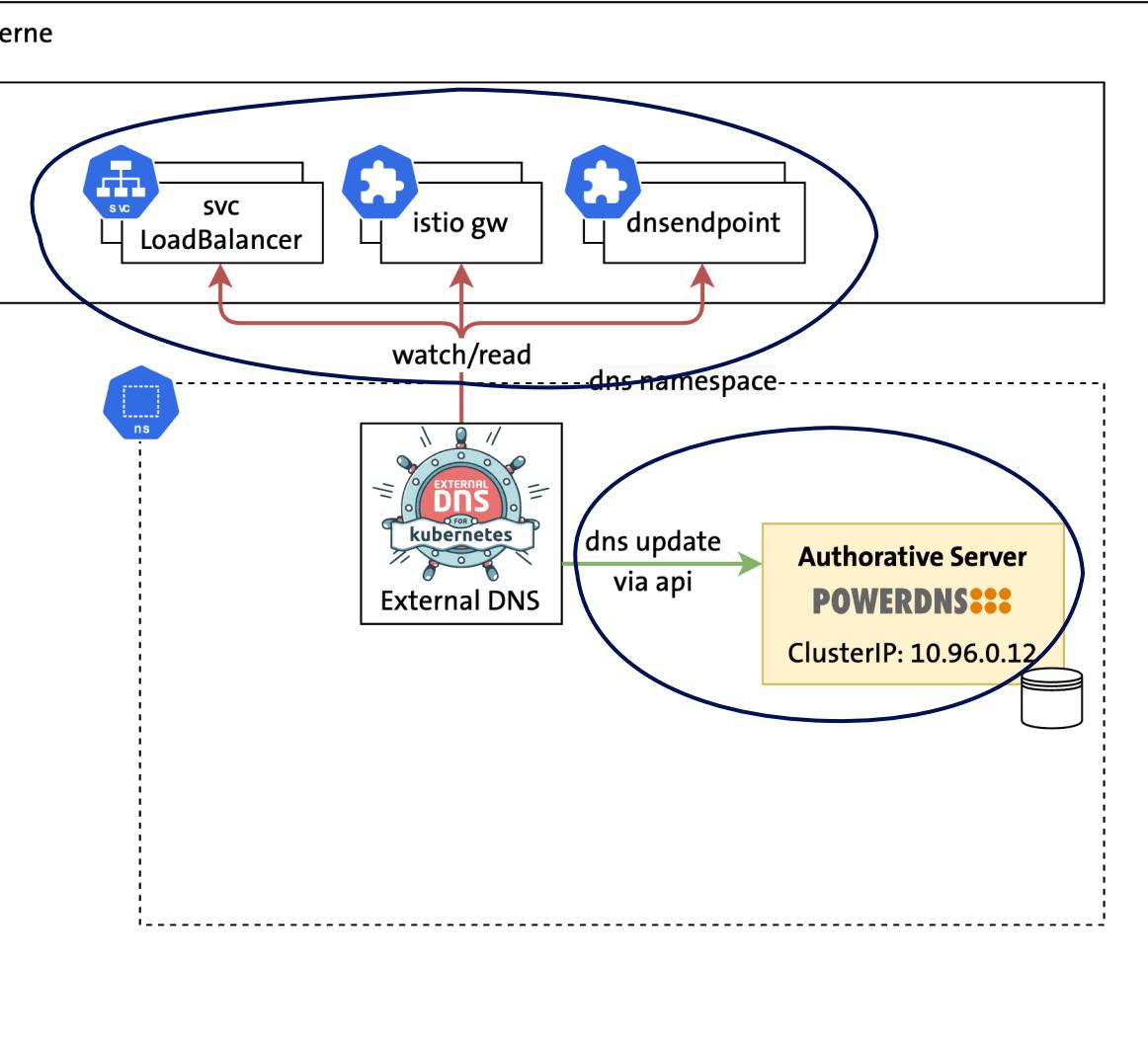
# Overview





# Automation of Authoritative Server using ExternalDNS

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ExternalDNS <https://kubernetes-sigs.github.io/external-dns>

- Any Resource Record defined in «DNSEndpoint» CR
- Synchronisation with Resource Records as Kubernetes CRs to backends, e.g, PowerDNS Authoritative server.

Type A Records using Annotations

- Name definition via Annotation
- IP fetched from Service/Ingress status field



# ExternalDNS State management: GitOps + Kubernetes



```
apiVersion: v1
kind: Service
metadata:
  annotations:
    external-dns.alpha.kubernetes.io/hostname: my-app.example.com
  name: my-app
spec:
  ports:
    - name: http
      port: 80
      protocol: TCP
      targetPort: 80
  selector:
    name: my-app
  type: LoadBalancer
```

DNS Name  
defined in git



```
apiVersion: v1
kind: Service
metadata:
  annotations:
    external-dns.alpha.kubernetes.io/hostname: my-app.example.com
  name: my-app
spec:
  ports:
    - name: http
      port: 80
      protocol: TCP
      targetPort: 80
  selector:
    name: my-app
  type: LoadBalancer
status:
  loadBalancer:
    ingress:
      - ip: 192.168.0.35
```

IP read by  
ExternalDNS

ExternalDNS creates

DNS Backend:  
my-app.example.com. 3600 IN A 192.168.0.35



Berne

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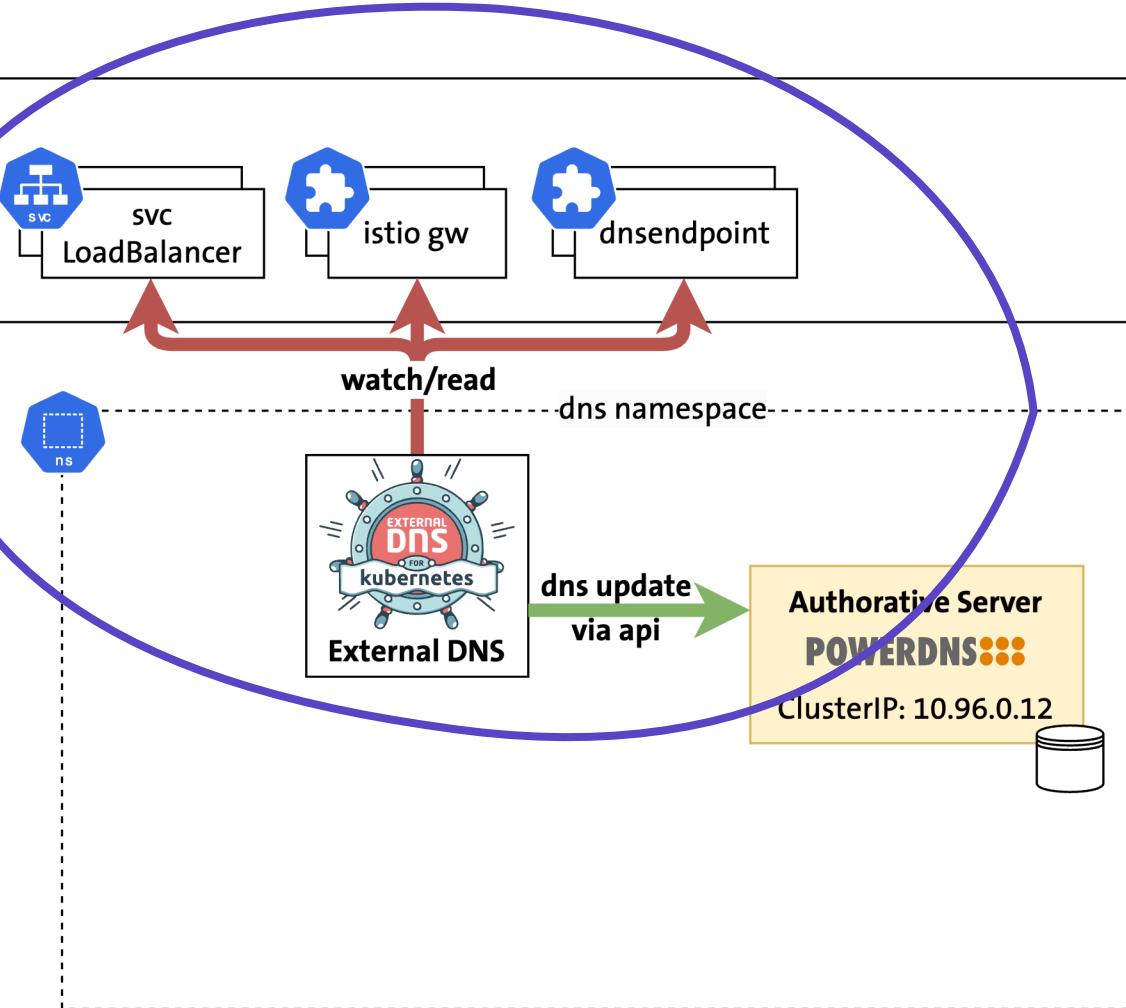
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s

ns

vc

SVC

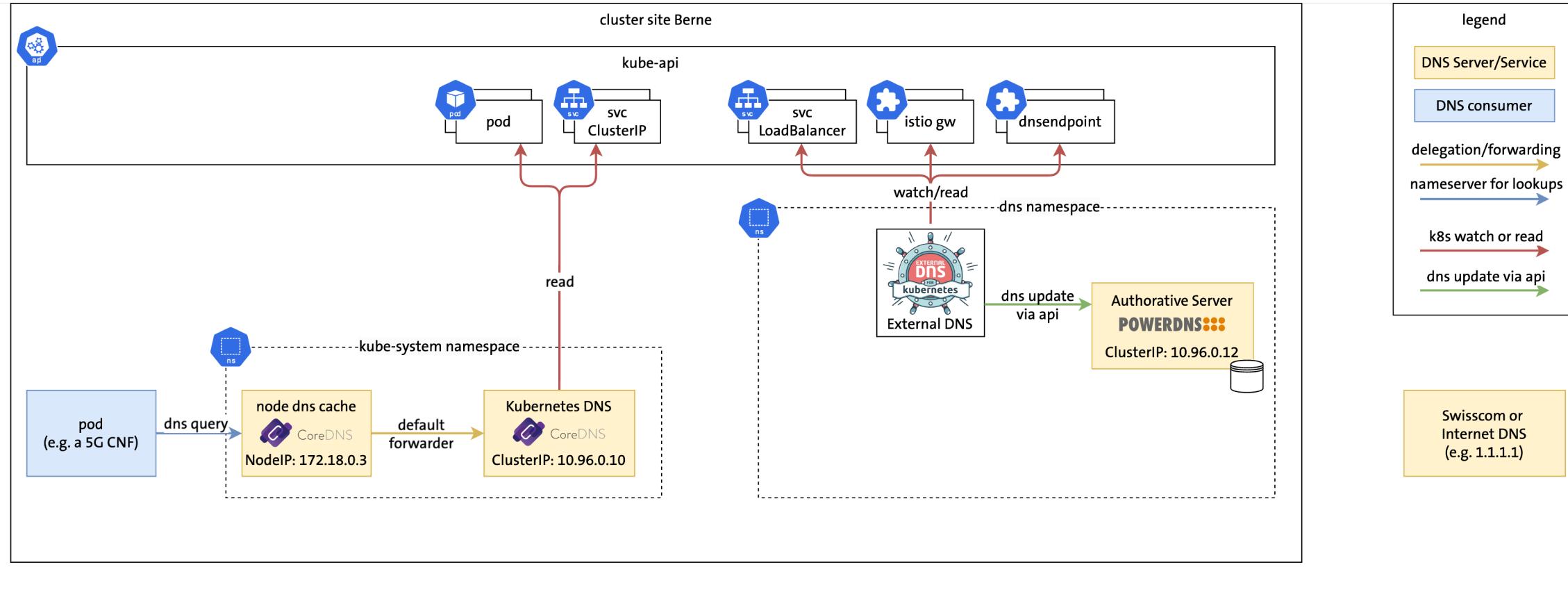


# Demo ExternalDNS + PowerDNS Single Cluster



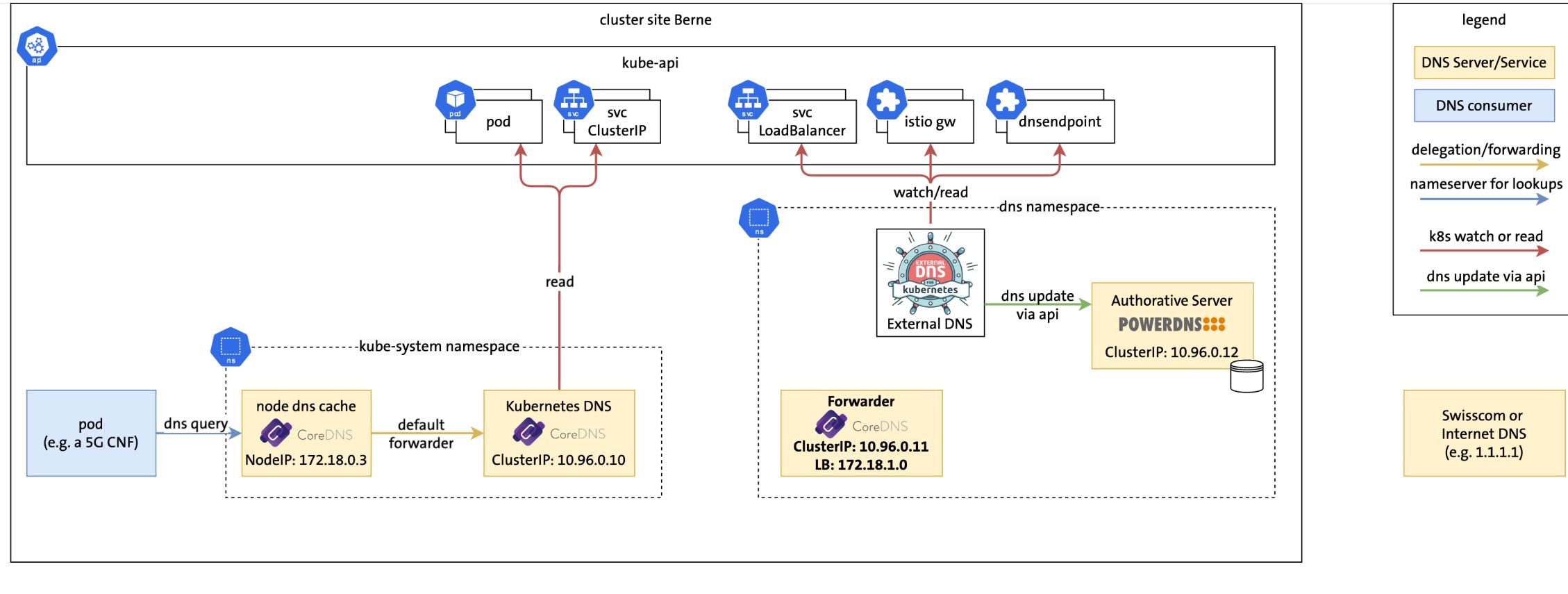


# Forwarding to Authoritative Server



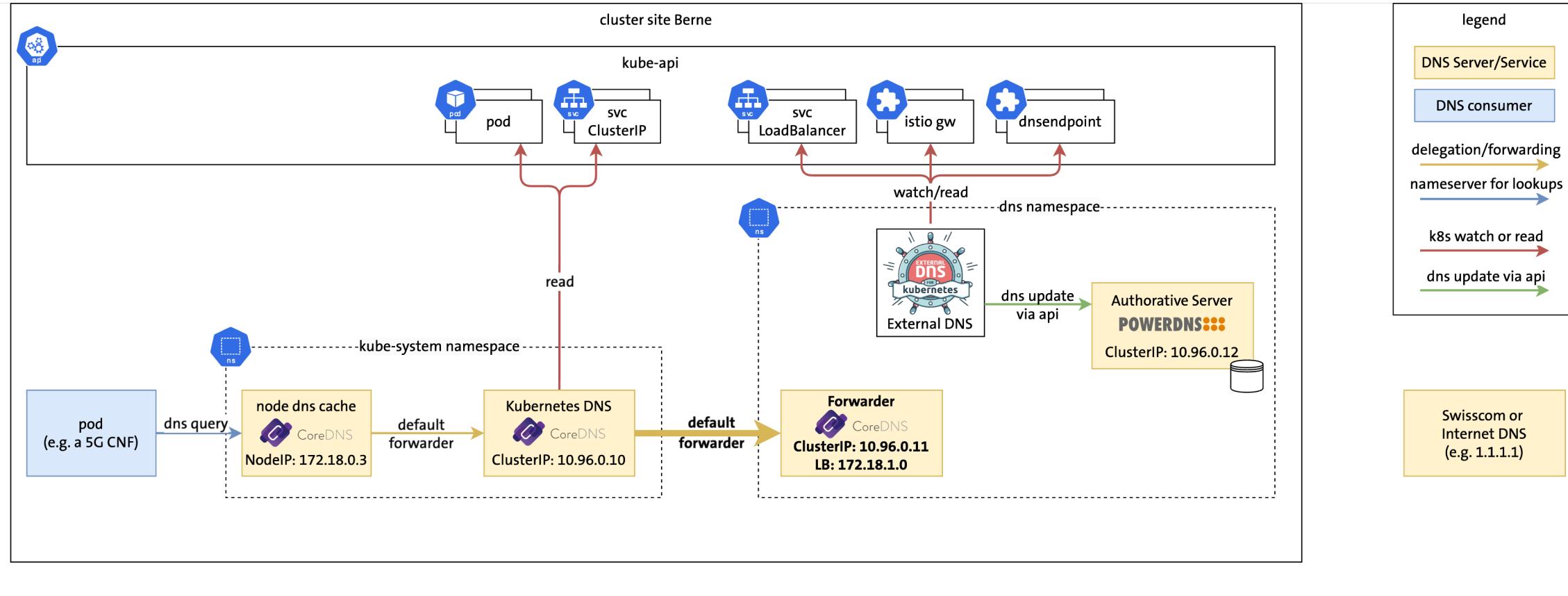


# Forwarding to Authoritative Server



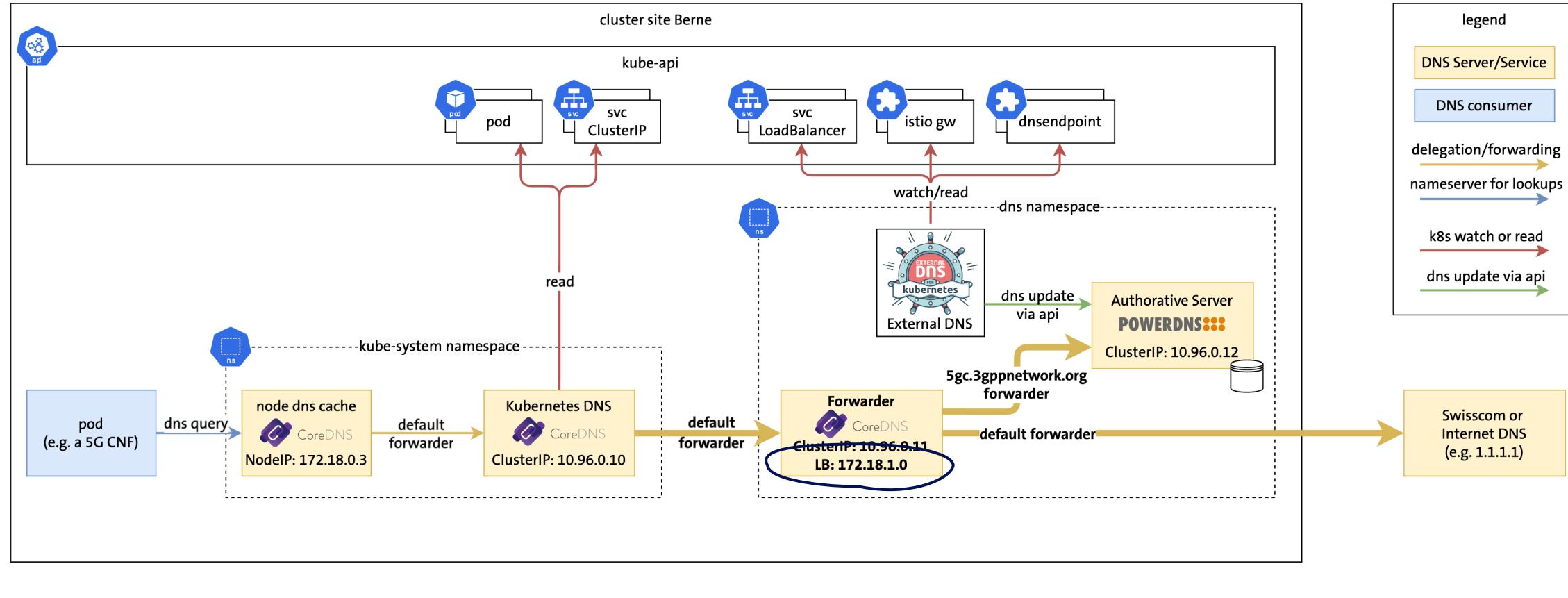


# Forwarding to Authoritative Server



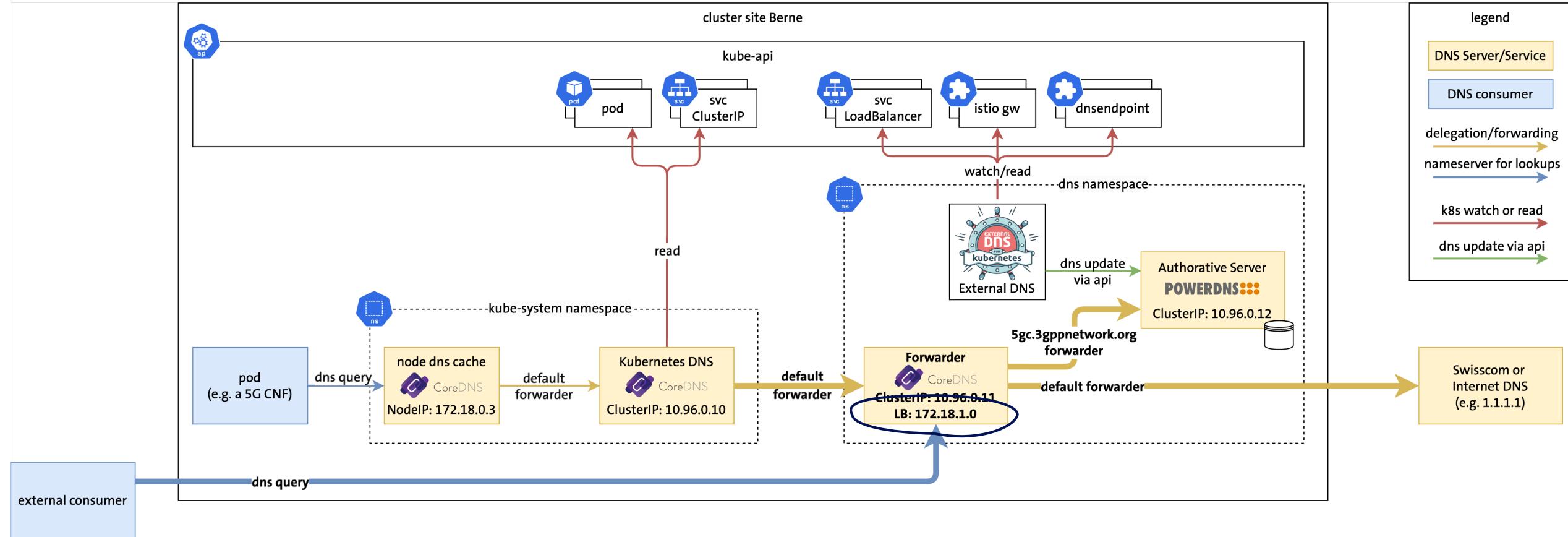


# Forwarding to Authoritative Server

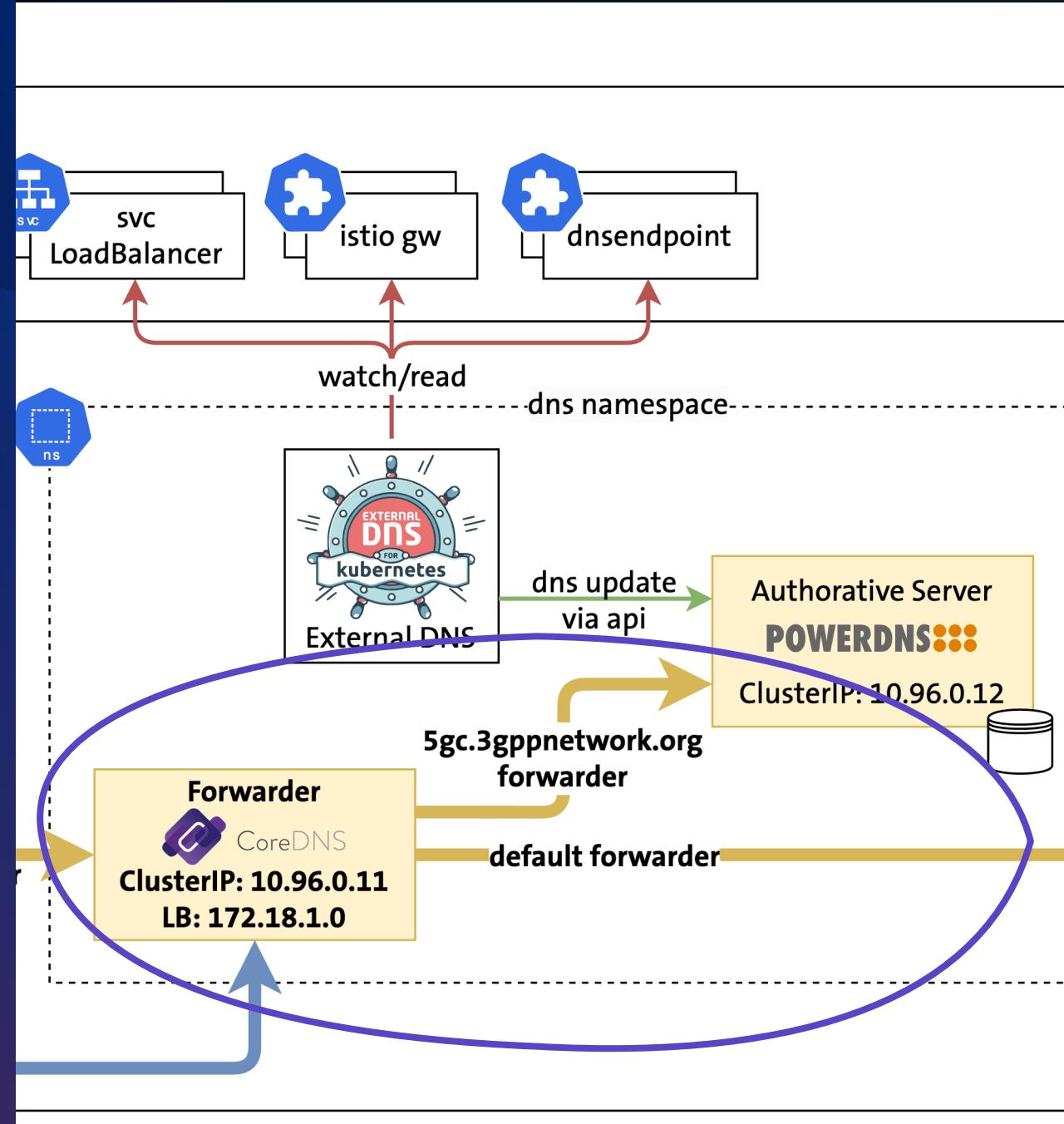




# Forwarding to Authoritative Server

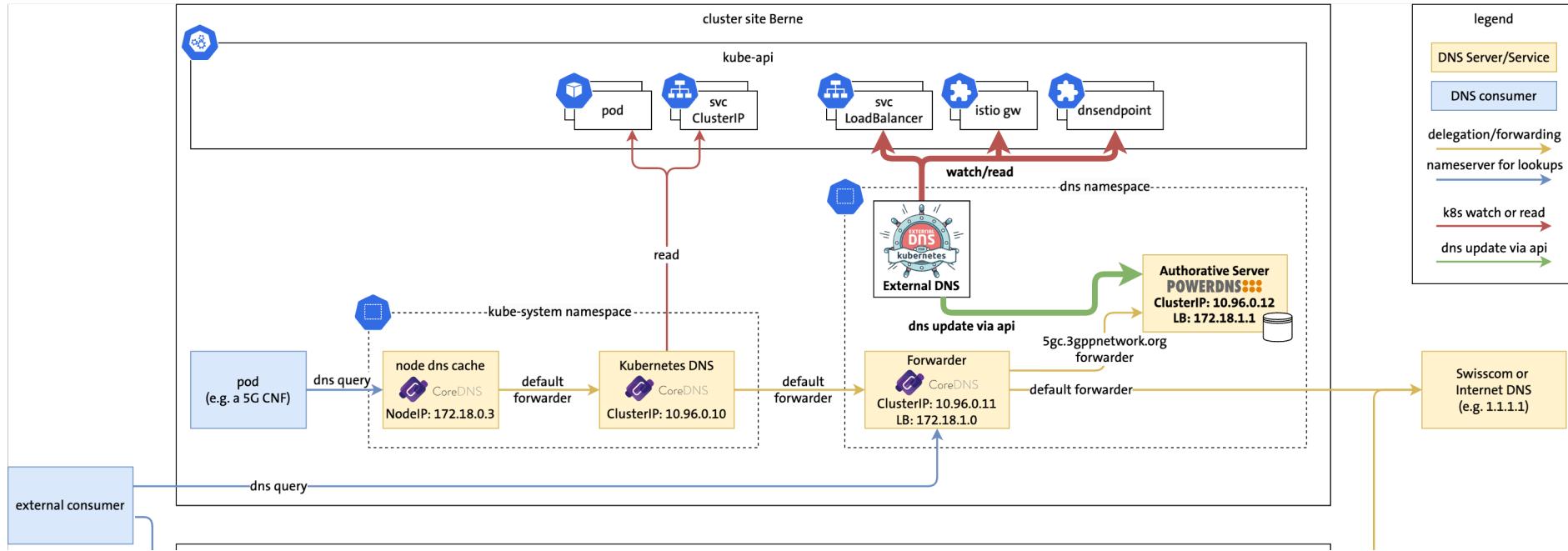


# Demo Forwarding



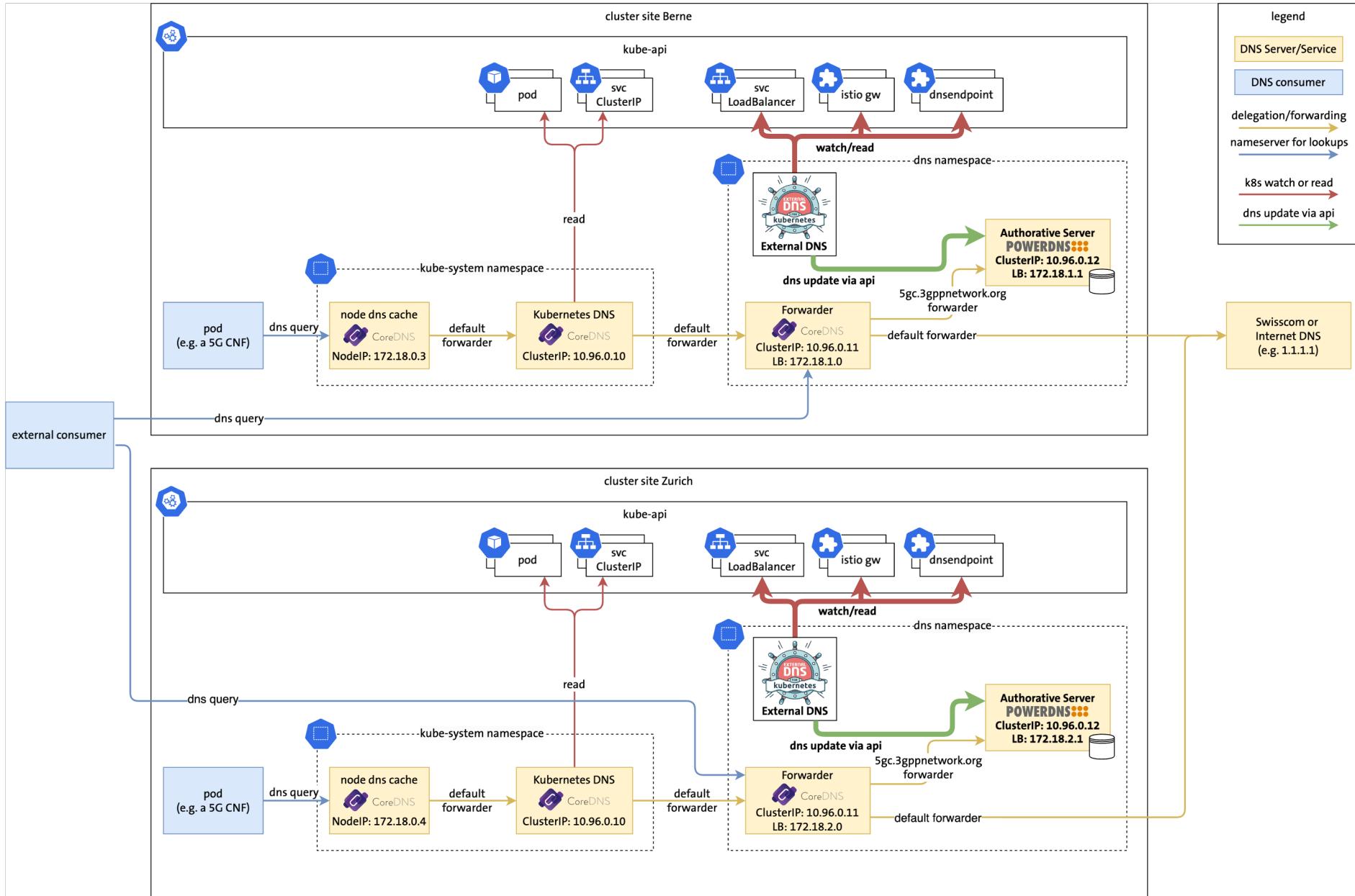


# Dual-Cluster using ExternalDNS



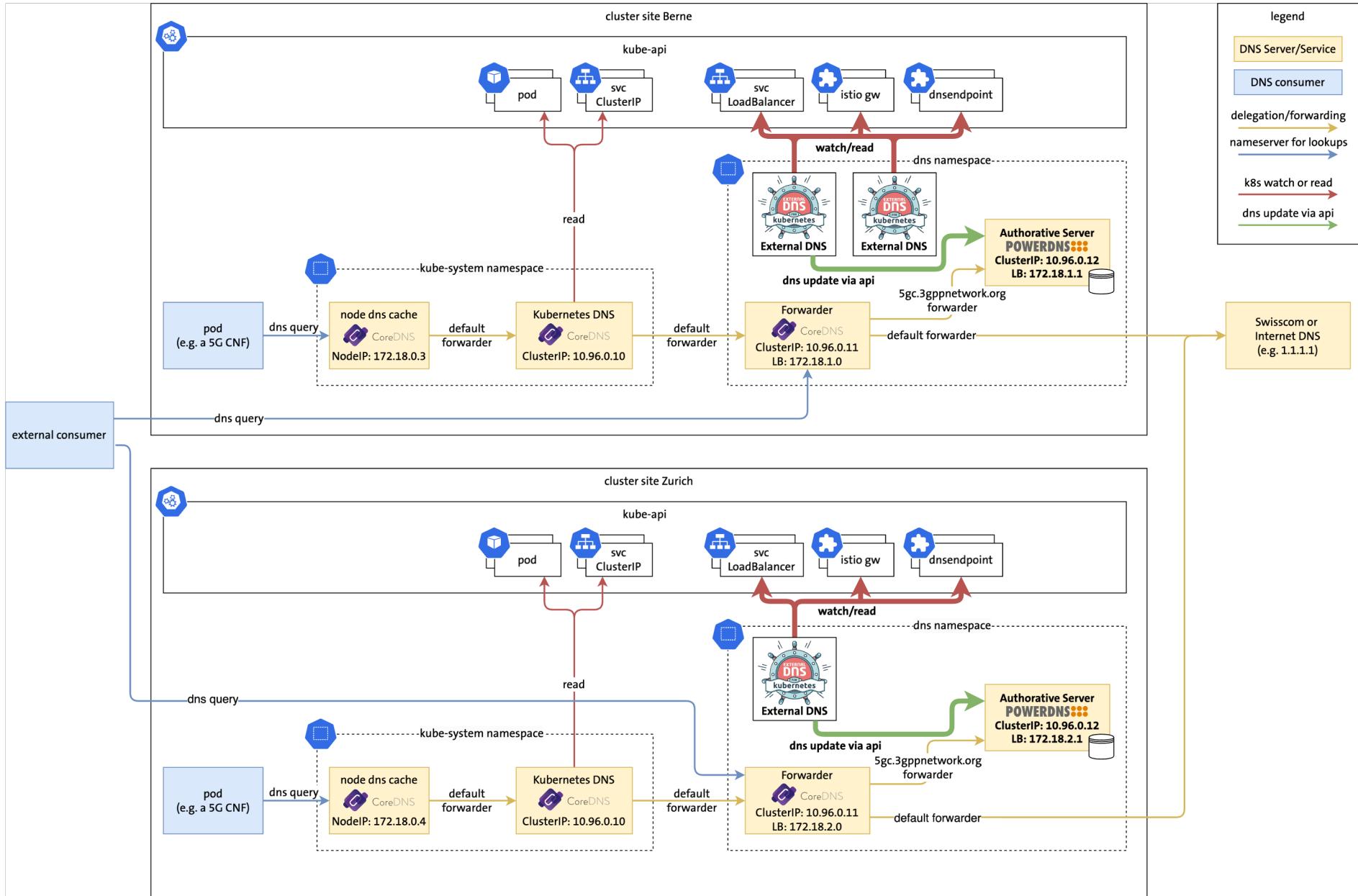


# Dual-Cluster using ExternalDNS



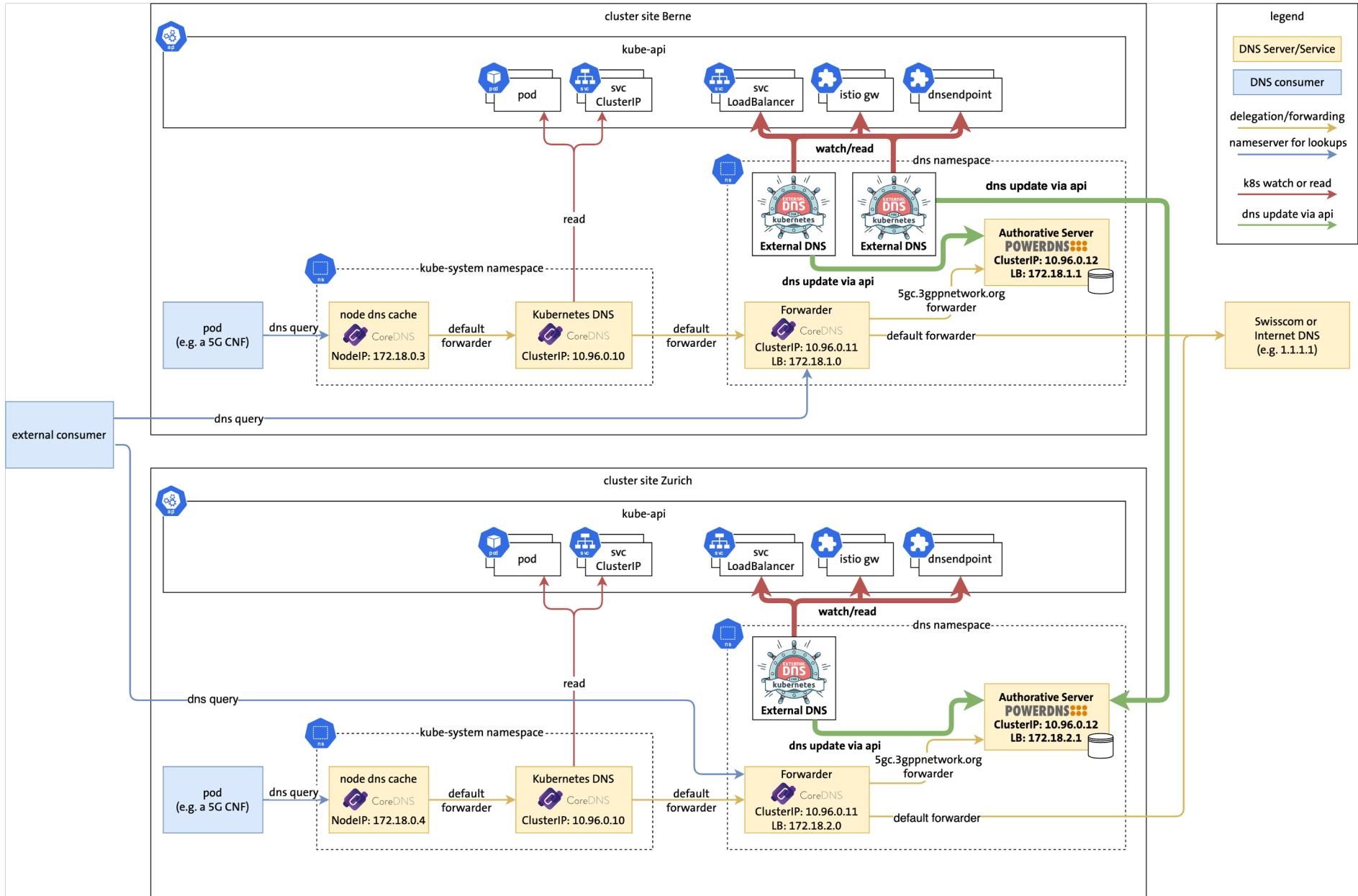


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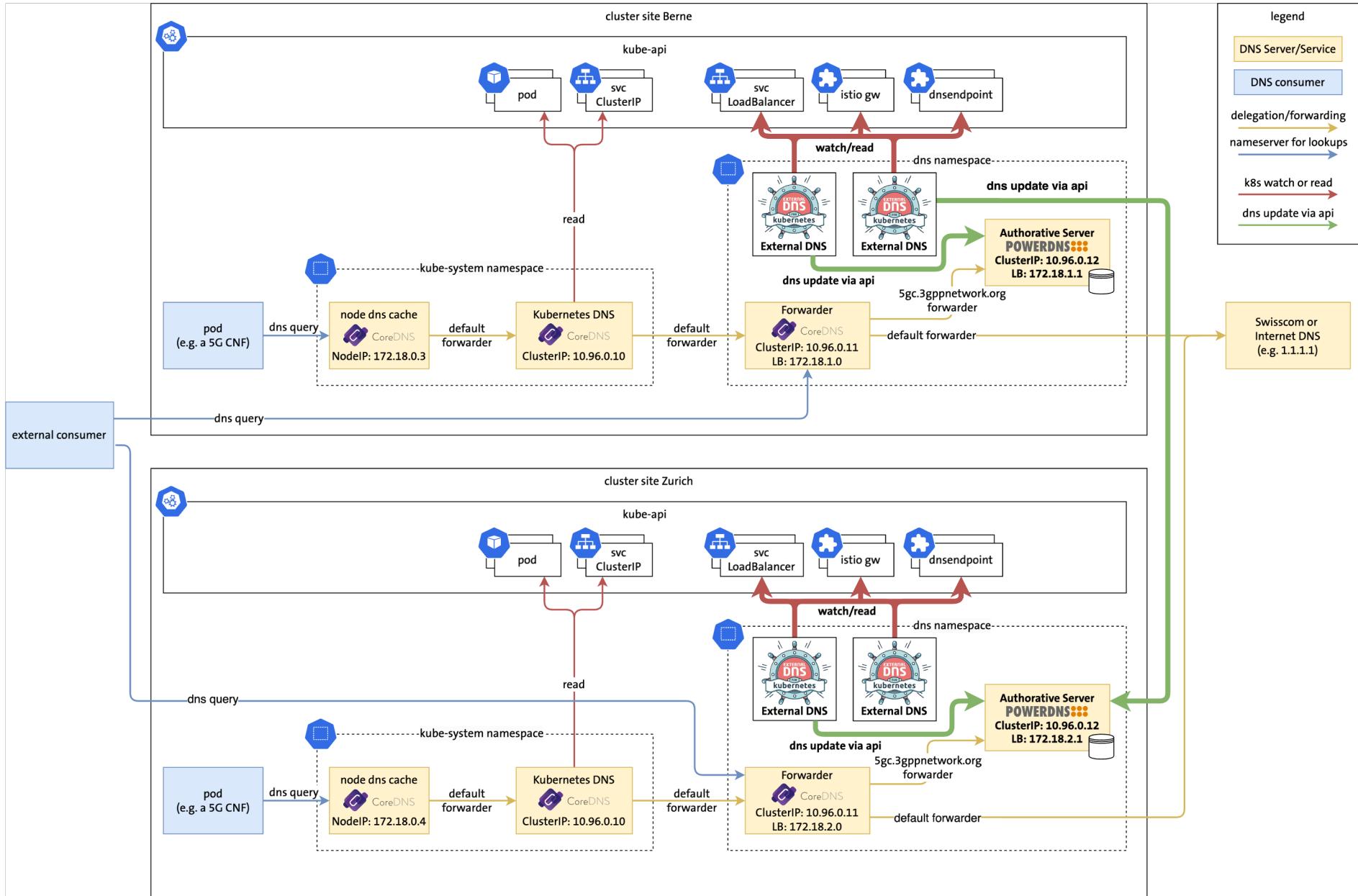


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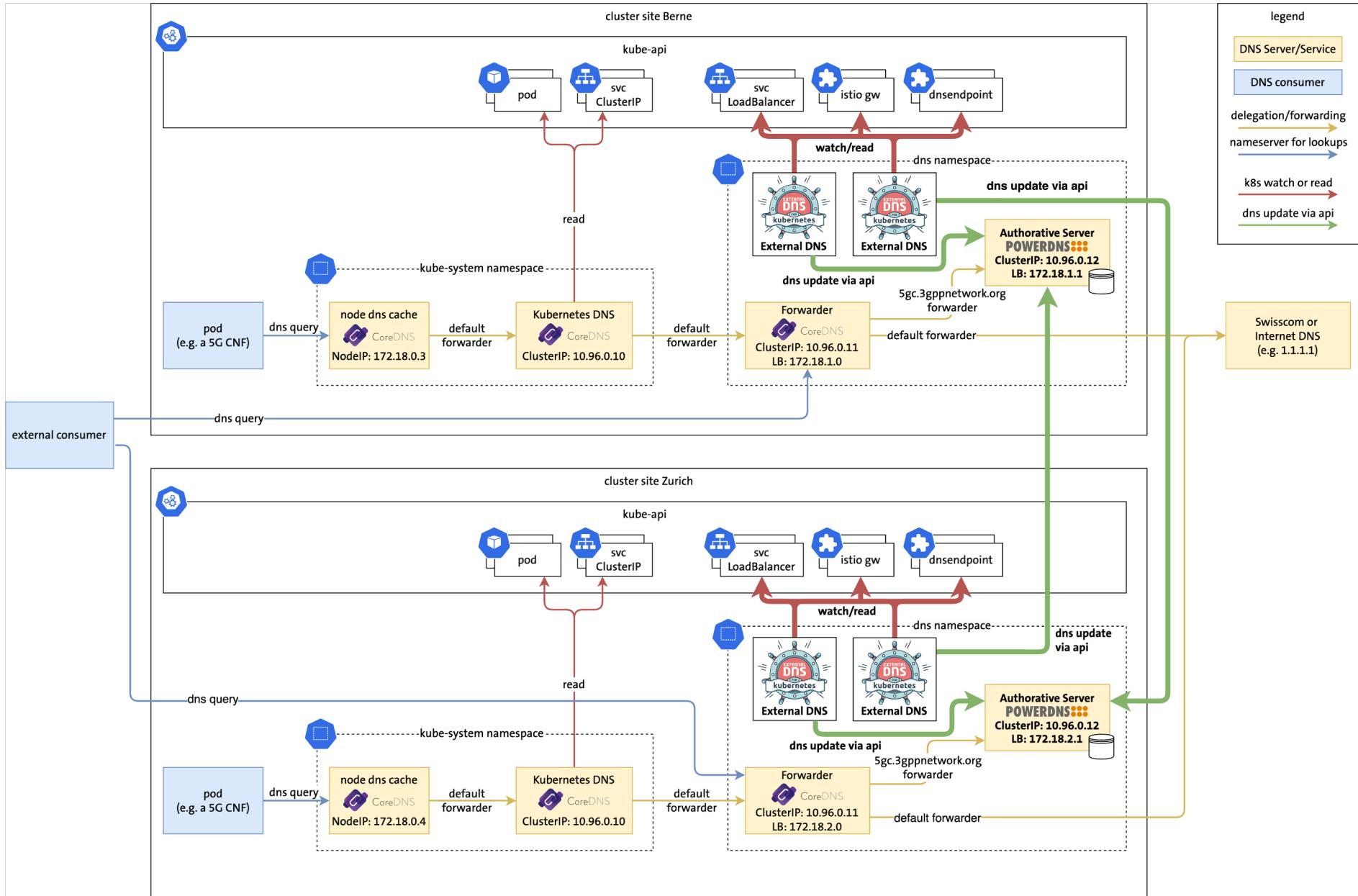


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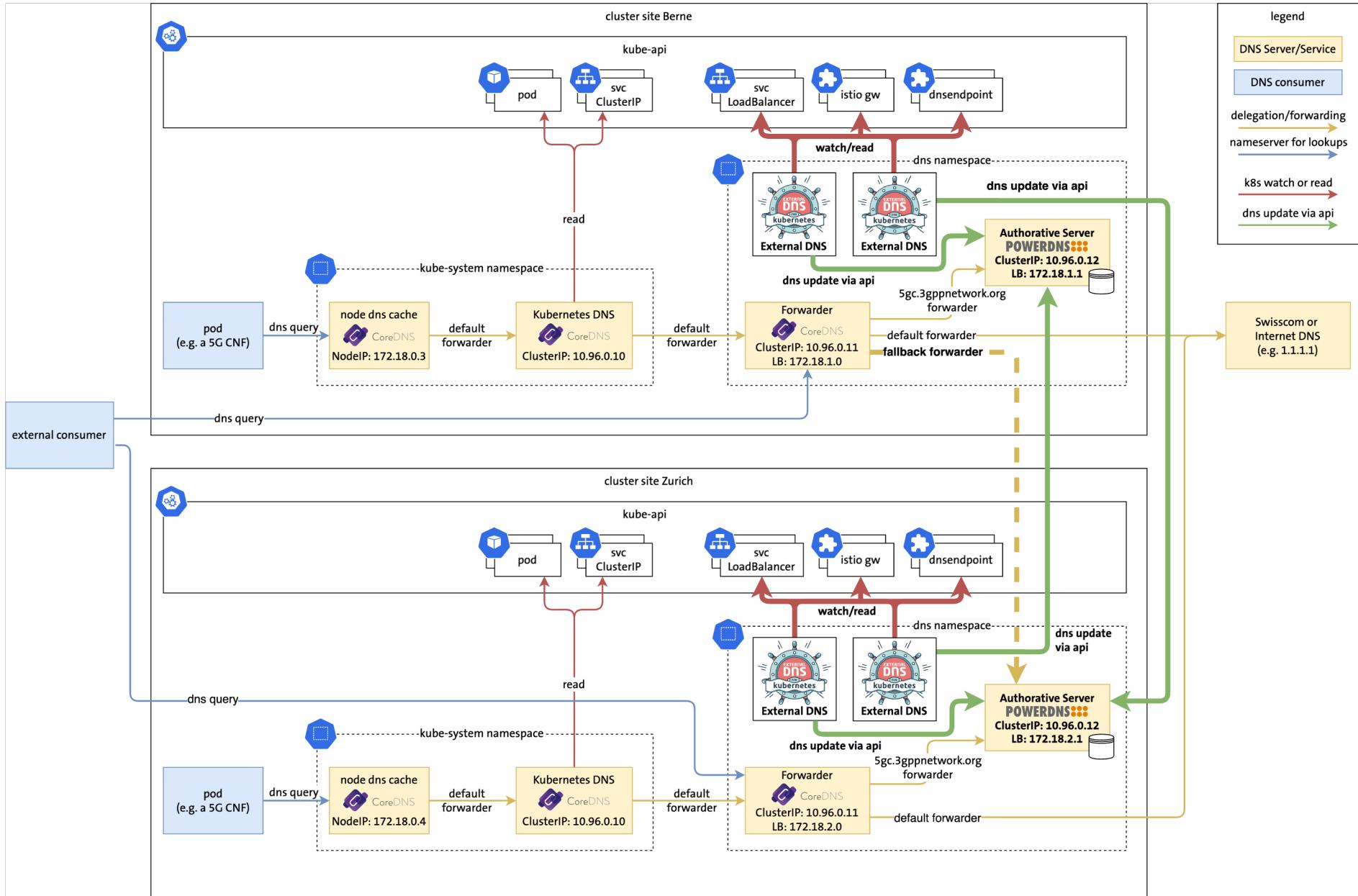


# Dual-Cluster using ExternalDNS



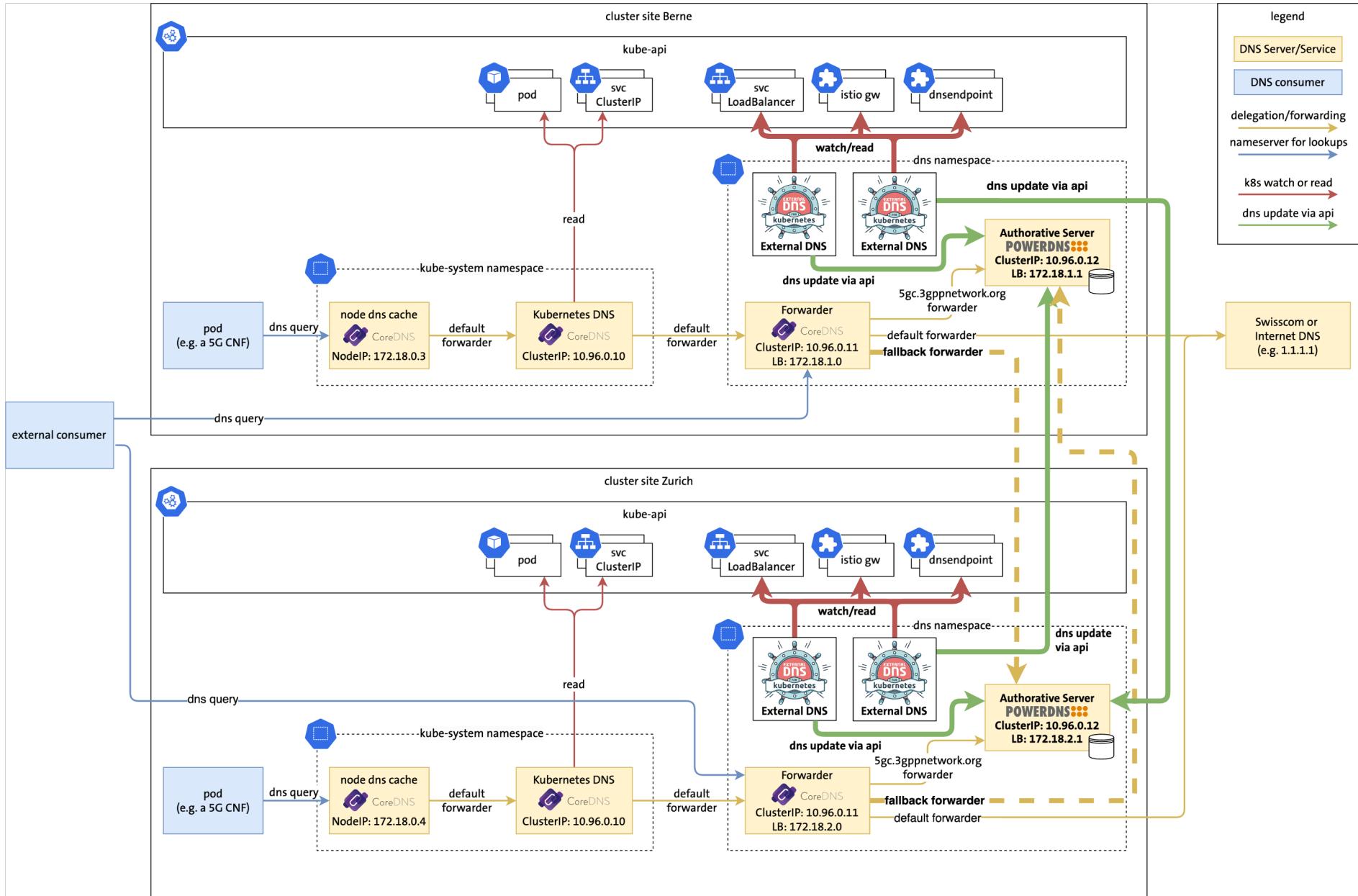


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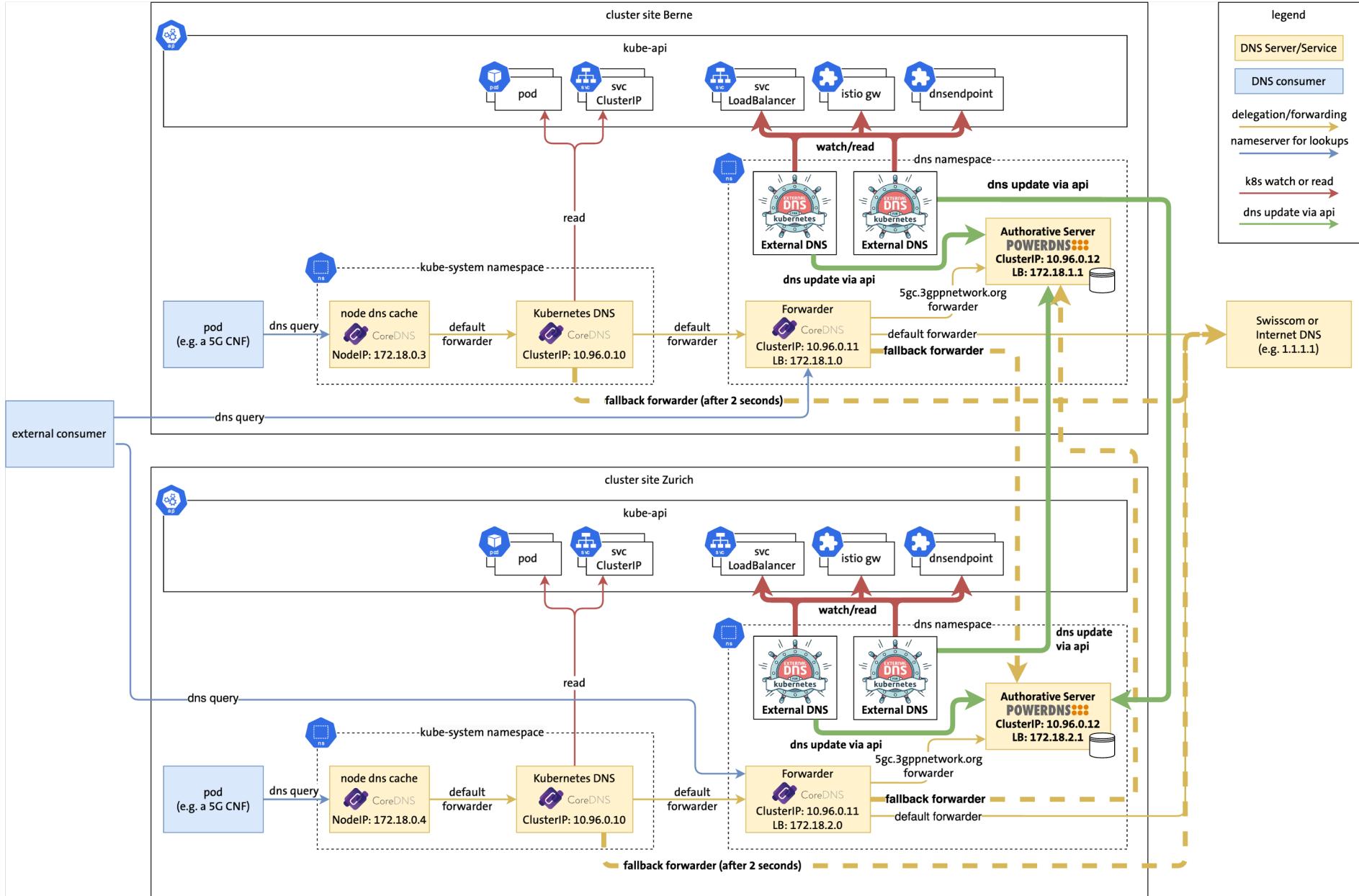


# Eliminating Single Point of Failure

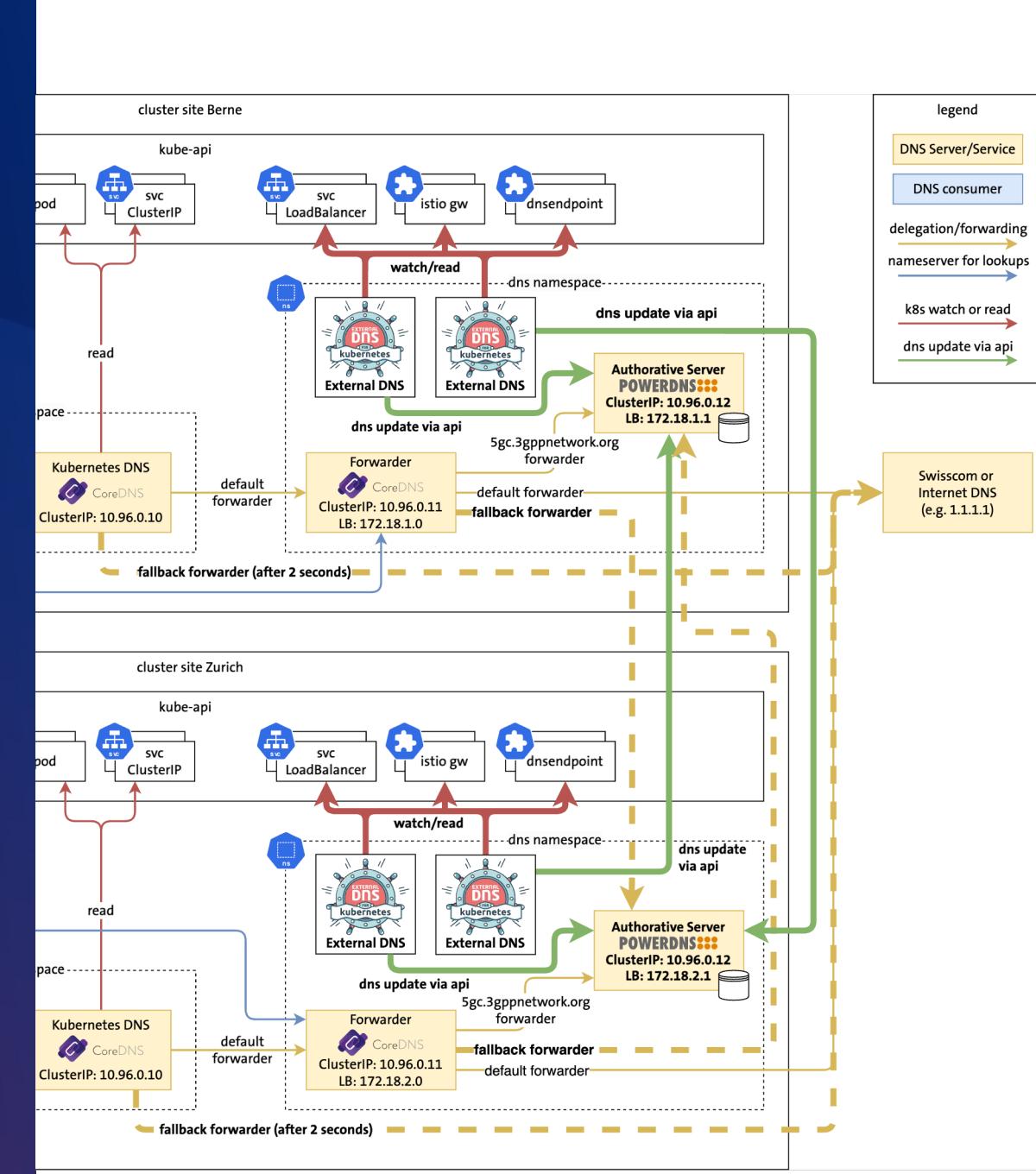




# Eliminating Single Point of Failure



# Demo Multi Cluster





## Limitations of our DNS Service



### **Self-dependence**

Complexity increases when consuming the Service from within the same clusters.



### **Kubernetes Resources only**

Limited to Kubernetes Resources and GitOps



### **Service Discovery**

ExternalDNS not suited for service discovery



# Limitations of ExternalDNS: Service Discovery

Interval-Based Syncing due to architectural decisions

- ⚠ Delayed Resource Record creation

No Health Checks (e.g. integration into [Kubernetes Services/EndpointSlices](#))

- ⚠ Cannot rely on ExternalDNS for app readiness

No Multi Cluster Round Robin for A records: one record cannot be shared by multiple ExternalDNS

- ⚠ Cannot use DNS records created by ExternalDNS for routing across multiple clusters

Full cluster outage will not revoke DNS records

- ⚠ Tight monitoring and additional automation needed to avoid outages



# What did we achieve?



## Proximity to Consumer

Minimal amount of hops between 5G Core and DNS

✓ On-prem deployment



## Fully Automated

GitOps driven and automated provisioning of DNS records

✓ GitOps + ExternalDNS



## Geo Redundant & HA

Spread across multiple K8s clusters and geo regions to increase reliability

✓ Spread across multiple K8s Clusters



## Support of Advanced DNS features

Resource Records such as NAPTR and SRV supported for e.g. SIP Phone Calls

✓ Advanced RRs supported



## K8s integration with ExternalDNS

The System leverages Kubernetes Patterns such as CRs and Operators

✓ 100% Kubernetes Resources



## Minimal Amount of SPOFs

Remove single points of failure from the System

✓ Distributed control plane



# Thanks!





# Q&A

